Prolonged Field Care

A grounded theory of mitigating risks to health in remote environments

Thesis submitted for the degree of

DOCTOR OF PHILOSOPHY

Risk and Disaster Reduction

Myles Harris

UCL

Institute for Risk and Disaster Reduction

2023

Declaration

I, Myles George Harris, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Total word count (excluding references and appendices): 98,957.

Signature: *Original signed.*

Date: *Original dated*.

Acknowledgements

Firstly, I would like to thank Professor Ilan Kelman, whose supervision and mentorship has been immeasurably valuable. Thank you for encouraging me to develop as an academic and for always being there to provide guidance.

Thank you to my friends and colleagues at UCL Institute for Risk and Disaster Reduction for the most enjoyable PhD experience that I could have hoped for. Thank you for welcoming me and for sharing your world-renowned expertise so openly. I greatly admire you all and your work.

Thank you, also, to my friends and colleagues across UCL. It has been an immense privilege to learn in such a multidisciplinary, inclusive environment. I will look back at my PhD experience at UCL with the greatest fondness.

I would like to thank Group Captain Professor Di Lamb and her colleagues from the MoD Royal Centre for Defence Medicine. I am incredibly fortunate to have had such a supportive and motivating subsidiary supervisor.

Thank you to Mathew Davies, the director of Remote Area Risk International (R2Ri) and the Institute for Remote Area Risk and Medicine (IRARAM), for his enthusiasm and unquestionable drive to improving risk management and health care in remote environments. Thank you to all the faculty at R2Ri and IRARAM, especially Dr Pete Bradley for his passion of remote medical care.

I sincerely thank my friends and family for their support throughout my PhD. I am forever grateful for you being there and for your belief in me, which has meant more to me than I could ever put into words. Thank you.

Lastly, I would like to sincerely thank and dedicate this thesis to my parents, who have generously supported me in so many ways. Their life-long commitment to the service of others has taught me –

Do not only practice your art, but force your way into its secretes,
for it and knowledge can raise people to the Devine.
Ludwig van Beethoven.

Abstract

The United Nations predicts that, despite a rise in urbanisation, by the year 2050 there will be up to 3.1 billion people living in a remote environment. All of these people will have health needs; however, this figure does not include people who travel through, or who are caught in remote environments. Moreover, they are exposed to health risks associated with the hazards and challenges of providing healthcare in remote environments. This research aims to make an original and significant contribution to knowledge of how prolonged field care (PFC) mitigates risks to health in remote environments.

The defining features of remote environments that are included in the context of this research are they have no access to health services, there is limited resources, and communication is unreliable, so the risk of delayed evacuation caused by challenging conditions is exacerbated. The identified research gap is an explanatory, evidence-based theory of how PFC can be used to mitigate risks to health in remote environments. Thus, the question for this research is, “What is an explanatory, evidence-based theory of how PFC mitigates risks to health in remote environments?”

Grounded theory was used to achieve the research aim and answer the research question. The theoretical finding is a PFC grounded theory, which emerged from analysing data from semi-structured interviews of research participants with experience of PFC in remote environments. The PFC grounded theory was methodologically and empirically tested, which provided greater depth to this research. The methodological test was conducted during the planning of analogue mission that simulated the human exploration of another planet. The simulation was achieved during the empirical test, which took place on a remote and uninhabited island in Scotland that had similarities with the remoteness of another planet. A cross-country skiing expedition provided another case study for the empirical test.

Impact statement

This impact statement identifies how the content of this thesis has the potential to deliver impact for public benefit – a positive effect on people and their livelihoods from the theoretical, methodological, and empirical contributions to knowledge. Potential benefits within and outside academia are identified. How these benefits may be brought about is also presented for consideration.

An impact within academia is an original and significant contribution to health and risk disciplines in remote environments. The contribution is an explanatory, evidence-based theory of how PFC can mitigate risks to health in remote environments – a PFC grounded theory. Research impact can be brought about through conference presentations and scholarly journal publications to inform clinicians, policy-makers, and educators about mitigating risks to health in remote environments. This may benefit people in remote environments by reducing the risks of illness and injury, thus protecting and promoting their health. An example of an impact is contributing to the Royal College of Surgeons of Edinburgh, Faculty of Remote, Rural, and Humanitarian Healthcare capabilities framework.

Within this thesis, the PFC grounded theory is methodologically and empirically tested by investigating evidence in practice. The findings suggest the PFC grounded theory is an explanatory and evidence-based theory. For these tests, an analogue mission that simulated the human exploration of another planet was designed. The simulation was achieved by taking place on a remote and uninhabited island in Scotland – the first of its kind in the UK. The impact of the analogue mission was providing proof of concept that the UK can be used as an analogy of space. Academic and industry researchers may benefit from this by having access to an affordable, high-fidelity (realistic) fieldwork site, which can be brought about by the provision of more analogue missions in the UK.

To continue this work, an organisation called Space Health Research was incorporated by the researcher as a limited company in May 2022 to provide affordable, high-fidelity analogue missions. A two-week analogue mission was successfully completed in August 2023 on the same remote Scottish island. The analogue mission hosted five studies from UK universities and the European Space Agency. Thus, another research impact is the founding of an enterprise that has increased engagement in cross-disciplinary UK space research. Further benefits of this may be brought about by increasing public awareness of UK space activities, enterprises, and research through media engagement and widening participation outreach projects.

Lastly, this research was included in the successful application for an organisation called Remote Area Risk International to become the Institute for Remote Area Risk and Medicine. This was approved by the UK Secretary of State for Education in October 2023. The Institute for Remote Area Risk and Medicine provide education courses about mitigating risks to health in remote environments, including a PFC course. Thus, an impact of this research has benefited an organisation who provide education about PFC and risk mitigation in remote environments. Further benefits to course participants and their patients may be brought about my continued collaboration and future collaborative research.

Table of contents

List of tables

List of figures

List of appendices

Part I Research context

Chapter 1 Introduction

1.1 Introduction

It is predicted that despite increasing urbanisation, by the year 2050 there will be up to 3.1 billion people living in a remote environment (United Nations Department of Economic and Social Affairs, 2018). It is well documented that people in remote environments can experience socioeconomic inequality that can increase risks to their health (Smith et al., 2008). The COVID19 pandemic is a recent example of health disparities experienced by people in remote environments (Karos et al., 2020). There are many reasons for these experiences. (1) There is no access to health services that are required to meet their health needs (Henning-Smith, 2021). (2) There are limited resources that are required to provide the health care they need (Lehmann et al., 2008). (3) There is unreliable communication required for health care provider supervision and guidance, and, or request a resupply of resources, or an evacuation (Davies, 2021). (4) There is a delayed evacuation from the remote environment to a location with health services that have the capability to meet their health needs (Badzri et al., 2018). These reasons for socioeconomic inequality are defining characteristics of the remote environments that are included the context of this research (see 2.2); however, what constitutes a remote environment requires further explanation.

The prediction of up to 3.1 billion people living in a remote environment refers to people in a permanently remote environment. This includes indigenous communities that have lived in polar, desert, island, or mountain environments for generations (Ahmed et al., 2022, Ali et al., 2021, Arbour et al., 2010, Binns et al., 2010). Many indigenous communities living in remote environments have access to local health services that provide traditional health care (medicine or healing) that have historically had the desired efficacy and, therefore, been passed on (Tran et al., 2016). Traditional medical and health practice is often in juxtaposition to Western medicine. Traditional health care is based on what has historically been done to treat illness and injury, whereas Western medicine is based on the results of clinical trials and research (known as, ‘evidence-based,’) (Williamson et al., 2015). A comparative analysis of Western medicine and traditional health care is not within the scope of this research, but the experiences of health and the risks to health in remote environments is relevant. Thus, Western medicine and traditional health care are included in the context of this research from the perspective of the permanently remote environment they are practiced in, which is critically appraised in 2.2. It is important to note, however, that not all remote environments are permanently remote. Temporary remote environments, and the risks to health presented in these environments, is also included the context of this research.

Remote environments can be permanently remote due to their geographical isolation, or they can be temporarily remote. For the context of this research, temporary remote environments are when the socioeconomic inequality that people experience in remote environments causes vulnerability to hazards, which leads to the environment become temporarily remote (Gencer, 2013). One example includes the natural hazard of flooding. Vulnerability to flooding can cause a well-connected and sufficiently resourced urban environment to become remote or, in other words, cut-off from services, resupply of resources, reliable communication, and, or rapid evacuation (Quesada-Román et al., 2021). Thus, the experiences of health risks for people in temporary remote environments are congruent to people in a permanently remote environment.

Another example of an environment becoming temporarily remote is as a result of conflict or war. Local communities can become cut-off from supply lines, critical national infrastructure (power, water, energy), and, or increase the number and severity of illness and injury (Garry and Checchi, 2020). Furthermore, humanitarian crises such as conflict and war, or disasters caused by vulnerability to natural hazards, can lead to communities becoming displaced from their homes (Adger et al., 2018). Thus, humanitarianism in remote environments is a relative field to the context of this research, including the experience of civilian and military personnel deployed to provide aid and health care in these environments.

The examples of permanently and temporary remote environments does not define remote environments (this is not the aim of this research); however, explicitly explaining these contexts is necessary to contextualise this research. Appendix 1 outlines different categories or situations that relate to temporary or permanently remote environments, mapped with case studies of disasters related to health risks that have occurred there. These case studies have been purposefully selected to provide clarification of the context for this research (the case studies are not included within the methodology or methods of this research). A critical appraisal of permanent and temporary remote environments within the context of this research is explored in greater detail in 2.2.

As indicated by the case studies in Appendix 1, a common thread through permanent and temporary remote environments (collectively known henceforth as 'remote environments'), are the experience of vulnerability to hazards and the associated risks to health (Leight, 2003). Vulnerability to hazards can be caused by the socioeconomic inequality experienced in remote environments; however, risks to health can be defined as the likelihood of the vulnerability to a hazard causing harm (Surjan et al., 2016). The illnesses and, or injuries that can be caused by the vulnerability to hazards and risks within remote environments are also included in the scope of this research.

The risks to the health of people in remote environments are multifaceted as a result of the characteristics of specific remote environments (Daley et al., 2015). In other words, the remote environments in Appendix 1 illustrates that there are multiple risks to health, and resultant injury and, or illness, within each of the remote environments. Thus, the context of this research does not concentrate on one 'type' of remote environment, but the experience of how risks to health, that could result in or lead to injury and, or illness, can be mitigated, based on the perspective of health care providers. These experiences transcend multiple remote environments due to the similar risks to health caused be vulnerability to natural hazard – no access to services, limited availability of resources, unreliable communication, and delayed evacuation. The body of literature about these risks and the challenges to providing health care is predominantly focused on one type of health care – emergency response.

Within the contexts of remote environments, the evidence-base for the treatment of illness and injury is well documented. There is a substantial body of literature on how to meet acute health needs of people in an emergency; known as emergency response within the context of this research (Weiss and Batchelor, 2019). Clinical interventions of major trauma, for example, in Western medicine were catalysed by Middle Eastern conflicts and war in the 2000s (Kotwal et al., 2016). A cusp point in major trauma care is the development and integration of the 'golden hour' model into military health systems – rapidly evacuating casualties to a field-based trauma and, or surgical centre within one hour after injury (Forrester et al., 2019). The golden hour model of care can increase the chance of survival for traumatically injured personnel (Abhilash and Sivanandan, 2020). This evidence-base informs the training of health care providers before deployment and is critically appraised in the literature review for this research (see 3.3.2.6) (Suresh et al., 2021). For communities in remote environments who practice traditional health care, however, their experience of training for health care provision is informed by the historical practices passed on to them from previous generations (Strasser, 2016).

Many indigenous communities have limited access to services or resources (Nguyen et al., 2020). Indigenous communities approach to health care often uses local resources, such as herbal remedies (Kingston et al., 2007). Their experience of training for and providing health care in remote environments is equally important to Western medicine and makes valid contributions to this research. Traditional approaches to emergency care may be different to Western medicine; however, indigenous people make up approximately 5% of the world's population and have lived in their homelands for generations with the same approaches to their health services and emergency response (Carrie et al., 2015, Feiring, 2013). However, the focus of this research is not limited to emergency medical care. This research investigates how PFC in remote environments mitigates risks to health before illness and injury become acute and life threatening.

There is no universal definition, standard, or theory of PFC. PFC can be identified as a hypernym – a universal term that describes many different categories of holistic, prehospital care (Keenan and Riesberg, 2017). There is some literature related to PFC embedded within medical texts; however, it is limited in breadth and depth. The advice about PFC (identified as field nursing care) in the Oxford Handbook of Expedition and Wilderness medicine is to be a patient's mother[1] (Dallimore et al., 2023). Literature about PFC such as this is vague and not based on valid, reliable evidence. The body of literature about PFC within the context of this research is critically appraised in Chapter 3, which concludes that there is a distinct absence of literature about how PFC can mitigate risks to health in remote environments.

For this research, the lens that it used to examine how health care mitigates risks to health in remote environments focuses on the holistic application of PFC. A critical analysis of health in remote environments is included in 2.4, whereas the conceptual framework of health that this research focuses on is presented in 5.3. It is important to note, however, that the discovery of the absence of literature about how PFC can mitigate risks to health in remote environments is also based on the researcher's background and experience of health care provision in remote environments. The next section provides a positionality statement from the researcher.

1.2 Researcher's positionality statement

Positionality statements are often used, even in quantitative research (such as engineering), to define how researcher's philosophies may influence the research process (Secules et al., 2021). Doing so provides transparency to who conducted the research, which may explain why the results or findings are identified, analysed, or critically appraised. A positionality statement has been

[1] This quotation presumes that the experience of motherhood is the same and, moreover, a positive experience for everyone, which is not always the case for some people.

included in this research to outline the researcher's background and experiences that may inform this research. It is important to note that the researcher's background and experiences enabled this research to take place. This is not to say others could not do this research. It follows that other researchers are encouraged to critique this research and conduct their own to make further contributions to knowledge in this field. Outlining this researcher's positionality statement, however, provides a transparent background to how and why the researcher conducted this research.

The researcher for this PhD thesis is a nurse by background with an interest in emergency care. The vast majority of the researcher's clinical experience, however, is in remote environments as an expedition medic. The researcher recognised that expedition medic training and the relating literature focused primarily on how to respond to major injury and, or illness in remote environments. It is evidently important for expedition medics to have knowledge and skills to protect and preserve life in the event of major injury or illness in remote environments. Specific training on this is especially important considering the additional hazards, risks, and challenges that influence patient's health outcomes. However, in the researcher's clinical experience the vast majority of health care that was provided focused on treating minor illness and injury to prevent clinical deterioration leading to major injury and illness.

A primary focus of the researcher's clinical practice was to protect and promote health in remote environments, opposed to solely focusing on preservation of life following emergencies. Furthermore, the incidents of illness and injury in remote environments did not solely focus on physiological health but psychosocial, mental health and wellbeing also. The researcher recognised that training about a holistic approach to health care to protect and promote health and, therefore, mitigate risks to health in remote environments did not exist. Similarly, the literature about this approach to health care in remote environments was minimal. Thus, the researcher chose to investigate this further through academic research.

The researcher conducted a systematic review as part of a MA Education that investigated the principles of nursing in expedition medic training. This research project was the genesis of the academic curiosity in this topic, alongside the motivation to have meaningful impact through research. After engaging in the literature around health care in remote environments, the concept of PFC was identified. The literature was predominantly focused on military health systems. This body of research concentrated on investigating how to provide emergency care to majorly injured or ill personnel in remote environments. The researcher recognised that the challenges faced by military personnel were similar to civilians living in, travelling through, or caught in a remote environment. Thus, this research focuses on military and civilian perspectives and contexts of PFC in remote environments. In the next section, the perspectives and contexts of PFC within the scope of this research are defined and critically appraised to provide explicit clarity for this PhD thesis, in addition to the introduction provided so far.

1.3 Research aim, objectives, and question

The aim of this research is to make an original and significant contribution to knowledge of how PFC mitigates risks to health in remote environments.

The research aim is achieved by rigorously investigating a PFC grounded theory, which provides an explanatory, evidence-based theory of social practice. It follows that the literature review and concept analysis (see Chapter 3 and Chapter 4) provides evidence of PFC being used to mitigate risks to health in remote environments. No evidence of an explanatory, evidence-based theory of this phenomenon was identified in the literature; thus, a well-defined research gap was identified. It is important to note that this research does not aim to define PFC but focuses on rigorously investigating an explanatory, evidence-based theory of how PFC can be used to mitigate risks to health in remote environments.

Achieving the research aim will provide an explanatory, evidence-based theory to inform health care providers, patients, and policy makers on how PFC can mitigate risks to health in remote environments. To achieve this aim, this research has the following objectives:

1. To rigorously investigate an explanatory, evidence-based theory of how PFC mitigates risks to health in remote environments.
2. To methodologically investigate how a PFC grounded theory could be used to plan for the mitigation of health risks in remote environments.
3. To empirically investigate how a PFC grounded theory can mitigate risks to health in a remote environment.

Thus, the question for this research is, “What is an explanatory, evidence-based theory of how PFC mitigates risks to health in remote environments?”

1.4 Research overview

Part I of this thesis provides the context of this research, which includes the research aim, objectives, and question. To robustly answer the research question, the philosophical landscape that this research is conducted within requires identification. The underpinning methodology (research philosophy) for this research is contextualism. Contextualism ontology and epistemology (see 5.2.1 and 5.2.2) acknowledges that the reality of knowledge and how we understand it is dependent on the context. In Chapter 2 the context for this research is outlined and critically appraised. The context that constitutes remote environments, health, and risk reduction. Thus, the context of this research is complex due to the multifaceted, dynamic nature of remote environments, health, and risk reduction. To robustly answer the research question within this context requires contextualism because this philosophy acknowledges that knowledge is relative.

To obtain knowledge, that is to answer the research question, an inductive qualitative research methodology is utilised. In other words, evidence is collected and analysed to formulate a theory of phenomena. The rationale for an inductive qualitative methodology is in Chapter 3, the literature review, it is identified that PFC already takes place in practice. It is identified, however, that an explanatory, evidence-based theory of how PFC is used to mitigate risks to health is a well-defined research gap. Thus, inductive qualitative research is appropriate and required to answer the research question and achieve the aim and objectives. To develop the explanatory, evidence-based theory of how PFC is used to mitigate risks to health, grounded theory was utilised.

Grounded theory is a research method used to construct an explanatory, evidence-based theory of phenomena. Approaches to grounded theory are critically appraised in 6.3, and in 6.4 Straussian grounded theory approach is identified as the method used for this research. It is explained that Straussian grounded theory is a logical method that uses theoretical sampling (see 6.4.1) to collect data, based on theoretical sensitivity, that is analysed (see 6.4.3) to formulate a grounded theory. Theoretical sensitivity to the emerging PFC grounded theory was attuned as a result of the literature review and concept analysis presented in Chapter 3 and Chapter 4. Once theoretical saturation was achieved (see 6.4.1.2) and the data analysis complete, the PFC grounded theory of mitigating risks to health in remote environments was established. The PFC grounded theory is the salient theoretical finding of this research, which concludes Part II of this thesis.

It is important to note that this research does not aim to define the efficacy of the PFC grounded theory (that is, the desired outcome of how effective the PFC grounded theory is). Rather, in Part III of this thesis, the PFC grounded theory is methodologically and empirically tested. Testing grounded theories is not part of any grounded theory methods; however, to achieve the research aim of an original and significant contribution to knowledge, and objectives 2 and 3, the PFC grounded theory was tested methodologically and empirically. The methodological and empirical test investigated evidence of the PFC grounded theory in practice. In other words, a true grounded theory is an explanatory, evidence-based theory of the defined phenomena. Thus, the discovering evidence of the PFC grounded theory being used to mitigate risks to health in remote environments proved that the theoretical findings were accurate, and that the research question had been answered.

The methodological test investigated evidence of the PFC grounded theory being used by the researcher to inform the strategies for mitigating risks to health during the planning of fieldwork. The fieldwork was an analogue mission that simulated the human exploration of another planet. The simulation was achieved by the analogue mission (the fieldwork) taking place on a remote and uninhabited island in Scotland. In other words, the island was a remote environment where PFC was required to mitigate risks to health. Planning how to mitigate the risks to health during the fieldwork enabled the methodological test to take place. Evidence of the PFC grounded theory suggested that the findings were the PFC grounded theory was methodologically accurate. Deploying the analogue mission design enabled the empirical test of the PFC grounded theory.

The empirical test investigated evidence of the PFC grounded theory being used to mitigate risks to health during the analogue mission (see 9.3.1). The PFC grounded theory was purposefully not explained to the research participant. If the theoretical findings were an accurate explanatory, evidence-based theory, evidence of the PFC grounded theory could be identified without any intervention. Evidence of the PFC grounded theory was identified in the empirical test, which suggested that the theoretical findings were accurate. The connection between the analogue mission methodological and empirical test provided continuity; however, due to researcher's involvement, the influence of confirmation bias was a risk. To mitigate this risk, a second case study was included in the empirical test.

The second case study for the empirical test was a cross-country skiing expedition in Norway (see 9.3.2). The researcher was not involved in the design or deployment of this expedition. The empirical test for the analogue mission case study was repeated for this case study; thus, the influence of confirmation bias was controlled by including the findings of the cross-country skiing expedition. The findings similarly identified evidence of the PFC grounded theory being used during the expedition to mitigate risks to health; therefore, strengthening the rigour and validity of the empirical test findings. Part IV of this thesis is the research synthesis (see Chapter 10 and Chapter 11). The theoretical, methodological, and empirical contributions to knowledge are situated in the evidence-base that was identified in the literature review. Evidence that the research aim and objectives were achieved and the research question answered are presented critically appraised. Furthermore, the research design and limitations are outlined and also critically appraised to demonstrate the rigour and validity, trustworthiness, and applicability of the findings from this research. Finally, the key findings and considerations for future research are presented in Chapter 11. The next section of this chapter builds on the research overview and presented the structure of this thesis.

1.5 Thesis structure

Chapter 1 introduces this research and Chapter 2 defines the context that the rigorous investigation of the research topic is conducted within. A literature review is presented in Chapter 3, which defines the research gap and informs the research aim and questions this thesis achieves. One of the key findings from the literature review is that the research topic – PFC – is an under researched field and, therefore, there is limited literature available. As a result, a concept analysis was conducted to fully understand what constitutes PFC, according to the available literature. The concept analysis is presented in Chapter 4.

While Chapter 2 provide a definition of the context for this research, it does not identify the perspectives that this research is conducted from. Chapter 5 provides definitions of the philosophical landscape and conceptual framework of health for this research. Providing explicit clarity of these elements strengthens the transparency and, as a result, trustworthiness of the research findings. To conduct this research and identify the research findings requires the application of research methods. The research methods used for this thesis are outlined and critically appraised in Chapter 6.

By conducting this research using the identified research methods, the findings were identified. The findings of this research – a PFC grounded theory – are presented in Chapter 7. To provide greater depth to these findings, the PFC grounded theory was methodologically test and empirically tested. The findings of these studies are presented and critically appraised in Chapter 8 and Chapter 9.

All findings of the grounded theory, methodological test and empirical test are critically discussed and synthesised in Chapter 10. This chapter situates the findings within the existing knowledge identified in previous chapters. Lastly, the conclusions of this research are presented in Chapter 11, including a summary of the key findings, the research impact, and implications for future research. To aid navigation through this thesis, hyperlinks are embedded to chapters, chapter sections, tables, figures, and appendices.

1.6 Summary

In this chapter, the research topic of how PFC can be used in remote environments to mitigate risks to health has been introduced. The features of this research have also been outlined, namely – health, risk, and remote environments. These features are explored and critically appraised at more depth in Chapter 2. The research aim, objectives, and question have been presented. Completing these will demonstrate the standard of a PhD in Risk and Disaster Reduction. While this chapter has introduced the research topic, the context requires explicit definition. In Chapter 2, remote environments, health, and risk reduction are critical appraised to clear define the contextual landscape of this research.

Chapter 2 Defining the research context

2.1 Introduction

An introduction to the context of this research has been provided, which has briefly explained how the research topic of PFC is related to remote environments, risks to health, and the researcher's background. Chapter 2 provides an in-depth explanation and critical appraisal of how PFC can be used to mitigate risks to health through the lenses of:

- A person already having minor injury or illness, or a long-term condition, while in a remote environment – therefore, when PFC is applied in practice to protect and promote health, thus mitigating the risk of clinical deterioration into major illness and injury (and death); and,
- Before illness and injury takes place in a remote environment – similarly, PFC is applied in practice to protect and promote health but to mitigate the risk of minor and major injury and illness

The specific research gap that this research aims to bridge is the absence of an explanatory, evidence-based theory of how PFC can mitigate risks to health in remote environments. Thus, the lenses that this section examines PFC through is within the research gap. The in-depth explanation and critical appraisal of how PFC practice can mitigate risks to health in remote environments is achieved by critically analysing the perspectives and contexts of PFC, beginning with remote environments.

2.2 A critical analysis of remote environments

Humankind has always ventured to explore remote environments. Remoteness can suggest a bleak, barren environment devoid of all life. Yet the abiding allure of remote environments means people often venture into these wildernesses for scientific interest, discovery, or recreational purposes. There is no standardised definition of a remote environment, as this phrase has different contextual meanings. For example, working remotely may mean working in a virtual online environment, away from a communal workplace. The term isolated is sometimes used to describe a remote environment, but this can be a psycho-sociological construct that is not applicable to this research in that context. For example, being isolated may refer to people living in an urban environment that feel unconnected to family and friends, or are homeless or unemployed, yet these situations are not physically remote. A remote environment in the context of this research is a geographical location with permanent or temporary limited accessibility and, or connectivity (Smith, 2017).

The phrase 'remote environment' has been used in this thesis to include all related environments that have some or all of the following features:

1. No access to health services that are required
2. Limited resources
3. Unreliable communication
4. Delayed evacuation.

These features of a remote environment can increase the risks to health (Dallimore et al., 2023). Remote environments are dynamic and can change depending on the time an activity takes place. It follows that the activity influences the exposure to health risks, as some activities have more severe risks to health in comparison to others. Furthermore, each person (or people) that are exposed to these risks are different and have individual health needs.

People in remote environments may have pre-existing health needs and, or they may experience new health needs (injury or illness) due to the consequences of vulnerability to health risks. Thus, vulnerability to health risks can lead to injury and, or illness, exacerbating the challenges to health care that are experienced by people in remote environments. This research seeks to explain how PFC could mitigate risks to health in remote environments. It is important to recognise that in the literature, there is variation in the terminology used to identify and describe a remote environment.

Phrases in the literature are occasionally used when there is regional influence of language. For example, in the US, the phrase, "wilderness medicine," is often used to describe health care in geographically remote environments (Andrews et al., 2009, Hawkins et al., 2021). Wilderness medicine is, therefore, relevant to this research. The phrase, “extreme medicine,” however, is often used in the UK to describe similar environments that the phrase wilderness medicine is used for where medicine is practiced (Kirkpatrick et al., 2017). Thus, extreme medicine is similarly relevant for this research. The phrases of wilderness and extreme medicine can be compartmentalised further to describe prehospital health care that takes place in specific remote environments (see 2.3.1). In the next section, remote environments are explored in more detail to distinguish between permanently and temporarily remote environments.

2.2.1 Permanent remote environments

Within the context of this research, permanent remote environments can be described as geographically distanced from settlements (towns, villages) that have basic health services, or none at all (Charlton and Brabazon, 2020). Included within the use of the phrase remote environment is, “rural environment,” which may have limited health services to meet the health needs of local communities (Herron and Skinner, 2018). For example, a rural environment may have a local General Practice (GP, also referred to as family doctor in North America); however, this service may not include mental health care or x-ray capability (Kretowicz, 2010). In the circumstance that a patient requires health services that are not available in the rural environment, this is relevant to PFC and this research. In other words, rural environments are relevant to this research due to there being no access to health services and resources that are required to meet the health needs of a patient. Thus, when the phrase remote environment is used within this thesis, it includes rural environments that have circumstances of no access to health services, limited resources, unreliable communication, and, or delayed evacuation. Within the literature, however, alternative phrases are used to describe remote environments, which requires further clarification.

The phrase ‘isolated environment’ is occasionally used in the literature (Carver, 2015). When this term is used to describe an environment geographically isolated from another, such environments are relevant to this research. However, in searching the literature, the term isolated has been used to describe a person who feels cut-off from society (lonely) (King et al., 2011). Use of the term isolated in this context is not relevant to this research; although, it is noted that people can feel isolated in geographically remote environments, which is a relevant health need (Géczy et al., 2020). In this circumstance, the health need of feeling isolated while in a remote environment is relevant.

Many environments are permanently remote due to their geography and environmental conditions, which has impacts on health (Andrews et al., 2012). Some small islands are permanently remote, either uninhabited and maintained where communities have settled (Palafox and Hixon, 2011). Mountain regions with high to extreme altitude or the polar regions are also remote, with few populations choosing to live in these demanding environments (Hennessy and Bressler, 2016, Niermeyer et al., 2009). Space is an environment where currently no one lives, but a small number of people are rotationally based on the international space station (ISS) to conduct research into aging (Khoo et al., 2020).

Space health can be defined as the provision of health care to people in space, to protect and promote health, prevent illness and injury, and provide long-term care; however, space health is commonly referred to a space medicine, which focuses on the biomedical care of people in space (Clément, 2011). Although space health may seem too abstract or niche to be relevant to health care on Earth, the lessons learned in providing health care in space are applicable to providing health care in remote environments due to the limited resources and connectivity (Ruyters and Stang, 2016, Waisberg et al., 2023).

The ISS is in low-Earth orbit, which can be described as a remote environment. The remoteness of the ISS has similarity with the research stations based in Antarctica because people living there experience long periods of remoteness (Clément, 2011). Arguably, Antarctica in winter is more remote when compared with the ISS due to the approximate 24-hour evacuation to Earth from the ISS, verses up to 8-months evacuation from an Antarctic base in winter (Walton and Kerstman, 2020). However, Antarctica is an example of a remote environment that has variant levels of 'remoteness' due to the increased accessibility in the summer (Mills and Mills, 2008). It is important to note that some environments are only temporarily remote. The next section explores this concept in more detail.

2.2.2 Temporary remote environments

People living in the research stations of Antarctica during the winter are trained to live and provide health care in the extreme conditions until the summer (Mills and Mills, 2008). However, other environments can become temporality remote without warning. Within the context of this research, temporary remote environments include locations that were previously well-connected and had sufficient services to meet the health needs of the local population, including illness and injury.

Examples of health services are hospitals, health centres, or family doctors, which are usually located in urban environments. Urban environments can become temporarily remote due to the impact of a disaster, limiting access during the COVID19 pandemic to essential services such as schools and some health services (Fairman et al., 2022). Urban environment disasters can be caused by vulnerability to natural hazards. An example is Hurricane Sandy, which was a category 3/5 hurricane that hit New York in 2012. The total financial cost of Hurricane Sandy was US$70 billion (Davis, 2019). The immediate to short-term impacts of the hurricane caused huge health service disruption and limited access to services that were operational (Persoff et al., 2018).

Catastrophic disaster events such as Hurricane Sandy cut off access to health services and, or supply chains. Depending on damage to other critical national infrastructure, communication may also become unreliable (Deepak et al., 2019). As a result, the resources that were available for the disaster can become limited, especially if supply chains are disrupted (Raillani et al., 2020). In other words, any resources used during the disaster response will not be resupplied until supply lines and communications networks are reconnected

(Syahrir and Vanany, 2015). However, disasters induced by vulnerability to natural hazards are not the only cause of urban environments becoming temporarily remote.

Urban environments can become temporarily remote due to geopolitical instability, conflict, and war. Conflicts in the Middle East, such as Iraq and Syria, provide examples of displaced communities that, as a result, have limited access to health care services (Odhaib et al., 2022). Thus, people are travelling through temporarily remote environments, which has negative impacts on their health. It is important to recognise, however, that while conflict and war may be temporary, the recovery from these events is often substantially longer.

In the aftermath of the Iraq war, the public health system was destabilised as a result of the 2003 Iraq invasion, resulting in short- and long-term negative impacts on the health of local communities (Al Hilfi et al., 2013). After the invasion, clean water provision, electricity and sewage system were destroyed in vast areas of the country, exposing the population to disease and illness. In Baghdad, for example, a cholera epidemic occurred in 2007 (Mukhopadhyay et al., 2014). Thus, without a public health system the health disaster continues long after the war has ended.

It is evident, therefore, that conflict and war can lead to humanitarian crises and negative impacts on health (Khorram-Manesh and Burkle, 2023). Not only can the duration of the impacts vary, but the scaler of impact. The humanitarian crisis in Yemen was caused by civil war and the availability of health care services was extremely limited for the population (Bakather et al., 2019). More than 21.6 million people need humanitarian aid, which equates to 69% of the 31.2 million people population (United Nations Office for the Coordination of Humanitarian Affairs, 2022). The geography of Yemen is an important consideration in managing this crisis; therefore, health geography is another field that is relative to this research.

Health geography focuses on the understanding of the spatial aspects of health and well-being relative to place (Crooks et al., 2018). In other words, health geography considers the distribution and arrangement of health-related phenomena in geographic locations. The study of health geography also explores how socioeconomic and environmental factors create disparities in health outcomes across different geographic areas, which aligns with the context of this research. It follows that the examination of how spatial factors influence health risks and outcomes is relevant to this research. Health geography applies to all locations; however, this research focuses on remote environments. With this in mind, the interrelation of health geography and remote environments requires clarification for this research.

Health geography investigates health at various scales, ranging from local communities to global contexts. Health geographers employ a range of qualitative and quantitative research methods, including spatial analysis, Geographic Information System (GIS), and statistical modelling, to investigate health patterns and their spatial determinants (Wood et al., 2023). This research, however, focuses on health within in remote environments, and how PFC can mitigate risks to health with the challenges of no access to services, limited resources, unreliable communication, and delayed evacuation. The identified research gap, as defined explicitly in Chapter 1 (see 1.3), is how a PFC grounded theory can inform the mitigation of risks to health in remote environments. This research gap encompasses people who live, travel through, or are caught in remote environments. Thus, health geography is relative to this research when focused on the risks to the health of people in remote environments.

A common thread running through health geography and this research are policy implications. Health geography research often seeks to inform policy-makers who are focusing on planning interventions to address health inequalities and improve health outcomes at the various geographic scales that health geography applies to (Carolan et al., 2006). This research similarly aims to inform policy makers through the establishment of an explanatory, evidence-based theory to build solutions and strategies to mitigate risks to health in remote environments. The similar implications for policy between health geography and this research demonstrates the relevance of health geography to this research and provides further clarification of the context. Health care and medical care that is referred to in health geography literature, however, requires clarification to provide additional clarification of the context for this research.

2.3 A critical analysis of health

2.3.1 Medical care vs health care

Medical care and health care are terms often used interchangeably, but they have distinct meanings and implications for what constitutes health. In this section, medical care and health care are critically appraised so that their similarities and differences are explicitly outlined, which provides additional clarification to the context of this research.

Medical care primarily refers to the diagnosis, treatment, and management of illnesses and injuries (Donabedian, 2002). It encompasses the services provided by health care professionals such as doctors, nurses, surgeons, and other allied health professionals; collectively, the multidisciplinary team (MDT). Medical care is predominantly aimed at curative measures, addressing acute illnesses and injuries to alleviate symptoms and promote recovery (Donabedian, 2002). Health care, on the other hand, refers to a broader spectrum of services that protect and promote overall health and well-being of a person from a holistic perspective (Charlton and Brabazon, 2020). It extends beyond medical interventions and incorporates factors that influence health, such as socioeconomic determinants of health, and health promotion initiatives (Dahlgren and Whitehead, 2021).

Health care focuses on the health needs of populations and local communities with an emphasises on health promotion, and illness and injury prevention through clinical interventions and education (Childs et al., 2022). Thus, health care places a greater emphasis on preventive measures and aims to reduce the occurrence of injury and illness, and their associated risk factors, thereby protecting and promoting long-term health and well-being (Orte et al., 2021).

Health care involves a collaboration amongst the MDT, with each member focusing on their specialism.

Both medical care and health care share the common goal of improving health outcomes and enhancing the quality of life for individuals and populations; however, their perspectives are different. While medical care addresses individual health issues, health care provides the broader framework for protecting and promoting health and well-being. Medical care and health care are interdependent aspects of comprehensive health care systems (Cunningham et al., 2021). This research, however, focuses on medical and health care relative to PFC being used to mitigate risks to health. In other words, the treatment of illness and injury to mitigate the risk of clinical deterioration (medical care), and the protection and promotion of health to mitigate the risk of illness and injury (health care) in remote environments.

The phrase ‘health care’ is used within this research henceforth to include medical care and health care to emphasise the holistic approach to health and risk mitigation in remote environments that this research has. In the literature review for this research (see Chapter 3), themes of health care in remote environments were identified. The literature about these themes is critically appraised, which informed the research design (not the utilisation of the research methods – see 6.3.3) and provides more detail about the context for this research. Health care, however, presumes a Western perspective of health. The next sections provide additional clarity of Western and traditional health care to strengthen the context for this research.

2.3.2 Western medicine and traditional medicine

The term health care usually presumes a Western perspective of medicine that focuses on the treatment of illness and injury; however, many local communities and people practice traditional medicine. In this section, the similarities and differences between Western medicine and traditional medicine are explored and critically appraised to provide clarity to the context of this research. Foremost, the term ‘medicine’ that is used within the phrases Western medicine and traditional medicine is adopted in this section to reflect the body of literature in this area; however, for this research, the focus remains on the holistic perspective of ‘health’ (see Medical care vs health care2.3.1).

Both Western medicine and traditional medicine focus on the treatment of illness and injury of people who are unwell (Van Wyk, 2005). Western medicine and traditional medicine include physiological and psychosocial health in their foci and share the common goal of providing effective and appropriate care to individuals with health needs (Nzweundji and Agbor, 2019). Western medicine and traditional medicine employ various methods to diagnose patients. Western medicine often relies on laboratory tests, imaging studies, and advanced medical technology, while traditional medicine may utilise observation, anecdotal evidence, or alternative therapies (Wang et al., 2021). Both approaches to health care use natural resources in the treatment of illness and injuries, such as plant-based products for medications (foxgloves are used to make the cardiac medication, Digoxin, for example). However, the philosophical premise between Western medicine and traditional medicine differs.

Western medicine is largely based on scientific principles and empirical evidence-based practice (Linn, 2011). It emphasises rigorous research, clinical trials, and standardised treatment protocols to meet people’s health needs. Traditional medicine, on the other hand, is often rooted in cultural beliefs and local practices passed down through generations (Oliver, 2013). It is important to note that Western medicine and traditional medicine are not defined by geography – traditional medicine practice does take place in Western society; however, the clinical interventions are different (Stefanov et al., 2020).

Western medicine primarily uses pharmaceutical and surgical interventions, and advanced medical technology for treatment (Wang et al., 2021). It advocates the use of medicines and procedures supported by scientific evidence. Traditional medicine, on the other hand, employs a wide range of therapies, including acupuncture, massage, or traditional Chinese Medicine (Linn, 2011). To acquire knowledge and skills, Western medicine use accredited educational pathways, typically medical schools or universities where health care professionals receive training and education that is set by a

Governing body (Cuellar et al., 2003). Traditional medicine is often passed down through generations or specific traditional medicine schools within local communities (Han et al., 2016).

Western medicine is highly regulated by Governing bodies that has established standards for clinical practice education and training (Cuellar et al., 2003). Traditional medicine varies in regulation and often does not have the same level of standardised practices or Governance. Rather, traditional medicine is often regional or related to local communities (Egharevba et al., 2015). It can be argued, from a Western perspective, that strict Governance and standardisation of evidence-based clinical guidance promotes patient's safety; however, from a traditional medicine perspective, many people choose traditional medical care and are satisfied with the outcome (Kim et al., 2020).

While Western medicine is widely recognised and practiced globally, traditional medicine can vary significantly depending on the cultural context and region. The similarities and differences provide a general framework for critically appraising Western and traditional medicine within the context of this research, but individual practices and variations within each system may exist. For the context of this research, Western medicine and traditional medicine are relevant, depending on the experience of the research participants in remote environments (see 7.2.2). It is important to note that Western medicine and traditional medicine take place in many different types of environments; therefore, the next section critically appraises health in remote environments.

2.4 A critical analysis of health in remote environments

The previous section critically analysed health from the perspectives of medical care verses health care, and Western medicines verses traditional medicine. This critical analysis provides additional clarity of the context for this research, in addition to the critical analysis of remote environments. However, what constitutes health in remote environments requires critical analysis to complete the context of this research. In this section, health and health care in remote environments is critically analysed to complete the contextual definition of this research.

Health is a complex and multidimensional concept that includes people's physical, mental, and social wellbeing. To critical analyse the concept of health involves examining health through various lenses, including the definition, determinants, and the role of healthcare systems in promoting and maintaining health. Firstly, health can be described as having complete physical and psychosocial wellness, and not simply the absence of illness or injury (World Health Organization, 2020). This definition recognises the holistic nature of health, acknowledging that it extends beyond the absence of illness, which aligns with the context of this research. It can be argued, however, that health is extremely difficult to define due to the many interpretations (Kelly et al., 2023). Developing a universal definition of health is not within the scope of this research; however, what determines health is relevant.

Secondly, determinants of health are factors that influence an individual's health status that can be classified into two broad categories – individual factors and socioeconomic determinants. Individual factors include genetics, age, and lifestyle choices (diet, physical activity, and substance use) (Fraiman and Wojcik, 2021). Socioeconomic determinants of health include economic status, education, employment, access to healthcare, social support networks, and environmental conditions (Dahlgren and Whitehead, 2021). To understand what constitutes health requires an examination of the complex interplay between these determinants and their impact health disparities.

Health disparities refer to differences in health outcomes between various population groups (McCartney et al., 2019). These disparities are influenced by various factors, including determinants of health, access to healthcare, and socioeconomic inequalities (Chang, 2019). For the context of this research, the disparity of health is relative to remote environments. Health in remote environments poses unique challenges and requires careful consideration due to limited or no access to health services, resources, communication, and delayed evacuation.

People in remote environments often have limited access to health care services (Notara et al., 2023). This limited access increases the risk of delayed health treatment, especially for emergencies or complex health conditions. This challenges also applies to mental health care services too (Sutton and Isaacs, 2020). The complexity of providing health care in remote environments is due to physical challenges and, or conditions limiting logistical accessibility (Notara et al., 2023). The environments and situations listed in Appendix 1 exemplify the broad variety of remote environments. Each category has a unique physical nature, such as the topography of mountains or the diverse ecosystem of jungles and forests. Furthermore, the conditions within a remote environment are highly dynamic. It is important to note, however, that people can experience the same challenges of health and health care in remote and rural environments. The next section of this chapter critically appraised remote and rural health.

2.4.1 Remote and rural health

Rural health can be referred to as the provision of health and social care services in a small, rural community that has limited resources, but has access to basic health care facilities (Stewart, 2023). Rural health is related to the context of this research, as a rural health service may be closest in proximity to some of the remote locations listed in Appendix 1 (although there are exceptions, such as in space health). Alternatively, as explained in 2.2.2, a rural environment may be come temporarily remote as a result of a disaster caused by vulnerability to a natural hazard or crisis. In both remote and rural health environments, there are many challenges and risks to health and health care (see 2.2) that health care practitioners (practicing Western or traditional medicine) need to be prepared for.

Registered health care practitioners can provide health care in remote environments, and many have received specialist education in remote and rural health (Strasser, 2016). Registered practitioners have Governing bodies that have minimum practice standards that all registrants are required to maintain. Practice standards are a quality assurance tool to promote patient safety (Donabedian, 2002). However, not all providers of health care in remote environments are registered practitioners.

Non-registered health care practitioners can also provide health care, within a defined scope of practice. A first aider who has completed sixteen hours or more of training is one example (Walsh et al., 2023). First aiders may be the only providers of healthcare in some remote environments, particularly during immediate disaster response (Fatoni et al., 2022). Thus, any provider of PFC in remote environments is included within the scope of this research. Furthermore, PFC that is provided within a variety of health systems in remote environments is also relevant. Military and civilian healthcare systems are an important consideration for this research, which are critically appraised in the next section.

2.4.2 Military and civilian healthcare systems

Healthcare systems refer to organisational services, infrastructure, and resources that exist to provide health care (Golembiewski et al., 2022). Healthcare systems can range from focusing on small local communities to large-scale national institutions, such as the UK National Health Service (NHS). The NHS is an example of a civilian healthcare system, which is compartmentalised into multiple constituents. This research focuses on remote environments, and civilian healthcare systems in these locations aim to provide healthcare to a local population (Murphy et al., 2019).

Civilian healthcare systems in remote environments often focus on primary healthcare (hospitalised care), emergency services, and preventive care through patient education and community services. One of the challenges for civilian healthcare systems is the limited resources and infrastructure available to them, particularly in the event of a crisis or disaster when demand and reliance on the healthcare system increases (Al Harthi et al., 2020). The other healthcare system relevant to this research is military healthcare systems.

Military healthcare systems refer to the health services that military forces provide, including in their home country and when deployed overseas (Hospenthal et al., 2011). Military healthcare systems are always active in the

UK and there are mobile units ready to deploy as required. Missions for military healthcare systems focus on maintaining readiness, treating combat-related injuries, and supporting military operations. The purpose of military healthcare systems in remote locations is to provide healthcare to military personnel, their families, and local populations in conflict or disaster-affected areas (Tanielian and Farmer, 2019). Thus, military healthcare systems, and the wider military, are not limited to conflict and war (which can create temporary remote environments) but also focus on deployment to humanitarian crises (Hutter et al., 2019).

Military health systems in remote locations are primarily focused on providing healthcare during specific deployments. The sustainability of a healthcare system in remote environments is dependent on the duration and scaler of the military's presence in the area. Community engagement efforts may be limited to immediate healthcare needs, and long-term development of local healthcare infrastructure may not be a priority. Civilian healthcare systems, particularly those serving communities in remote environments, have a greater emphasis on long-term sustainability and community engagement (Morton and Burnham, 2010). They often work with local stakeholders, NGOs, and government agencies to develop sustainable healthcare solutions and address the specific needs of the population. This includes communities living in permanently remote environments and people who are caught in a temporary remote environment, such as during a humanitarian crisis.

2.4.3 Humanitarian healthcare systems

Humanitarianism is a common thread through military and civilian healthcare systems; therefore, humanitarian healthcare systems are relevant to this research. Humanitarian healthcare systems in remote locations face numerous challenges that require critical analysis to contribute to the overall contextualisation. Humanitarian healthcare systems are largely setup in remote environments in response to a disaster (such as in the aftermath of a natural hazard, or during a conflict or war) (Waldman and Toole, 2017). These remote environments lack infrastructure, namely transportation networks for the supply and distribution of resources to humanitarian responders and local communities, thus making it difficult for humanitarian organisations to reach these areas promptly (Jahre et al., 2016). As a result, risks to health are increased due to the limited resources and capability of humanitarian healthcare systems.

Remote environments that require humanitarian healthcare systems typically have limited resources, including healthcare facilities, trained personnel, and medical supplies (Kohrt et al., 2019). Inadequate healthcare infrastructure, such as clinics, hospitals, and laboratories limit the delivery of health services to meet the needs of local communities (Geiling et al., 2014). Insufficient medical personnel, including doctors, nurses, and technicians, can further limit the capacity to provide comprehensive care. Reliable information about diseases, health risks, and population dynamics is crucial for effective planning and resource allocation within humanitarian healthcare systems (Waldman and Toole, 2017). However, local cultural practices and beliefs are an important consideration also.

Humanitarian health systems must consider cultural factors to increase the efficacy of the services they provide (Hunt et al., 2014). It is crucial to engage with local communities, respect their cultural practices, and ensure healthcare interventions are tailored to their specific health needs. Failure to do so can undermine trust and acceptance of health services that can lead to making the crisis worse. Coordination and collaborations is, therefore, a significant consideration within humanitarian healthcare systems. Remote environments that have a humanitarian crisis may have multiple organisations and agencies working simultaneously, leading to coordination challenges. Lack of communication channels, information sharing platforms, and standardised practice can hinder collaboration and lead to duplication or gaps in humanitarian health services. Thus, establishing effective coordination mechanisms among organizations and leveraging local partnerships is essential to optimise resources, improve health outcomes, and mitigate risks to health.

Due to the challenges of operating in remote environments during a humanitarian response, risks to health are increased, namely from disease, injury, and illness (Boyd et al., 2017). Humanitarian healthcare systems need to be adequately prepared to respond swiftly and efficiently during such crises to mitigate these risks. This includes establishing rigorous communication networks, pre-positioning essential medical supplies, training local health care practitioners in disaster management, and developing evacuation plans. This leads to a critical aspect of humanitarian healthcare systems in remote environments – to ensure long-term sustainability and capacity building. Sustainable interventions can enhance resilience and improve health outcomes (Jordan et al., 2021). Rigorous monitoring and evaluation mechanisms are crucial for assessing the effectiveness of humanitarian healthcare systems, which include collecting data on health indicators, service utilisation, and patient outcomes (Waldman and Toole, 2017). This data helps to identify gaps, measure impact, and make evidence-based improvements to local health services, led by the communities they serve.

It is clear that humanitarian healthcare systems in remote environments have multiple challenges related to accessibility, resource constraints, cultural sensitivity, coordination, emergency preparedness, sustainability, and monitoring. Limitations in the scope of humanitarian healthcare systems can escalate risks to health and, therefore, be counterintuitive. Addressing these challenges requires a comprehensive and context-specific approach that involves local engagement, collaboration, and long-term capacity building. This can be achieved through rigorous research, which highlights the impact and significance of this research. Research during humanitarian response is possible; however, there are significant ethical considerations. A potential solution to manage this is to conduct research in alternative fields that have similar challenges faced by humanitarian healthcare systems. An example is space, which is an important dimension to this research, namely the use of a simulated space mission (an analogue mission – see 8.2).

2.4.4 Space medicine and space health

Space medicine, also known as aerospace medicine, is a specialism of medicine that focuses on the physiological health of humans in space (Waisberg et al., 2023). Literature about space medicine is explored in Chapter

3; however, for the purposes of defining the context of this research, space medicine also includes the psychological health of humans in space (see 3.3.2.4). Similarly to medical care and health care (see 2.3.1), the term space health is used to describe the holistic approach to health care in space, including the psychosocial health and wellbeing of astronauts. Thus, space medicine and space health include the study, prevention, and treatment of illness and injury that can occur during spaceflight.

When humans venture into space, they are exposed to a unique set of conditions that have significant risks to their health. The predominant risks are prolonged microgravity, radiation, isolation and confinement, altered sleep patterns, and communication latency (Hodkinson et al., 2017). While microgravity is not a common risk to health on Earth, radiation exposure can be in the aftermath of nuclear disasters. Beyond the Earth's protective atmosphere, astronauts are exposed to higher levels of radiation from sources such as solar flares and cosmic rays(Stepanek et al., 2019). Prolonged exposure to radiation can increase the risk of cancer, damage DNA, and cause central nervous system disorders, similarly to the Chernobyl and Fukushima nuclear disasters (Krittanawong et al., 2022).

Prolonged periods of microgravity can also cause cardiovascular damage, including reduced heart muscle mass, weakened heart function, and diminished blood vessel tone (Campbell and Charles, 2015). Space travel can also affect astronaut’s immune system, making them more susceptible to infections (especially when arriving in space and back on Earth) (Shirah et al., 2023). However, not all risks to health in space are physiological.

Long-duration space missions can have profound psychological and psychosocial effects on the health of astronauts (Velasquez, 2021). Factors such as isolation, confinement, and separation from loved ones can lead to feelings of loneliness, depression, and anxiety (Cromwell et al., 2021). The psychological and psychosocial health and well-being of astronauts is critical for their overall health and mission success. These psychological and psychosocial risks in space are similarly experienced in remote environments on Earth, due to the same factors – as isolation, confinement, and separation from family and friends (Cromwell et al., 2021). Thus, these factors are another example of the parallels between outer space and remote environments on Earth; therefore, research in space and of space can make contributions to understanding how to mitigate risks to health in remote environments on Earth, including for future spaceflight (Shirah et al., 2023).

Addressing risks to health in space requires a multidisciplinary approach that involves medical and health professionals, scientists, engineers, and mission commanders. Risk mitigation interventions, such as exercise programs, medication, improved nutrition, shielding from radiation, psychological support, and optimised spacecraft design, are developed to mitigate the risks and maintain the health of astronauts during space missions (Schroeder et al., 2021). Considering that there are parallel challenges of health care in space and in remote environments on Earth, these innovations have the potential to mitigate similar risks to health. In other words, the challenges to health care in space are similar to those in remote environments on Earth – namely, there are no services, resources are limited, communication is unreliable, and evacuation can be delayed (Antonsen et al., 2023). Thus, the study of health and risk mitigation in space is relevant to the context of this research and is used to conduct methodological and empirical research (see 8.2.2 and 9.1). To complete the contextual definition of this research, a critical analysis of health risks reduction is presented in the final section of this chapter.

2.5 A critical analysis of risks reduction in remote environments

The final component needed to complete contextual definition of this research is a critical analysis of health risks reduction in remote environments. Thus far, remote environments, health, and health in remote environments have been critically appraised; however, the predominant focus of this research is to rigorously investigate how to mitigate risks to health in remote environments. Mitigating health risks in remote environments poses unique challenges due to no access to health services, limited resources, unreliable communication, and delayed evacuation. However, within the context of this research, health risk reduction refers to the identification of hazards and the likelihood of consequences, which equates to the risks. By doing so, mitigation interventions can be developed and applies in practice. Thus, with careful planning, targeted interventions, and community involvement, it is possible to address these challenges, improve health outcomes, and mitigate risks to health.

Remote environments often lack health services and sufficient health care professionals. Limited access can lead to delayed response to medical and health emergencies and inadequate treatment of long-term conditions. Health risks reduction involves sustainably enhancing health services infrastructure, including the establishment of clinics or telemedicine services, and recruitment and retention of health care professionals. Additionally, training local healthcare providers and community health workers can help bridge the gap in healthcare delivery (Kenny et al., 2015). A focus of this research is on how training can benefit health risks mitigation before health care providers are deployed to remote environments and during their deployment. Evidence-based training can be identified as a tool to equip health care providers with the knowledge and skills to respond to emergencies and mitigate risks to health in remote environments before they escalate.

Remote environments are vulnerable to emergencies due to the socioeconomic inequality outlined in 2.2. Establishing reliable emergency response systems, including air or ground transport, can help ensure timely access to critical care. Community-based training in first aid and emergency preparedness can also empower local residents to respond effectively in emergencies, which also contributes to sustainable risk reduction (McNair and Robinson). By doing so, local communities and health services can be better prepared to manage illness and injury if they occur. Preventive measures such as vaccinations, health and risk education, and provision of basic sanitation facilities can empower local communities to mitigate this risk to health (Gencer, 2013). Thus, collaboration with local communities and NGOs can enhance the effectiveness of such interventions by considering cultural practices, language barriers, and local knowledge.

Remote environments often face risks such as exposure to extreme weather conditions that can delay evacuation to health services needed to meet the needs of people who are injured or ill. Identifying and addressing these hazards, including integrating early warning systems, having sufficient resources, and reliable communication mechanisms can significantly reduce health risks in remote environments (Vasileiou et al., 2022). This research seeks to understand these practices, as well as how to mitigate risks to mental health and wellbeing. It follows that empowering individuals and communities through health education is crucial in remote environments.

Educating people about physiological and psychosocial health and wellbeing, and the risks to health in remote environments, can empower them to take preventive measures and provide sufficient health care until evacuation to appropriate health services or recovery from illness or injury (Vasileiou et al., 2022). It is important to note, however, that tailoring health education initiatives to the cultural and linguistic context of the community can enhance their effectiveness and promote sustainable health services. Overall, reducing health risks in remote environments requires a comprehensive and multifaceted approach, involving collaboration between governments, healthcare organisations, communities, and stakeholders. It is crucial to consider the unique context of each remote environment and implement tailored interventions to address the specific health risks faced by those communities. Thus, this research rigorously investigates these phenomena to achieve the research aim and answer the research question (see 1.3).

2.6 Summary

In this chapter, the context of this research has been defined. The field boundaries that this research operates within are health and health risks in remote environments. Providing a contextual definition does not affect the research methods (which is important for this research; see 6.2) – it clarifies the subjects that this research is relevant to and, therefore, identifies where this research contributes to knowledge. This research does not aim to define the subject of PFC but aims to establish an explanatory, evidence-based theory of how PFC can mitigate risks to health in remote environments. How this aim is achieved is presented throughout this thesis, and the next section outlines how it is structured.

Chapter 3 Literature review

3.1 Introduction

In this chapter, a review of PFC literature is presented. A literature review is used to establish a synthesis of literature about a research topic. A literature review is essential to define the research gaps, or when developing policy, auditing practice, and implementing change (Beecroft et al., 2015). This literature review focuses on identifying and synthesising the evidence-base of PFC utilisation within remote environments and how risks to health are mitigated.

The aim of the literature review is to define the PFC research gaps and, therefore, develop theoretical sensitivity to the theory of PFC that is needed for data analysis (see 6.4.1.1). It is important to note that this literature review does not influence the research methods selected for this research. In Chapter 6, the research method for this research – grounded theory – is outlined and it is explained that influence of the data sampling, collection, and analysis methods contradicts the generation of theory from the data without influence of bias (see Straussian grounded theory approach in 6.3.3). Rather, this literature review provides boundaries for this research to be conducted within. Moreover, the findings of this literature review enable the development of theoretical sensitivity to the emerging PFC grounded theory (see 6.4.1) (Glaser, 1978, Stainton, 2010). The methods and search strategy used for this literature review are outlined in this chapter.

A variety of methods can inform the process of a literature review, as one article claims there to be fourteen review types (Grant and Booth, 2009). A traditional literature review has been used for this research because this approach enables a broad, comprehensive review of the literature. Thus, a traditional literature review provides a synthesis of the evidence-base about PFC in remote environments that will identify the research gaps and any previous research in this topic, so to avoid duplication. A limitation of a traditional literature view is the potential introduction of selection bias;

however, an explicit description of the literature search process promotes transparency and strengthens the reliability of the findings. The search strategy demonstrates the robustness of this literature review and presents the approach transparently, which illustrates the process of how the key findings where reached.

Alternative literature review methods considered for this research are listed in Appendix 2, which includes an overview of their use and an explanation about why they were not selected for this research. The rationales are based on the development of the search strategy, which was used to identify the most appropriate literature review method. This demonstrates the critical approach that was used to design this literature review.

This literature review identifies the following key findings. Firstly, PFC is a newly recognised area of clinical practice and, more so, research. Secondly, the body of literature is primarily based on PFC within military health systems, although PFC is relevant to clinical practice in remote environments. Thirdly, the risks to health in remote environments requires more systematic enquiry to understand the risks, and how technology can contribute to this mitigation. Fourthly, there is no theory in PFC in remote environments to inform clinical practice, policy, and pre-deployment training on how to mitigate risks to health. The conclusions include considerations for future research, which contextualises the research within this thesis.

3.2 Search strategy

In this section, the search strategy is outlined. Firstly, the research tool SPIDER was used to identify key components of the literature search, which is presented in Table 1. Identifying the search strategy before the literature review provided an opportunity to ensure the literature review method was valid, comprehensive, and robust. These qualities are important so that the literature review provides an accurate context to this research (although, not influencing the methods) and identifies PFC research gaps.

Table 1 SPIDER Research Question Model

SPIDER	Focus
Sample	Healthcare providers (any)
Phenomenon of Interest	PFC in remote environments
Design	All research methods
Evaluation	Experiences of PFC provision and training
Research type	Qualitative, quantitative, and mixed methods

SPIDER is a tool that can be used for a literature review of research with a qualitative methodology or mixed methods (Cooke et al., 2012). It is possible for SPIDER to be used for a literature review of quantitative research; however, other tools are usually more appropriate, such as PICO. SPIDER was developed as an alternative to PICO, which is commonly used for research with a positivist (namely, research with quantitative methods). SPIDER was used to develop the search strategy for this literature review because it enables the inclusion of literature published about research with quantitative, qualitative, and mixed methods; thus, ensuring this literature is comprehensive and inclusive of peer-reviewed research on PFC. During the search strategy development process, it became apparent that the majority of PFC research had qualitative methods; therefore, SPIDER was identified as the most appropriate tool to develop the search strategy. Using PICO as a tool to design the literature review would be possible; however, this would exclude a vast amount of non-quantitative literature and, therefore, not provide sufficient context to this research.

The SPIDER components were designed to capture all relevant literature that could provide context to this research. The sample was all health care providers, rather than one specific discipline (such as medicine), as many health care professionals engage in providing PFC (Smith and Withnall, 2018, Ball and Keenan, 2015). Remote environments include all interpretations of these terms (excluding virtually remote); namely, permanently and temporarily remote environments. All research designs and the methods used were included to mitigate the risk of some literature being missed and, therefore, limiting the findings of this review. This literature review focused on the experience of providing PFC and the training involved beforehand, or during this practice. While literature that focused on patient outcomes of PFC provision was not excluded, it is important to note that the focus of this literature review concentrated on clinical practice and decision-making of PFC providers. All research types (methods) were included; although, it was evident from the process of developing the search strategy using SPIDER that most research of PFC used qualitative methods. All of the above rationales for the SPIDER components ensured the search strategy of this literature review enabled the review to be as comprehensive as possible; thus, providing accurate context to this research.

The SPIDER tool was used to write the research question for this literature review. The review question is, "what are the experiences of PFC provision and pre-deployment training by health care providers in remote environments?" This research questions relates to the aim of this literature review – to define the PFC research gaps and, therefore, develop theoretical sensitivity to the theory of PFC that is needed for data analysis. To achieve the review aim and answer the research question, the review objectives are to –

1. Conduct a rigorous and comprehensive literature search and review of all peer-reviewed literature about PFC in remote environments.
2. Critically appraise the included literature from the perspectives of PFC practice and pre-deployment training.
3. Synthesise the findings of the literature review and present considerations for future research, including for this thesis.

Based on the aim and objectives, the following search terms were written for this literature review – *"prolonged field care" AND (rural OR remote)*. These search terms were used to ensure the validity of the literature review and the results were relevant to PFC in remote environments. Additional search terms could have been included to focus on PFC experience, practice, and pre-deployment training; however, an objective of this review is to be comprehensive, therefore, a more focused literature review would have excluded literature of PFC and limited the contextual grounding for this research. In other words, the identified search terms ensured the literature review was comprehensive. Thus, it was decided to keep the literature search broad to mitigate the risk of excluding important literature about PFC and to exclude irrelevant literature during the review process. No Boolean operators or truncation were used for this literature review because (in this circumstance) they did not expand, or focus the search in any way; however, quotation marks were used for PFC to ensure the literature identified was relevant to PFC. It is not claimed that this literature review is a systematic review, but a systematic approach was utilised to strengthen the reliability of the findings. Namely, the same search terms were used for all databases (see Table 2) and the following inclusion and exclusion criteria were consistently used.

3.2.1 Inclusion and exclusion criteria

Before conducting the literature review, the inclusion and exclusion criteria were defined for use during the literature search and reviewing process. The inclusion criteria were –

- Literature source: research article, review article, government publication or policy, book, or dissertation.
- Peer-reviewed publication.

The rationale for these inclusion criteria is they strengthen the reliability of the literature review. The listed literature sources will have been written for an academic purpose (opposed to entertainment or commercial reasons); therefore, written to contribute to science, knowledge, and the evidence-base of PFC. Although some literature containing the search terms may be excluded because they do not meet the inclusion criteria, the literature that is included will have been peer-reviewed, which demonstrates the literature has been scrutinised and critically appraised before publication.

The exclusion criteria enabled the standards of validity and reliability for the literature review to be upheld. The exclusion criteria were –

- Literature source: patents, reports, newspaper articles, letters to editors, blogs, conference proceedings, or grey literature.
- No search terms identified in the literature.
- Irrelevance to the literature review SPIDER.

Excluding the named literature sources ensured that literature which commonly has less academic rigour was not included in this review (it is acknowledged literature from these sources have quality; however, to ensure this literature has academic rigor, they are excluded). Some literature that was reviewed contained none of the search terms or were irrelevant to SPIDER, therefore, were excluded due to lack of relevance. A summary of the included literature review is provided in Table 2.

Table 2 Literature review overview

Database	Number of articles identified	Number of articles included
Allied and Complementary Medicine Database (AMED)	0	0
Cumulative Index to Nursing and Allied Health Literature (CINAHL) Plus	5	2
Cochrane Library Database description	0	0
Elsevier: Science Direct Database description	13	3

E-Theses Online Service (EThOS)	0	0
Google scholar (including Open WorldCat, findit@UCL)	61	43
National Institute for Health and Care Excellence (NICE) Evidence[2]	2	0
ProQuest	39	24
PubMed (including MEDLINE, PubMed Central)	16	11
UCL Explore	82	20
Web of Science	6	0
Total	**226**	**103**
Total articles included after citation snowballing	**108**	

3.2.2 Review method

Thematic analysis is a method used to identify patterns of themes within data and critically analyse them (Terry et al., 2017). Thematic analysis is used in this literature review because the data being collected is mostly qualitative literature about expert opinion or case reports of PFC (based on initial searches conducted to develop the search strategy). Thus, the data is not

[2] Database closed on 31st March 2022

numerical or a narrative, so a thematic analysis method is required to appropriately identify and analyse the data (Boyatzis, 1998, Javadi and Zarea, 2016, Maguire and Delahunt, 2017). In thematic analysis, a theme can be described as a salient concept that is relative to the research question. Analysing the themes within data – thematic analysis – can be used to answer the research question by establishing meaning from correlating and contrasting themes within the data, and investigating the research impacts when applied (for this research, impacts for clinical practice) (Alhojailan, 2012, Tuckett, 2005). There are multiple approaches to thematical analysis and it is advocated that the approach to be used should be selected based on the suitability to answer to the research question (Braun and Clarke, 2006). For this literature review, a reflexive thematic analysis approach is used.

Reflexive thematic analysis is the process of identifying and analysing recursive themes within the data from the perspective of the researcher (Braun and Clarke, 2019, Campbell et al., 2021). For this research, the reference management software, EndNote, was used to store, organise, and record notes on the included literature. To record and analyse themes within the literature (as explained later in this section) Microsoft Excel was used. The rationale for using software manually, rather than automated software such as NVivo, was to provide consistency with the software and analytical approaches used in this research (see 6.4.3). Each paper was coded using the citation to enable accurate cross-referencing during the reflexive thematic analysis. It is important to note, however, that reflexive thematic analysis has limitations that require critical appraisal.

A limitation of reflexive thematic analysis is the risk of selection bias being introduced by the researcher. In this literature review selection bias is mitigated by the robust, systematic approach to the traditional literature review method. Furthermore, the search strategy, results, and findings are explicitly outlined for transparency and to enable critical appraisal. Thus, the reflexive thematic analysis approach for this literature review is based on the original Braun and Clarke (2006) thematic analysis method, and the updated method (updated to provide clarity) by Braun and Clarke (2019). The reflexive thematic analysis approach method is outlined in Table 3.

Table 3 Reflexive thematic analysis approach method

Stage		Action
1	Familiarisation	Immersion into the data (the included literature)
2	Identification	Systematically document the themes identified within the data
3	Reviewing	Assess the accuracy of identification and cross-check all themes for duplication
4	Mapping	Map the themes to identify correlations or contradictions
5	Refining	Continue reflexive thematic analysis to combine or separate themes for clarification
6	Report	Critically appraise the themes and findings of the thematic analysis

Braun and Clarke (2006) advocate themes are the combination of codes. In a later publication the original wording of the method is changed from ‘theme searching’ to ‘theme generating‘ to emphasise that themes are created rather than discovered (Braun and Clarke, 2019). However, for this literature review, themes are recognised as individual concepts within the data. The rationales for this deviation from Brauna and Clarke (2006, 2019) are, firstly, this approach begins thematic analysis at an earlier stage. The impact of this is the resultant findings are based on analysis of individual components of the data, rather than the combination of data before analysis which risks the exclusion of data that may contribute to answering the research question. The second rationale is it removes a point in the process that cognitive and confirmation biases may be introduced – that is, the reaffirmation of beliefs or evidence based on subjectivity. The decision to combine data to form a theme may perniciously alter the original meaning of the data, whereas acknowledging salient data as themes removes the potential for cognitive and confirmation biases to be introduced at this point in the analysis – step two in the original method by Braun and Clarke, (2006, 2019). A final rationale for selecting a reflexive thematic analysis approach is this method unlocks the tools required to engage with the data and rigorously analyse it to produce enriched, evidence-based findings (Braun and Clarke, 2021).

3.3 Findings

In this section, the findings of the literature review are presented. Figure 1 is a PRISMA flow diagram[3] which is used to present the results of the literature search strategy. PRISMA flow diagrams are typically used to illustrate the results of a systematic review (Page et al., 2021). This literature review is not a systematic review; however, it uses a systematic approach to achieve the objective of being rigorous and comprehensive in the pursuit and analysis of peer-reviewed literature about PFC in remote environments. Presenting the results of the literature search strategy demonstrates the academic rigour that this literature review has been conducted with. The automated and manual removal of duplicate and ineligible articles was managed using EndNote X9 software (The EndNote Team, 2013). The analysis of included literature was managed using Microsoft Excel (Microsoft Corporation, 2021). During the analysis, a quality assessment of the included literature was conducted to strengthen the academic rigour of the literature review and reliability of the findings.

[3] The original colouring of a PRISMA flow diagram has been removed to increase accessibility and clarity of the diagram.

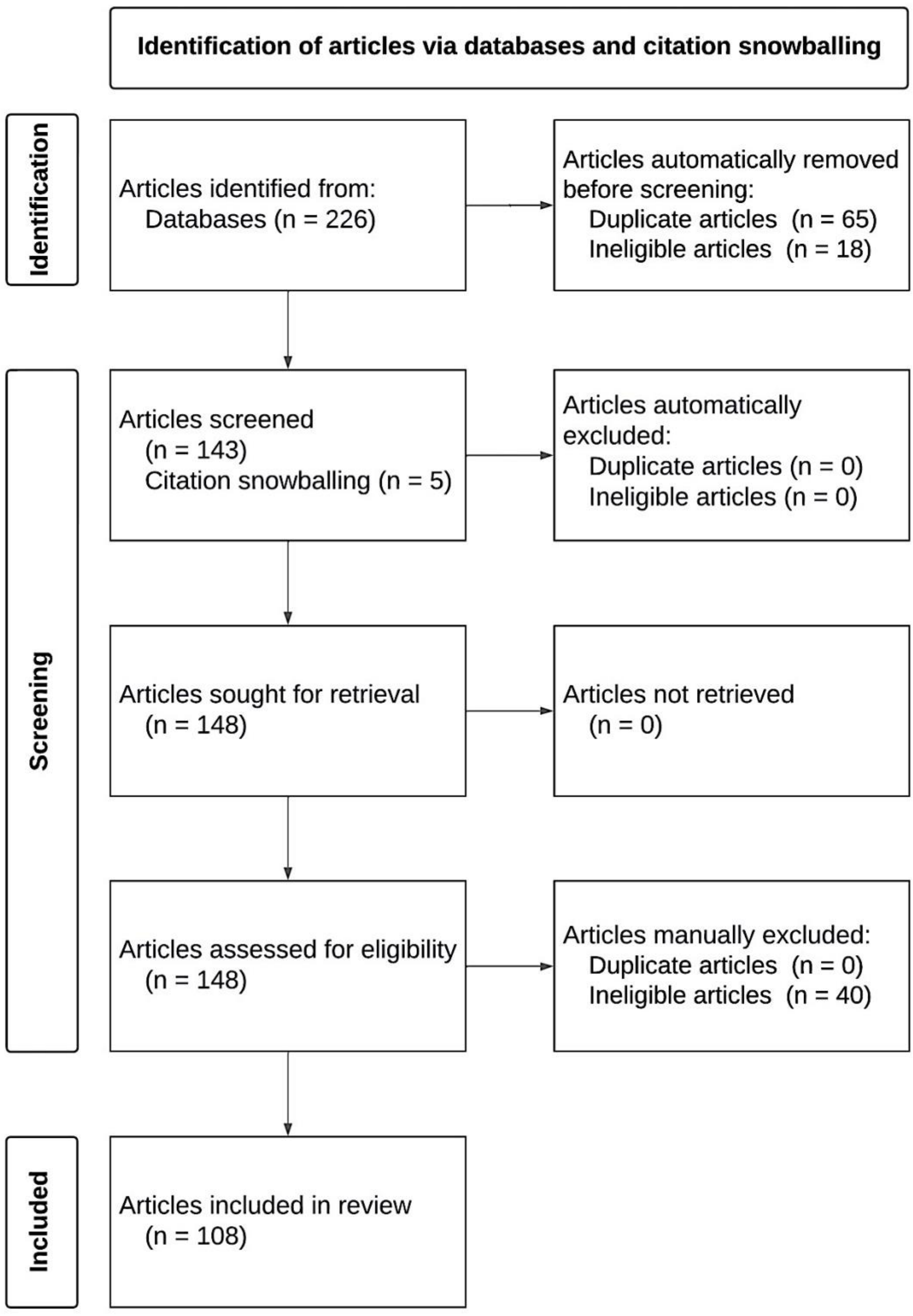

Figure 1 PRISMA Flow diagram: literature review

3.3.1 Quality assessment

All included literature in this review was subject to a quality assessment. To assess the literature quality, a critical appraisal tool was used. The tool used to assess the quality was the Critical Appraisal Skills Programme (CASP) Qualitative Studies Checklist (Critical Appraisal Skills Programme, 2022). Similarly to PRISMA flow diagrams, CASP checklists are typically used to critically analyse research that uses quantitative methods. The rationale for using a CASP checklist for qualitative studies was the included literature had qualitative methods (namely, expert opinion or case reports); therefore, using a valid and reliable qualitative critical appraisal tool contributes to the academic rigour and systematic approach to this literature review.

The CASP Qualitative Studies Checklist applies to all qualitative methods (Critical Appraisal Skills Programme, 2022). The first two questions are used to screen each article included in the literature review, which are followed by eight questions that deepen the quality assessment. In the CASP (2022) guidelines, it is advocated not to use a scoring system (that is, a score out of ten) but to critically appraise each article through narrative based on the subject of the question (Critical Appraisal Skills Programme, 2022). All included literature in this review (n = 108) were deemed as having acceptable quality of qualitative research. It is likely no included literature needed to be excluded due to lack of quality because an inclusion criterion was being a peer-reviewed article; however, the quality assessment demonstrates the academic rigour of this literature review. The critical appraisal of the included literature is included in the thematic presentation of the literature review findings.

3.3.2 Themes

The findings of this literature review are presented in the themes that were identified using reflexive thematic analysis. Eight themes were identified following the completion of the reflexive thematic analysis approach that was used for this literature review (see 3.2.2). Each theme is critically analysed, following which a discussion of how the findings answer the research question and achieve the research aim is presented.

3.3.2.1 Beyond planning timelines

Resent conflicts in the middle East catalysed a paradigm shift in military health systems that was needed to meet the health needs of service personnel traumatically injured in battle (Smith and Wainscot, 2021, Quinn et al., 2020). The injuries service personnel had been life-threatening and complex, caused most often by improvised explosive devices (IEDs) buried in the ground or rocket propelled grenades (RPGs) (Travers et al., 2019, Bricknell and Nadin, 2017). As with all warfare, strategies needed to be in place to mitigate risks to health (Powell et al., 2016). Tactical combat casualty care (TCCC – a military trauma care model) was enhanced to increase the capability of prehospital care, including blood transfusions and trauma care in the field (previously completed in hospital), and aeromedical evacuation to a trauma or surgical centre (Fisher et al., 2015, Daniel et al., 2016). This model of prehospital care is known as the 'golden-hour' – to stabilise and evacuate a patient within one hour from the point of injury to a sufficiently resources health centre or hospital (Jamie et al., 2017, Keenan and Riesberg, 2017). The impact of this change of practice held down mortality and morbidity rates to significantly lower levels in comparison to previous conflicts and evidently saved many lives (DeSoucy et al., 2017).

The golden-hour of prehospital care was extremely successful at mitigating the risk of morbidity and mortality, as such similar models were adopted and adapted for civilian trauma systems (Callaway, 2017). While the golden-hour model of trauma care has been proven to be vital in saving lives, it relies on infrastructure and capability of aeromedical evacuation (Scallan et al., 2020). The conflicts in the Middle East of the early 21st century saw exceptionally advanced field hospitals built, such as Camp Bastion, and a fleet of Chinook helicopter that flew huge amounts of trauma care equipment (including highly trained personnel) to the field to aeromedically evacuate injured personnel to the field hospitals. Camp Bastion was closed in October 2014 and, as a result, the infrastructure that the golden-hour model of trauma care relied on was not available (Bricknell and Nadin, 2017). This situation highlighted the need for another transition of military health system that could meet patient's health needs with limited resources and delayed evacuation beyond the golden-hour (Smith and Withnall, 2018).

It is well documented that future warfare (although, some argue it is current warfare) requires smaller military units being deployed to remote environments who will be required to operate self-sufficiently and autonomously (Russell et al., 2020). Thus, if a personnel are injured, health care providers will need to meet the patients' health needs by optimising the resources available to sustain life and promote health until evacuation is possible (Jamie et al., 2017). It is important to note that in some contexts, the length of delay until evacuation or aeromedical evacuation is possible ranges from hours to weeks (Kirkpatrick et al., 2017). Thus, there is an evident recognition in the literature that the development of clinical practice, policy, and training in PFC is required to mitigate risks to health in remote environments beyond planning timelines (Bricknell and Nadin, 2017).

It is noted that without PFC – capability of meeting health needs in remote environments with minimal resources, limited access to health systems, and delayed evacuation – the risk of patient morbidity and mortality will increase (Keenan and Riesberg, 2017). Thus, PFC may improve the health outcomes of patients and reduce risks to their health (Smith et al., 2021). Things brings into question how the contextual influences of health change while in a remote environment for longer periods can caused additional delays (Daniel et al., 2016). Changeable weather, helicopter availability, or poor communication chains may cause evacuation to be delayed further (Smith, 2017). Circumstances such as this force military units deployed to remote environments to conduct advanced care prehospitally, which may even include dialysis (manual filtration of the blood) after acute kidney injury (traumatic injury to the kidneys) (Sever et al., 2020). This will result in an adaption of the medical resources that are required for deployment to remote environments and it is recognised that denying patients to the same standards of evidence-based care is not an option (Mallinson, 2017). Thus, further analysis of pre-deployment training and preparation for PFC is required (Bridges, 2018). It is noted that although military health systems have substantial experience of

PFC, the future characteristics of deployment raise significant challenges – military health systems are required to become more expeditionary, dynamic, and adaptive to the environment they are in beyond the typically planning timelines current health systems are modelled on in order to meet all patients' health needs (Smith and Withnall, 2018).

3.3.2.2 Holistic health and interdisciplinary practice

The ability to provide PFC, that is care beyond the planning timelines, is advocated as being able to provide all the health needs of patients. In other words, providing holistic care – the combinations of clinical intervention and therapy to meet physical, psychosocial, and all other interpretations of health. It is advocated that planning for health care provision in remote environments should involve PFC capabilities, conducted by the leadership team (Callaway, 2017). This includes the ability to provide holistic health care, which ultimately mitigate risks to health as well as having the capability to respond to acute medical situations. However, it is acknowledged that holistic health needs will be influenced by the environment (weather, geopolitical, or anthropogenic influences) and resources available. This includes from trauma care and PFC of patients with minor injury or illness (Chalela and Britell, 2019).

A current model of health systems in remote environments, particularly for trauma care, is the having the ability of rapid aeromedical evacuation to a well-resourced care setting. In this model of health system, stabilising the patient in the field is a priority knowing that they will have continuity of care away from the field. It is, however, noted that this model of health systems cannot be relied upon for all circumstances, therefore, capability of PFC must be included (Convertino et al., 2017). Two challenges to this capability is have finite resources available and PFC providers who are trained to provide holistic health care (Daniel et al., 2016). In other words, an urban model of health systems relies on the patient being transferred to members of a MDT; however, in remote environments this is not an option so PFC providers must have interdisciplinary practice. This is not something typically taught (Callaway, 2017).

Reflecting on and critiquing previous experiences of providing PFC are methods to identify lessons learned of PFC. While this is not teaching, this approach to learning from experience was completed by the UK Defence Medical Services after OPERATION TELIC (Iraq) and OPERATION HERRICK (Afghanistan) (Bricknell and Nadin, 2017). It enabled the Defence Medical Services to develop clinical policy that improved their ability to provide continuity of holistic care beyond planning times; that is, PFC. Training on decision-making and resource optimisation were identified as key subjects; however, it is highlighted by Bricknell and Nadin (2017) that more research in this area is needed.

In military medicine, it is seen as significantly important to be able to provide PFC due to the likelihood of delayed evacuation caused by conflict (Bridges, 2018). This applies from the moment of injury until evacuation to a care setting with substantial resources, enough to meet the holistic health needs of the patient. Furthermore, the use of technology informs clinical decision-making, which contributes to enabling person-centred care (Bui et al., 2021, Mesar et al., 2018). For example, mobile ultrasound can be used for diagnosing reversable causes of cardiac arrest – tension pneumothorax (collapsed lung), hypoxemia (low oxygen in the blood), hypovolaemia (low levels of blood), cardiac tamponade (compression of the heart from fluid in the membrane surrounding the heart) and pulmonary thromboembolism (a blocked blood vessel to the lungs) (Budimski, 2018). Evidence-based clinical decision-making is significantly important considering the influences of the remote environment patients are in, potentially for significantly long periods of time.

3.3.2.3 Remote environment

The application of PFC takes place prehospitally in a remote or rural environment. Prehospital care includes care provided in an urban community; however, PFC is different due to the minimal amount of available resources, limited access to health care services, and delayed evacuation. These three challenges are threads that tie all remote environments together within the context of PFC. It is important to note that the difference between all remote environments are vast. In this section, the findings from the literature about the remote environment that PFC takes place in are presented.

As previously noted, the majority of literature about PFC focuses on military health systems. Telemedicine is identified as key technology that can extend the reach of health systems; in other words, virtually bringing clinical experts from a hospital setting to the remote environment (Nettesheim et al., 2018). This is important for long-duration and long-distance deployment where land, sea, and air evacuations are likely to be delayed, thus the focus of clinical practice needs to be readjusted to protecting and promoting health regardless of the environment (Rasmussen et al., 2015, Smith and Withnall, 2018).

In the military context, special forces (SF) operations frequently require capability of PFC. Small units are covertly deployed into austere environments (conflict zones or enemy territory) which can be geographically remote or remote because SF cannot use local health services to ensure their identities and location are protected. Thus, SF operations are required to be light-touch (unnoticeable) and, therefore, they have limited resources available to avoid attracting attention, and personnel are required to be highly mobile to avoid being identified, captured, or injured (Daniel et al., 2016). In effect, due to the requires of SF units, they operate in a remote environment regardless of the infrastructure they can reach. Other military forces may also be required to be deployed in small numbers and, therefore, can experience similar circumstances.

Once example of an environments military forces can be deployed to is a Naval ship. Naval vessels often have designated hospital facilities; however, space is confined so resources are also limited and access to more substantial resources or evacuation may be delayed due to poor weather or conflict (Whybourn et al., 2019). In this circumstance, although there are more people deployed on military operations, the influences of remoteness are resolute. However, the geographical location of deployment also influences the remoteness or ruralness. One study examined 54 cases of PFC and analysed the location each episode of care took pace in (DeSoucy et al., 2017). 52 cases (96%) were described as taking place in a remote environment, identified as mountainous, desert, maritime, or jungle. This study quantifies the number of PFC cases in remote environments; however, this sample size is small in comparison to the total number of PFC cases that take place. There is no database of PFC cases, therefore, the total number is unknown; however, it is evident that there are a significantly high number when considering acute and minor care in remote environments (military or civilian).

Another perspective that is considered is the effect of international military alliances. What is described as hybrid conflict refers to the shift away from large single military deployment towards multiple militaries working together for a common cause. As a result, smaller numbers of military personnel are deployed across larger geographical areas. While this mitigates the risk of a high-density of casualties in one area, it spreads resources more thinly and increases the risk of not having sufficient capability to provide health care when required (Jamie et al., 2017). Military health systems operating in remote environments are often in different circumstances in comparison to civilian health systems; however, the relative risks to health are similar (Smith, 2017).

Although much of the PFC literature focuses on military health systems, it is acknowledges that civilians also require PFC capability in remote environments because many of the risks are the same – minimal resources, limited access to health services, and delayed evacuations (Callaway, 2017). Even the risk of being in an austere environment can be relevant to civilians – recent conflicts in Ukraine shows more than 14 million people have been displaced from a conflict zone and many humanitarian NGOs have personnel deployed to the front line, despite being civilians. Civilian operations in remote environments are often for expeditions – trips to remote environments for adventurous sport or scientific research, for example. One publication quantified remoteness by the amount of time it would take to evacuate someone to a care setting with sufficient resources available to meet their health needs (Mellor et al., 2015). (Mellor et al. published an update of this article in 2020; however, it was published online via The Royal College of Surgeons of Edinburgh website and, therefore, it was not captured as a peer-reviewed article.) The time parameters are less than 4 hours, 5-11 hours, greater than 12 hours – the longer duration equates to the more remote a location and, therefore, the high risks to health. Mellor et al. (2015) add that there are other influences of risks to health, namely the physical location, the activities taking place there, and the demographics of the group. The last feature listed here is unique to civilian PFC in that greater diversity of people travel to or pass through a remote environment in comparison to military service personnel. Service personnel will be trained the very similar physical and psychological standards, whereas civilian groups on an expedition have huge variance in their experience levels and health on arrival. According to Mellor et al. (2015), this potentially increases the levels of risk to health.

Mellor et al. (2015) explores the risk of illness and injury in remote environments. They conclude that often severe traumatic injury has very poor morbidity and mortality in remote environments due to circumstantial increases in the risks to health and the complexity of expeditions to these locations. Examples of influences include –

- Injury or illness occurs away from PFC provider
- The patient is travelling alone and is not able to identify their location or call for help
- A delayed response due to poor weather or communication errors

It is important to note that Mellor et al. (2015) does not licence standards of evidence-based, person-centred care to drop; however, they do highlight that the number of non-survivable cases of traumatic injury or illness in a remote environment are small. The majority of health needs during an expedition to remote environments are the prolonged care of minor injury or illness that can be provided by a suitably trained and experienced PFC provider. Mellor et al. (2015) continues that care begins before being in the environment, that is the health and safety screening of expedition participants to identify long-term health needs that require monitoring or care during the expedition. Furthermore, having a rigorous leadership process in place and ensuring those who need to know about the ongoing care during the expedition is fundamental to ensuring continuity of care during the expedition. Education about risks to health during the expedition while in a remote environment also mitigates risks by raising awareness and if new information about long-term care needs surfaces, a new risk assessment should be conducted in the field. Sharing the findings of risk assessments with expedition participants is important to enable informed decision-making about if participants would like to take part in the expedition; thus, rigorous planning and processes should be explained to participants, so they know the risks to their health they are taking.

3.3.2.4 Space

Space is as another remote environment that humans have a presence in, and space exploration can be described as an extreme example of PFC utilisation (Schlotman et al., 2019). Many of the environmental challenges faced by PFC in outer space are in parallel with PFC in remote environments on Earth, namely limited accessibility to health services, minimal resources, and delayed evacuation. In other words, care beyond planning timelines (Schlotman et al., 2019). Some challenges are unique to space, such as zero- or low-gravity, which could suggest PFC in space has no relevance for life on Earth; however, it should be emphasised that each remote environment (on- or off-world) is unique and often incomparable. In the aftermath of a volcanic eruption, toxic gases inhibit a breathable atmosphere and underwater diving expeditions provide a low-gravity simulations. Thus, although space may appear at first to be aliened to Earth, it is another remote environment people require PFC.

In addition to the environmental risks to health in space, other risks to health include pre-deployment training for PFC providers in autonomous clinical decision-making (including astronauts who are not from a health care background) without real time support from experienced colleagues, which includes resource optimisation. The relevance here is closely related to people deployed to a remote environment (military, humanitarian, expedition) who require PFC – they require bespoke pre-deployment training in order to meet the health needs of colleagues, knowing that the health systems they are used to are not available. People who live in remote environments could be better equipment to meet these challenges due to their life experience of not having substantial health systems available to them. Schlotman et al. (2019) compares compensatory reserve measurement (CRM) utilisation in military medicine with space exploration. CRM is the measurement of blood pressure, blood flow, and tissue oxygenation through via non-invasive wearable technology using machine learning. CRM data provides physiological and psychosocial health information; thus, it acknowledges the interrelation between physical and psychosocial health. CRM data, therefore, enables informed clinical decision-making and early intervention to be made, which mitigates minor injury or illness (physically and psychosocially) escalating into life-threatening conditions.

To prepare for space flight and exploration, space agencies conduct analogue missions – simulated space missions that take place on Earth – which provide opportunities to train and test people, procedures, and equipment for space travel (Posselt et al., 2021). analogue mission simulate specific aspects of space that are identified in the mission design, for example confinement and isolation, low- or zero-gravity, or remoteness. analogues, therefore, provide an opportunity for PFC pre-deployment training (although, PFC may be referred to by other names), such as the use of remote monitoring technology as explained by Schlotman et al. (2019). It is important to note, however, that analogue which take place in remote environments simulate health risks in space and have risks to health in reality. Posselt et al. (2021) advocates separating the in-simulation and in-reality risks in the analogue mission design, then allocating resources to each and defining procedures to follow for in-simulation and in-reality PFC and emergency response.

Table 4 maps the space simulation and analogue environments with risks on earth (based on (Posselt et al., 2021)). Thus, analogue missions are a vehicle to develop disaster risk reduction strategy for space travel and contribute to disaster risk reduction in remote environments on Earth. In any environment, it is important to understand the risks to health in order to mitigate against them.

Table 4 Analogue mission risks to health

Analogue environment	Space simulation	Risks to health[4]
Altitude	Remoteness, environmental conditions	Altitude-related sicknesses Cold injury Heat injury Hypoxia (low oxygen level) Sleep disorder UV radiation exposure
Arctic/Antarctic deserts	Remoteness, environmental conditions	Circadian rhythm disturbance and seasonal disorders (sleep disorder) Cold injury Polar animals UV radiation exposure (summer)
Desert (non-polar)	Remoteness, aesthetics	Cold injury (night) Dehydration Heat injury (day) UV radiation exposure (day) Venomous animals

[4] In addition to limited accessibility to health services, minimal resources, and delayed evacuation, which all analogue environments listed experience.

Subaqueous	Low- or zero-gravity	Cold injury Decompression sickness Drowning Fire Hypercapnia (carbon dioxide accumulation) Hypoxia (low oxygen level) Marine animals
Subterranean (cave systems)	Remoteness, environmental conditions	Cold injury Flash flooding Infectious diseases if pathogens present with necessary vectors (bats/vermin) Rock fall Toxins (mould/fungus)
Volcanic	Remoteness, environmental conditions	Volcanic activity including earthquakes, venting of toxic gases, airborne particulates, heat, lava flows, volcanic bombs, and other ejecta

3.3.2.5 Risks to health

People in remote environments have increased risks to their health due, in part, to socioeconomic inequalities – minimal resources, limited access to health services, and delayed evacuations. Societal vulnerabilities to hazards such as poor or extreme weather, conflict, and displacement compound these risks to health. In this section, the risks to health of people in remote environments identified in the literature review are presented.

Traumatic events that cause acute medical injuries are frequently referred to as risks to health; namely, blood loss and kidney damage (Hoareau, 2017, Morgan et al., 2019). Traumatic events are likely caused by the activities taking place during time spent in a remote environment – conflict dominates the literature; however, civilian expeditions can also be high-risk of traumatic injury, depending on the activities taking place (Mellor et al., 2015). When such injuries occur, PFC is required until evacuation is possible (which ranges from hours to weeks). The logistics of getting to a remote or rural environment, however, limit the number of medical and health resources available to meet traumatic injury health needs. Blood loss requires blood transfusions; however, transporting blood products is exceptionally difficult due to the requirement of keeping them at a consistent temperature until the point of use (Bonanno et al., 2018). For acute kidney injury, dialysis may be required yet this treatment requires large, heavy, and expensive equipment (Napolitano, 2021). Thus, limited resources are risks to health in remote environments.

Rapid aeromedical evacuation to settings with advanced capabilities was possible during recent conflicts in the Middle East, and military health systems were recognised as excellent; however, geopolitical, socioeconomic, and operational influences have evolved military health systems into smaller, more agile forces (Bricknell and Nadin, 2017). Thus, providing PFC in war and conflict zones is a risk to service personnel and the PFC providers (Chalela and Britell, 2019, Pamplin et al., 2019). This risk was present during historical conflicts; however, smaller units could be more exposed without the protection of large military infrastructure seen during OP HERRICK in Afghanistan (Gumbley et al., 2013).

A risk to health that was identified during the recent conflicts in the Middle East was a team not being able to develop (Dickinson et al., 2016). Teamwork is essential in health care, even in remote environments where there may be one designated PFC provider. If there is an emergency, team members may be involved in resource management, identifying evacuation routes, securing shelter, organising the next meal. Of course, people can be in a remote environment independently, in which case self-care is essential. In both circumstances, care of the caregiver is equally as important as providing PFC to people with injuries and illnesses – without self-care, health will deteriorate. Pre-deployment training is highlighted here as a tool to support the development of teamworking before deploying to a remote environment and to practice PFC (Royal and Smith, 2020).

PFC providers are usually practitioners with experience of providing health care with access to supervision and consultation if they require it (Gumbley et al., 2013). In remote environments, telemedicine may enable this; however, technology is temporary and there is a risk it will fail. It is emphasised that during pre-deployment training, familiarity of clinical guidance and policy is paramount due to the risk that telemedicine may not be available (Ieronimakis et al., 2021). Due to the demands of being in a remote or rural environment, human error and equipment failure adds to the risks to health (Martin et al., 2021, White and Smith, 2020). A gap in the literature is acknowledging the lack of evidence-base to inform PFC, despite western medicine advocating an evidence-based approach to all care.

The environment itself causes risks to health, namely climatic injuries from the heat or cold, the animals and insects that live there, or exposure to plant life that people are allergic to (Hawkins and Simon, 2021). These risks also apply to urban environments; however, the availability of resources and capability of evacuation underlines the need to recognise these risks are a greater threat to life in remote environments. For PFC providers, dynamic risk assessments and management are frequently needed (Hawkins and Simon, 2021). The resources needed to manage these risks are limited; however, an ethical and moral question is raised if people in the remote environment require medical attention unexpectedly (Smith and Wainscot, 2021). Thus, resource management is key for PFC.

3.3.2.6 Military and civilian PFC

The literature focusing on PFC within military health systems is substantial. The contexts PFC is explored are conflict zones and warfare. It is unsurprising that the majority of health needs that are highlighted are traumatic injuries as a result of explosives or weaponry (Travers et al., 2019). Due to the change in military operations from large-scale deployment and camp establishment to smaller, agile unit deployment, PFC has become an important focus of research and development for military health systems (Smith et al., 2021, Smith and Withnall, 2018). It is important to note that despite a movement away from the ‘golden-hour’ model of trauma care, this approach to care still has a place when resources and infrastructure enable it (Dobson and Letson, 2020, Mesar et al., 2018). Providing the same standard of care in a remote environment with minimal resources, limited access to health services, and delayed evacuation are exceptional challenges that require rigorous systematic enquiry (Hooper et al., 2014, Lechner et al., 2018, Travers et al., 2019).

The focus of trauma care within the literature about the capability of military health systems to provide PFC is unsurprising; however, it is evident that trauma care is a physiological need. Experiencing a traumatic event is both physically and psychologically traumatic but prolonged mental health care is a subject missing from the literature. There is no evidence to suggest that mental health care does not feature in the ‘golden-hour’ of trauma care; however, it seems unlikely that rigorous mental health care could be provided within an hour from the point of injury to delivery to a care setting – life-threatening injuries are rightly the priority at this point (namely, blood loss, shock, and infection) (Daniel et al., 2016, Dickinson et al., 2016). Mental health care within PFC is, however, more reasonable due to the amount of time that is available before evacuation or recovery. Evidence does suggest that early intervention for mental health care does mitigate the risks of further psychological trauma; however, this is usually completed by a mental health practitioner. A PFC provider, therefore, needs training in how to provide evidence-based mental health care.

Many of the physical and psychosocial health needs of service personnel are experienced by civilians in remote environments. It is important to note that civilians can be in conflict or war zones too, either permanently living there, temporarily working there as part of humanitarian relief, or being caught there unexpectedly. As a result, traumatic injuries are also frequently experienced that are treated within military or local health systems. The supply chain to local hospitals may become disrupted, therefore, what was previously a well-supplied hospital, can end up with minimal resources, limited access to other care settings, and delayed evacuations of those who need it – in other words, PFC within the urban environment (Quinn et al., 2020). As a result of war, many civilians become displaced and leaves their homes, often the country, to seek safety and the care they need. During this journey, the same challenges of minimal resources, limited access to health services, and delayed evacuation are experienced. Once they reach their destination, the resources of local health systems are in high demand, therefore, sustainable management of resources is required to continue meeting the needs of local communities and refugees.

Civilian PFC also includes people who travel through remote environments. Expeditions to remote environments are referred to in the literature. Similarly to military PFC, the capability of providing trauma care for extended periods with minimal resources, limited health service access, and delayed evacuation is frequently referred to. This suggests that shared learning between military and civilian health systems is necessary practice, which is also acknowledged in the literature (Bricknell and Nadin, 2017, Charnell and Rainey, 2019). What is missing in the literature is the variance in the number of resources available to civilians travelling through remote environments. Many expeditions, including on land, sea, and air, cannot take the same volume of resources as compared to military forces due to logistics and expense. Minimal resources are, therefore, taken during expeditions to save weight and finance. Minimal resources refer to taking what is required to meet common health needs while in a remote or rural environment; however, PFC providers and expedition leaders need to make careful decisions about what to take and, moreover, what to leave behind knowing that resupply may be delayed or impossible. Technology is a tool that can extend the reach of health services by providing access to consultation; however, availability of such resources varies hugely (Bui et al., 2021).

3.3.2.7 Technology

The utilisation of technology in remote environments is investigated within the literature. Telecommunications (also referred to as telemedicine, teleconsultation, etc.) is described as a tool to provide clinical supervision from experts anywhere in the world to those in a remote environment who require it. The traumatic events experienced by military and civilian persons is an example of when senior clinical supervision may be required, which is considered normal practice in urban environments (Vasios et al., 2017). In addition, other injuries or illness may require clinical supervision, for example, infections from insect bites in the tropics (Murray, 2017). There are significant numbers of insects and resultant infections, therefore, having an expert in tropical medicine or dermatology can help the PFC to make informed decisions in the field. It is important to note that PFC providers cannot be experts in every health discipline (nor are they expected to be in their usual working environment); however, they are expected to provide evidence-based, person-centred care. Telecommunication, however, can provide virtual access to health services where there are experts in other health disciplines; thus, without telecommunication, access would be severely limited and risks to health are increased (Murray, 2017).

Telecommunication is enabled by space technology via satellites. It can be argued, therefore, that space technology has an indirect role within PFC. Telecommunication provides video conferencing; however, satellite phones, and emails are also tools of communication that can be used to aid clinical decision-making during PFC. Information governance and the same standards of data protection are exceptionally important to maintaining patient confidentiality, therefore, data protection plans should be in place when in remote environments. While satellite technology provides global telecommunications, there are risks it will fail. The topography of the remote environment may prevent a signal, extremes in temperature may damage batteries and equipment, and solar storms are a hazard that could wipe out electrical capability of all devices. Reliance on telecommunications is, therefore, a vulnerability to disaster. To increase the resilience of remote health systems, including during an expedition, the capability of providing PFC should be planned for with and without the aid of telecommunications to mitigate the risk of disaster (Powell et al., 2016, Van Gent et al., 2018, Vasios et al., 2017).

PFC is often required during the response to a large disaster, such as conflict or disasters caused be vulnerability to natural hazards (for example, flooding) (Murray, 2017, Quinn et al., 2020, Sever et al., 2020). The same challenges arise during such events – minimal resources, limited access to health services, and delayed evacuations. Drone technology is explored in the literature as a potential tool to provide a lifeline in the aftermath of a disaster (Mesar et al., 2018, Mora, 2020). The impact drones could have on patients with health in needs in remote environments have been investigated in the transportation of resources, such as blood products (Mora, 2020). Drones, therefore, have the potential to resupply resources, which may mitigate risks to health; however, drones have a limited carrying capacity (at present) and can only fly in calm weather conditions (which are short-lived in remote environments). Furthermore, the current expense of drones limits this service to the wealthy; however, as this emerging technology develops, it is expected to become more affordable. Drone technology is not limited to resupply of resources. In the correct weather conditions, drones extend the reach of search and rescue services. The complexity of remote environments physical geography complicates search and rescue, such as in mountain regions. Drones equipped with cameras enable rapid aerial surveying of landscapes, which may help to locate people who are ill or injured. Rescue teams can more efficiently target their resources to a specific location, rather than spreading out to locate someone who is lost, then regroup before reaching the lost party.

The use of drone technology in remote health systems is innovative, therefore, to enable effect use requires training (Mesar et al., 2018).

3.3.2.8 Pre-deployment training

For planned deployment to remote environments, pre-deployment training is necessary to equip personnel with the knowledge, competencies, and approaches to undertake the planned activities. There are differences between military and civilian activities in remote environments, although there are similarities as previously discussed. Activities that require pre-deployment training include conflict, war, and humanitarian response (Bricknell and Nadin, 2017, Charnell and Rainey, 2019, Christensen, 2018). Military and civilian personnel are deployed at short notice for these activities; however, their pre-deployment training is ongoing in anticipation of these activities. Due to the demands of these activities in remote environments, pre-deployment training for health provision is similarly required.

The requirement for PFC pre-deployment training that will take place in remote environments is highlighted in the literature. Clinical simulation is highlighted as a tool for PFC pre-deployment training. Clinical simulation involves training in a formal learning environment (for example, a classroom or training exercise area) that has representative elements of the environment or context that is being simulated. For remote environment simulation, a health care scenario may be designed for health care providers to practise PFC. To increase the fidelity (realism of simulation), aspects of a remote environment will be represented – for example, resources for the exercise may be kept to a minimum, the ability to use telecommunication will be limited, and participants will be informed evacuation is delayed. Thus, clinical simulation provides an opportunity for PFC providers to develop strategies, test equipment, or consolidate team working before deploying to a remote environment. Engaging in pre-deployment training, therefore, can mitigate risks to health in remote environments because errors can be corrected within the safety of a learning environment. Errors may include equipment faults, human error, or flaws in policy. The higher the clinical simulation fidelity (that is, the more realistic the simulation), the more applicable the pre-deployment training will be when utilised in a remote environment (Andersen et al., 2017, Charnell and Rainey, 2019, Christensen, 2018).

A question the literature does not address is why PFC pre-deployment training is required for health care providers. In Western health systems, health care providers usually practice within a team of other health professionals – a MDT. The patient will be cared for by a member of the MDT who has the expertise to meet their health needs at a given time. The patient is described has having a journey from the point of illness or injury to good health (good health is relative to individual patients, which may not be their original state of health before the illness or injury). In remote environments, there is a limited number of the MDT at best; more likely there is one PFC provider. Thus, to meet the same standard of care in remote environments, health care providers need to be able to provide multidisciplinary care (within their scope of practice – a nurse cannot prescribe medications, unless they have completed a prescriber's course and successfully completed a competency assessment). In other words, PFC needs to meet all holistic care needs and, therefore, the PFC provider is an interdisciplinary practitioner. Interdisciplinary health care practice is atypical for the majority of health care providers, except in remote environments. This underlines the need for pre-deployment training in interdisciplinary health care practice to equip PFC providers with the knowledge, competencies, and approaches to meet all holistic care needs. This requirement is missing in the literature and is, therefore, a well-defined research gap.

3.3.3 Research gaps

It is evident that PFC in remote environments already takes place in clinical practice due to anecdotal evidence in the literature; however, there are defined research gaps that require further systematic investigation. The PFC research gaps have been compiled and are presented in this section.

The current prehospital trauma care system is based on the 'golden-hour' – the capability to aeromedically evacuate a patient from the field to a surgical or trauma centre (dependent on their medical needs) within 1-hour after the point of injury (Keenan and Riesberg, 2017). In many remote environments, the 'golden-hour' model cannot be relied upon due to the unpredictability of the conditions and context (Hawkins and Simon, 2021, Smith and Withnall, 2018). Some influencing factors include bad or extreme weather changes, geopolitical instability, or conflict. Thus, within the PFC context, it is advocated that the PFC model requires further research to inform pre-deployment training, clinical guidance, and clinical decision-making in remote environments (Jamie et al., 2017). It is also noted that care of non-physical illness and injury (psychosocial health needs) is absence from the literature, despite people having these health needs in remote environments (Mellor et al., 2015, Meyer and Wynn, 2018).

The use of technology in remote environments has been examined. For example, basic technology, such as the innovation of lightweight and portable oxygen apparatus, has been a topic of research to enable more resources to be transported to and in remote environments (Bialas et al., 2019). However, considering the rapid development (and reliance) on technology, the use of such innovations and the data they produce is a well-defined research gap. For example, telemedicine (also known as teleconsultation, ehealth, etc.) is a tool that can be used to virtually transport experience clinicians to a remote environment who can provide supervision, guidance, and consultation to PFC providers is an under researched topic (Nettesheim et al., 2018). The use of telemedicine is well documented; however, it is advocated that more research is needed to examine use during PFC in remote environments (Wells et al., 2018). It is insignificantly important to note that technology should not replace PFC – technology fails and reliance on this capability is a vulnerability that increases the risk of disaster. Drone technology is another example of innovations for remote environments; namely, to resupply resources, however, research in this area is still in the infancy stages, thus is it currently unclear how drone technology could mitigate risks to health (Mora, 2020).

It is clear the vast majority of PFC research that has been completed is primarily for and within military health systems. The approach to this research has been to combine published evidence (which is focused on practice accounts from experienced practitioners) with subject matter experts in PFC to develop clinical policy (Smith, 2017). This body of literature has been described as informing the practice of ‘Role 1’ health care providers – that is, primary health care practitioners (those who practice prehospitally) – which includes those in a remote or rural environment. ‘Role 1’ applies to military health systems and, therefore, limits the generalisability of this research to other military health systems around the world (who use a universal ‘military language’). Military PFC research has focused on developing evidence-based ‘algorithms’ for clinical practice (Smith et al., 2021). An algorithmic prescription of clinical practice is commonplace in military and civilian health systems to optimise clinical decision-making in well-defined circumstances (for example, sepsis – extreme blood poisoning as a result of infection) (Smith et al., 2021). This research is useful to inform pre-deployment training, clinical practice, and guidance in specific circumstances; however, predetermining all risks to health in a remote environment is exceptionally difficult due to the rapidly changing influencing factors. This identifies the research gap of a theory to PFC in remote environments.

A theory to PFC in remote environments is an area of research that has not been examined. Literature that is available does make valuable contributions PFC practice, policy, and pre-deployment training; however, without a theoretical foundation, there is no evidence-based framework to inform these areas and the future research of PFC in remote environments. As a result, clinical practice, policy, pre-deployment training, and research is developed heuristically by gathering evidence as it is identified. While this approach to science works to generate new knowledge, an important ethical consideration is PFC effects people’s health and wellbeing. In western medicine, a modern principle is clinical practice, guidance, and pre-deployment training should be based on evidence and not based on the traditional approach of trial and error. It can be noted, therefore, that a theory to PFC would make a valuable and original contribution to knowledge of PFC in remote environments. Furthermore, having a theory to PFC in remote environments would contribute to mitigating risks to health because the clinical practice, policy, and pre-deployment training can be based on a substantial and rigorous piece of research. By extension, this mitigates risks to health of people in remote environments.

3.4 Discussion

In the previous section, the findings of this literature review are presented. In this section, the findings are synthesised and critically appraised through narrative to define how this review informs the context of this research (Grant and Booth, 2009). The discussion has been organised into themes relevant to the research topic of PFC in remote environments to mitigate risks to health. This section also includes a declaration of the review limitations to define the limits of the review findings.

Overall, there are definitions of PFC in the literature; however, there is no standardised definition. The most common definition refers to planning timelines, but this definition also contains ambiguity – planning timelines differ hugely depending on the activity taking place in a remote or rural environment. The lack of clarity about the definition of PFC suggests this topic is not fully understood and, therefore, requires substantial systematic investigation. The data that is available is empirical, reporting on episodes of PFC in remote environments. There is anecdotal evidence that suggests PFC mitigates risks to health; however, the data that is available is limited when compared with the volume of high-risk activities in remote environments. It is clear that living in, travelling through, or being displaced to a remote environment has increased risks to health but how PFC mitigates these risks requires further systematic inquiry.

3.4.1 Remoteness

The environments that PFC take place in, based on the literature, are described as remote by the length of journey duration to or from a location. This measure of remoteness is adaptable enough to account of the circumstances that cause delayed evacuation when the distance is relatively short. For example, conflict or extreme weather may prevent aeromedical evacuation and, in both examples, the length of time it would take to evacuate a patient would be extended. Disasters caused by vulnerability to natural hazards, such as flooding, may also experience delayed evacuation and the journey time measure of remoteness fits with this context. However, it is important to note that remoteness brings to the surface other risks to health in addition to delayed evacuation – minimal resources and limited access to health services. The physical geography of remote environments – in the air (including space), on the land, and at sea – limits the logistics of resource management and access to health services. Thus, to understand remoteness, all aspects of what constitutes remote needs to be considered for PFC to mitigate risks to health. The literature refers to remoteness multiple times; however, ruralness is discussed less frequently. Rural health systems may have basic health service facilities and more resources; however, rural health systems are charged with providing care for larger amounts of people who are widely dispersed. Thus, resources can quickly become used up and resupply may not be an option, therefore, the risks to health in remote environments equate to rural environments too. More research is needed in this area.

3.4.2 Holistic health

Physical and physiological health in remote environments are thoroughly investigated in the literature (although more research is needed), particularly the challenges of trauma care. Psychosocial and mental health care is significantly important and effects physical and physiological health, yet literature focusing on psychosocial and mental health care is limited. For example, how remoteness effects mental health is an important consideration. For people deployed to a remote or rural environment, sociological relationships are starkly different in comparison to urban environments; namely, people are in close proximity for long durations regardless of if they have healthy relationships or not. If deployed to a remote environment for work, there the option for personal space may be limited, which may affect mental health. Furthermore, limited connection with family and friends may add to the strain of being remote so homesickness may start to affect functionality, which is missing from the literature. Minor injury and illness, such as homesickness or wound care, in remote environments is referred to in the literature; however, there are no studies that focus on how PFC of minor illness and injury can mitigate the risk of these conditions escalating into an acute emergency. Furthermore, the promotion of health in remote environments is not referred to in the literature at all, despite the potential for maintaining and promoting good health mitigating risks of injury and illness.

3.4.3 Pre-deployment training

It is clear that managing risks to health by providing PFC in remote environments is complex and atypical practice for health care providers. Pre-deployment training is, therefore, vital in preparing PFC providers to meet these challenges. A significant clinical challenge in the requirement to provide interdisciplinary PFC, potentially without the support of specialised from the MDT. Interdisciplinary practice is essential to meeting all the holistic care needs that patients have in remote environments, including drawing on the discipline of public health to promote and protect good health. Thus, interdisciplinary PFC practice has the potential to mitigate risks to health; however, there is currently no research in this area.

To develop interdisciplinary PFC practice, pre-deployment training is required. Pre-deployment training is acknowledged in the literature and is the focus of some research; however, the evidence-base is small. Clinical simulation is referred to as a method of pre-deployment training but the training of people first on scene, who may not be PFC providers (60% of the time according to DeSoucy et al. (2017)), is a noticeable research gap. Learning how to optimise resources as well as how to mitigate further risks to health are topics that are highlighted as needed in PFC curriculums.

While the importance of what to learn for PFC in remote environments to mitigate risks to health is clear, how to learn is less evident. Clinical simulation has been noted as one tool; however, the literature is based mostly on account of PFC from experienced practitioners, which suggests peer-learning is fundamental to PFC pre-deployment training. There is no literature on learning from other health care practitioners and how this could inform PFC practice in remote environments to mitigate risks to health. The evidence that is available to inform PFC pre-deployment training is, as previously noted, limited to accounts and anecdotes. There is also no research that investigates what evidence is used to inform PFC pre-deployment – a critical appraisal of this evidence would help to inform PFC providers and contribute to their clinical decision-making in the field.

3.4.4 Limitations

As with all literature reviews, there are limitations to this review. A traditional literature method was used to conduct a comprehensive search and analysis of literature about PFC in remote environments. A critique of this method is the potential for the introduction of selection bias when compared to a systematic review. A systematic review requires repeated use of the search strategy (with no deviation) to identify all literature on a topic that uses the same research methods. Systematic review findings are seen as more reliable (less risk of bias) due to the repeatability of the search strategy. A systematic review could have been conducted; however, the body of literature that is available has huge variations in the methods used – qualitative research is predominant, with methods such as case reports and expert opinion as the most frequently used. Thus, a systematic review would have excluded a significant amount of literature about PFC in remote environments, which would have prevented the review aim of conducting a comprehensive review of the literature to define the PFC research gaps and develop theoretical sensitivity to the theory of PFC that is needed for data analysis from being achieved. To increase the reliability of the review findings, the search strategy and review methods have been explicitly presented. Transparency of the search strategy and review methods demonstrates the robustness of this literature review and how the findings were identified.

The findings of this literature review are based on the literature published before the time of writing; therefore, subsequently published literature has not been included. More case study research and reports from practice may produce new insights into the understanding and knowledge base of PFC in remote environments, and how PFC mitigates risks to health. It is likely that all accounts and reports of PFC will be unique, even in locations where PFC has occurred previously, due to the dynamic nature of remote environments. Furthermore, the tidal change of geopolitics and international relations will fuel the evolvement of remote health systems, including within military and civilian practice. The absence of this new research limits the findings of this review to the time of publication; however, this limitation underlines the importance of conducting more research of PFC in remote environments to understand how PFC mitigates risks to health. This review has been conducted by one research, therefore, as more research is published, a team of researchers may be required to command the literature and synthesis new insights and developments of knowledge.

3.5 Summary

In this chapter, a review of peer-reviewed literature about PFC is presented. The literature review is used to identify PFC research gaps and to establish a synthesis of literature about how PFC mitigates risks to health in remote environments. Thus, a traditional literature review method was used to enable a comprehensive search strategy that identified literature containing the results and findings of research using quantitative, qualitative, or mixed methods research. While the findings of a systematic review may be considered more reliable due to the repeatable search strategy, the search strategy for this literature review was systematic in nature and was explicitly presented to enable opportunity for critique and repetition. The research gaps that were identified in this literature review are –

- PFC is a developing area of practice and research, therefore, algorithms of practice are required to inform practice, policy, and pre-deployment training
- The body of literature about PFC utilisation in military health systems is growing and is set to increase due to the shift in military operationalisation; however, literature focusing on civilian PFC is less in comparison. More research of military and civilian PFC practice in remote environments is required.

- The risks to health experienced in remote environments are dynamic and require further systematic enquiry to understand the circumstantial risks; that is, the risks from activities and from the environment itself.
- The use of technology in remote environments to aid PFC is increasing yet the impact of this technology to mitigate risks to health is poorly understood.
- There is no theory to PFC in remote environments to explain how this practice could mitigate risks to health.

Defining the PFC research gaps has provided clarity of what research of PFC has taken place and the priorities for future research. Identifying the PFC research gaps has informed the design of this research in terms of avoiding duplication and focusing on bridging a research gap that has meaningful impact for practice. Thus, the research gap that will be focused on in this research is a theory of PFC in remote environments to mitigate risks to health. The methodology and methods used for this research are explained in Chapter 5 and Chapter 6; however, it is important to note at this point the literature review does not influence the selected method for this research – Grounded Theory. It is later explained that influence of the data sampling, collection, and analysis methods contradicts the organic generation of theory from the data, as advocated in Straussian grounded theory approach (see 6.3.3). Rather, in this literature review the PFC research gaps have been identified (which informs future research). Moreover, this literature review provides the genesis of theoretical sensitivity to PFC in remote environments (see 6.4.1.1). Theoretical sensitivity is required to enable the researcher to determine if and how new data contributes to the emerging theory of PFC. In other words, the findings of this literature review do not influence the methods of this research but initiates theoretical sensitivity.

The research gaps that have been identified in this literature review can be described as broad. For example, more algorithms of PFC in remote environments does not define which algorithms are required. A list of which algorithms are needed is not provided in the literature; hence this research gap is broad. Broad research gaps enable the avoidance of designing duplicate research; however, the findings of this literature review highlight PFC is a newly recognised area of research with many unknowns. The findings of this literature review initiate the development of theoretical sensitivity; however, broad research gaps suggest PFC is currently poorly understood. Thus, to develop a theory to PFC in remote environments, theoretical sensitivity requires further development beyond the point this literature review has provided. To attune theoretical sensitivity of PFC in remote environments to mitigate risks to health, a concept analysis has been designed and utilised.

The limitations of the existing body of literature results in PFC providers being reliant on indeterminate guidance and their intuition. In other words, they are required to develop their PFC practice heuristically from clinical experience that may or may not be applicable to the experiences of health risks in remote environments. As a result, patients in remote environments are exposed to non-evidence-based PFC practice and human error. The risks to health experienced in remote environments is, therefore, increased and the disparity of health inequality for people in remote environments is worsened.

The literature review conducted for this research provides a rigorous critical appraisal of the body of literature about PFC and how it mitigates risks to health. The literature review provides synoptic context to the research topic of this thesis and has identified substantial research gaps (significantly more than what can be included in one PhD). The research gap purposefully selected for this research is the absence of a PFC theory. The development of an evidence-based PFC grounded theory would provide health care providers, patients, and policy makers and informed evidence-base that contributes to mitigating risks to health in remote environments through PFC. Thus, PFC grounded theory requires systematic investigation. The research aim, objectives, and question are outlined and critically appraised in the next section of this chapter.

Chapter 4 Concept analysis

4.1 Introduction

A concept can be described as a specific topic that constitutes knowledge of a wider discipline (Walker and Avant, 2018). A concept can be the topic of research if the concept is poorly understood. PFC is a concept which has been identified as having no standardised and evidence-based definition and is a newly recognised area of research. The concept of utilising PFC in remote environments to mitigate risks to health is poorly understood (evidenced by limited literature focusing on this area); therefore, this concept requires robust investigation. The rationale for needing to understand this concept is to develop theoretical sensitivity to the theory of PFC in remote environments to mitigate risks to health (Blumer, 1970, Flick, 2018). Furthermore, it was identified in Chapter 3 that limited literature exists about how PFC is used to mitigate risks to health in remote environments. Thus, the concept analysis presented in this chapter was required to develop theoretical sensitivity to PFC and develop a richer understanding of the concept.

A concept analysis is a research method that systematically compartmentalises a concept into individual elements for investigation (Nuopponen, 2010). The findings of the concept analysis will, therefore, provide understanding and clarity of health, risks, and PFC in remote environments. Being equipped with this understanding increases the validity and trustworthiness of this research because PFC already exists in practice; therefore, understanding this practice enables more focused research. On the contrary, the design of this research could be exploratory (with an unknown aim, objectives, and research question); however, this may duplicate previous research of PFC, which would not make any contributions to science (other than potential new insights or confirmation of previous findings). Thus, PFC exists in practice and there is limited understanding, so a concept analysis has been identified as an appropriate study.

A concept analysis will provide clarity of PFC in remote environments; however, the process of systematically analysing the concept will calibrate and enhance the theoretical sensitivity needed for the research of a theoretical foundation. The impact of a concept analysis is to further strengthen the reliability of the findings, due to the greater depth of understanding PFC in remote environments.

A literature review would usually provide sufficient context before conducting research; however, in this instance, the literature review has highlighted there is a lack of understanding about PFC in remote environments. A concept analysis will provide sufficient understanding of this concept to research PFC in remote environments; however, similarly to the literature review, it is important to note that the concept analysis will not influence the data sampling, collection, and analysis methods. It is imperative that these methods are not influenced by the literature review or concept analysis to ensure the findings of this research – a theory to PFC – has been organically developed from the data (see 6.3.3). Thus, the findings of the literature review and concept analysis will not influence the design of the data sampling, collection, and analysis methods. Rather, the findings of the literature review have identified PFC research gaps and initiative theoretical sensitivity, whereas the findings of the concept analysis will provide clarity of PFC in remote environments and enhance the theoretical sensitivity to this concept.

The concept analysis method that will be used for this research is based on a combination of Foley and Davis (2017) and Rodgers (1989) phases of concept analysis. The aim is to conceptually analyse PFC to develop theoretical sensitivity. To achieve this aim, the following objectives have been outlined:

1. Complete a concept analysis using the process outlined in Table 5.
2. Critically appraise the concept analysis findings.

4.2 Methods

Rodgers (1989) concept analysis method is built from the origins of concept analyses, developed by Walker and Avant (1983), which were developed as a systematic approach to provide clarity of poorly understood concepts of practice and research (Chinn and Kramer, 1983, Nuopponen, 2010, Walker and Avant, 1983). Rodgers (1989) approach adopts an evolutionary approach to concept analysis which accounts for the complexity and dynamic nature of knowledge and understanding within reality (Rodgers, 1989). In other words, Rodgers (1989) advocates compartmentalising a concept in order to understand it as a whole, within the context it is being investigated. Foley and Davis (2017) guide to using Rodgers (1989) concept analysis delineates the approach into a systematic process. A systematic approach to concept analysis it is not advocated or discouraged; however, to increase the clarity and robustness of this concept analysis, a systematic approach is utilised (Foley and Davis, 2017). A systematic approach has been adopted to align with the principles of high-rigour scientific enquiry, therefore, strengthen the reliability of the findings.

Thus, the concept analysis method used in this research is based on a combination of Rodgers (1989) and Foley and Davis (2017) approaches. The process used to conceptually analyse PFC in remote environments is presented in Table 5, with a description of what takes place during each stage of the process. The subsequent sections of this chapter are structured to reflect the stages of the concept analysis as outlined in Table 5.

Table 5 Concept analysis method process

Stage	Description
1. Identify the concept	Identify definitions of PFC
2. Identify relative terms and phrases of the concept	Identify other terms or phrases related to the concept
3. Identify and appropriate source of data related to the concept	Peer-reviewed literature
4. Identify concept antecedents, attributes, and consequences	Compartmentalise concept into constituent parts

5. Identify relevant contexts of the concept	Identify how PFC is utilised in practice
6. Identify a model case study of the concept	Exemplify how PFC is utilised in a relevant case study

4.3 Findings

In this section of Chapter 4, the findings of the concept analysis of PFC in remote environments are presented and critically analysed. The findings are presented systematically according to the stages of the concept analysis (see Table 5). The rationale for this is to provide a clear presentation of the findings from each stage of the concept analysis; therefore, providing transparency and demonstrating the rigorous approach that was used for this study. A quality assessment using a critical appraisal tool (such as CASP; see 3.3.1) is not a requirement of the concept analysis method. Rather, the critical appraisal of the included literature in this concept analysis is embedded within this section. To begin, the subject of the concept analysis requires defining.

4.3.1 Concept identification

The first stage of the concept analysis is to review the literature (see Chapter 3) and compile definitions of the concept for comparison and analysis. The objective of this stage is to identify what is understood about the concept, what is unknown, and what is confusing (Foley and Davis, 2017). To achieve this objective, the literature review findings (see3.3) will be explored to elucidate meaning of PFC from the literature about PFC in remote environments.

It was identified in the findings of the literature review that there is no standardised definition of PFC in remote environments (Mellor et al., 2015). There are definitions that appear to be accepted by practitioners and scholars; however, the evidence-base that informs these definitions is limited to expert opinion and case studies, or it is unpublished or non-existent.

The definitions that have been identified in the literature review are presented in literature containing definitions that were originally excluded from the literature review (see 3.2.1 for exclusion criteria) are presented in Appendix 3. The definitions Appendix 4 were identified by citation snowballing from literature included in the literature review and are presented separately to distinguish definitions published in peer-reviewed journals. It is important to note that non-scientific publications have quality and contribute to this concept analysis; however, the robustness of academic scrutiny cannot be guaranteed.

Appendix 3 includes analysis of the definitions. Literature containing definitions that were originally excluded from the literature review (see 3.2.1 for exclusion criteria) are presented in Appendix 4. The definitions in Appendix 4 were identified by citation snowballing from literature included in the literature review and are presented separately to distinguish definitions published in peer-reviewed journals and non-scientific publications. It is important to note that non-scientific publications have quality and contribute to this concept analysis; however, the robustness of academic scrutiny cannot be guaranteed.

The compilation of PFC definitions identified in the literature highlights the variance in interpreting what constitutes PFC. It is evident that PFC is, therefore, poorly understood as a concept; however, there is common ground between some of the definitions. Beyond planning timelines is frequently referred to, or words to that effect (that is, doctrinal timelines) (Keenan and Riesberg, 2017). Although the measurement scale of timelines is not definitively explained, previously existing models of prehospital care are referred to – TCCC guideline, 10.1.2 (2)+2, if evacuation is not possible (Callaway, 2017). Planning timelines can, therefore, be describe as the existing system of care put in place if a patient becomes injured or ill and, therefore, PFC occurs if this system of care cannot be implemented (for example, evacuation is delayed).

Limited resources are another thread that ties the identified definitions of PFC together, which complements the reference to planned care. In other words, PFC refers to the circumstance when prehospital care is required after the point in time that resources of the health system in place are limited or unavailable. In context, it may be planned for a patient with traumatic injury to be evacuated within one hour and there are enough resources to meet the patient's needs during the time; however, if the evacuation is delayed, resources are limited or unavailable past the planned time of one hour.

Evacuation from a prehospital environment is a commonality between these definitions. Other than being a non-hospital environment, the characteristics of a prehospital environment are described as an austere environment, which suggests the definitions refer to military health systems operating in conflict or war zones. Thus, the current understanding of PFC is heavily weighted on military health systems. There is limited reference to PFC being applicable to civilian health systems within the definitions identified (Schlotman et al. (2019) refers to exploratory spaceflight); however, it is highlighted that PFC is relevant to civlian practice in article texts. The focus on military health sytems in the PFC definitions suggests that civilian PFC practice is newer recognised area of practice and research in comparison to military PFC and that more research is required. Furthermore, there are references to PFC in non-austere prehospital environments, such as when responding to a humanitarian crisis. Similarly, the implicit reference to other environments and contexts that PFC is required for suggests more research is needed in these areas.

A critique of the definitions is the focus on emergency physical and physiological care. Within the extreme and high-risk context of military health systems in austere environments, a focus on trauma care is expected. The focus of physical and physiological health in the PFC definitions is based on the biomedical model of health care – diagnosing an illness or injury, prescribing, and implementing treatment, then evaluating the efficacy. While biomedical care is important to protect health, recognition of prolonged care after the biomedical health needs are met suggests a shift in the health needs patients have. There are references to how health needs changes over the duration of PFC, such as the need of nursing care (personal hygiene, nutrition, hydration, infection control, pain control are listed); however, the provision of prolonged care implies the need to be able to care for a patient when they are stable or recovering. The health needs of patients who are acutely unwell with major illness and injury are different to the prolonged care of patients who are not clinical deteriorating. In other words, lifesaving interventions are needed during a health emergency, whereas lifesustaining intervensions are required to maintain clinical stability until evacuation is possible. Lifesustaining care is a dimention missing from the PFC definitions. Furthermore, the provision of care for minor illness and injury is not mentioned, despite the risk of minor injuries and illness becoming worse and escalating into lifethreatening conditions.

The definitions of PFC recognise that patient care may be required for a long duration of time; however, the evidence that informs these definitions is largely based on expert opinion and case study reviews. It is important to note that the compiled evidence-base does not inform one standardised PFC definition; therefore, there is variance in the definitions and guidance available. Healthcare providers are, therefore, reliant unclear definitions of PFC and are required to use their clinical intuition, based on their experience (which may or may not be relevant to remote, prehospital care), to provide PFC. Thus, PFC providers need to be able to use the biomedical and holistic care models to be able to meet all patient care needs while they are in a remote environment until they recover or are evacuated to a hospital or an appropriately resourced care setting. In other words, PFC providers need to have interdisciplinary practice capabilities which a PFC grounded theory could support them in developing.

In relation to the holistic model of health, exposure to traumatic events are likely to have an immediate or delayed impact on mental health and wellbeing. The definitions concentrate on physical and physiological health; however, witnessing or experiencing traumatic events has the potential to result in mental health and wellbeing needs. Similar to physical and physiological health needs, mental health and wellbeing needs can escalating into acute health emergencies, resulting in a patient becoming a risk to themselves or others. The care of mental health and wellbeing is absent from the PFC definitions despite being an influence of health, which applies to civilian and military health systems.

The PFC definitions focus on the treatment of people prehospital environments once they are already ill or injured. The promotion of health and wellbeing is not acknowledged, which, if implemented in clinical practice, would reduce the risk of minor and major illness and injury from deteriorating or occurring in the first incidence. For example, infection control precautions (opposed to infection control, which occurs once infection has already begun), such as effective hand hygiene, reduces the risk of infection transmission and mitigate the risk of diverticulitis (vomiting and diarrhoea; a common illness in the remote environment) and other contagious illnesses. The inclusion of health promotion in PFC practice, therefore, would contribute to mitigating risks to health. Furthermore, reducing the incidences of PFC would contribute to the sustainable use of the limited resources available in remote environments. For this concept analysis, the absence of health promotion in the PFC definitions reaffirms the research gap of a theory of PFC in remote environments to mitigate risks to health. To analyse the concept of PFC in greater details, however, the relative terms and phrases identified in the literature review require further investigation.

4.3.2 Relative terms and phrases

The second stage of the concept analysis is to further investigate the meaning of PFC by widening the lens of analysis to identify relative terms and phrases (Foley and Davis, 2017, Rodgers, 1989). Relative terms and phrases are described as surrogates that can substitute a relative meaning to the concept. A concept that is being analysed may not have one term or phrase that identifies its meaning; thus, several terms and phrases may be used as manifestations to describe the concept meaning and how it is used in practice (Rodgers, 1989, Rodgers and Knafl, 2000). Based on the findings of the first stage of this concept analysis, it is evident (from the variance of definitions) that PFC is a complicated concept that has multiple applications to practice and interpretations of this practice. Thus, the process of identifying and analysing the relative terms and phrases enables the identification of how PFC is utilised, which provides more depth to the understanding of PFC in remote environment.

When conducting a concept analysis, it is important to recognise that some terms and phrases may communicate multiple concepts. Conveying multiple concepts may be due to different interpretations of the concept and, or homonyms of the concept. Having awareness of the potential for other concepts to be identified is important to ensure the concept analysis has clear focus on the original concept being analysed. Unconsciously enabling other concepts to be introduced would be counterproductive to the aim of analysing the concept to provide understanding and clarity. For this concept analysis, homonyms of PFC are unlikely because the concept is a phrase (opposed to one word that can have multiple meanings); however, varying interpretations of PFC is a likely possibility. The strategy used for this concept analysis to ensure terms and phrases are relative to PFC is to ensure they can be traced back to an identified definition of PFC. In other words, the terms and phrases will be relative to PFC. Relevancy is documented by mapping the terms and phrases with the citation of the article it came from and the definition they relate to.

Thus, the relative terms and phrases of PFC are identified from the literature review. The variance of PFC definitions that were analysed during the first stage of the concept analysis highlights that the understanding of PFC is in its infancy. However, by combining the investigation of the relative terms and phrases, which leads to recognising how PFC can be utilised in practice, with PFC definitions enriches the understanding this concept. The relative terms and phrases identified in this concept analysis are presented in Appendix 5. The relative terms and phrases are mapped with the citation that they were identified in, the PFC definition they relate to, and an analytical narrative. s

The analysis of the relative terms and phrases provides greater depth to understanding the concept of PFC. There remains a clear focus on the military application and usage of PFC in remote, field, and/or austere environments; all of which are prehospital environments. The synthesis of surrogate terms and phrases from literature focusing on military PFC produces two salient points – (1) how PFC is used by personnel within military health systems and (2) the environment that PFC is provided in.

Firstly, the emphasis on how PFC is used within military health systems is the capability of highly trained personnel to provide continuity of medical and health care with minimal resources available. Prolonged care suggests that

PFC providers need to be competent in life saving medical interventions and life sustaining health care. Furthermore, the ability to provide PFC with autonomy is highlighted, which reiterates PFC providers need to be highly trained. The training requirements include how to provide emergency medical interventions and life sustaining health care with minimal resources (the term resources refers to equipment and senior or specialist health care practitioners). Thus, the relative terms and phrases suggest training on clinical competency and decision-making is required to be able to meet patient health needs. The conceptual meaning of this synthesis is PFC is advanced clinical practice due to the demand of complex clinical decision-making in challenging circumstances, which requires experience and training to develop.

The evidence that is available to inform PFC training comprises of case reports and clinical guidance (algorithms) based on expert opinions. This literature makes valuable contributions to the concept of PFC (clinical practice and training), which is likely to grow with the increased focus of PFC in military health systems. More research using these methods advances the conceptual understanding of PFC by investigation of historical practice; that is, case reports and expert opinion that produce data from the successes and failures of PFC provision. It could be argued that this trajectory of research contributes to the conceptualisation of PFC by trial and error. On the other hand, research that investigates the theory rotates the perspective of PFC research forwards. In other words, a PFC grounded theory would provide a framework to inform clinical practice, policy, and pre-deployment training, which contributes to the need of developing complex clinical decision-making abilities for PFC in remote environments.

The second salient point from the synthesis of PFC relative terms and phrases provides meaning to the environment that PFC is provided in. Multiple terms are used to describe the environment, such as remote, field, austere and prehospital. Thus, the environment is four dimensional – the physical environment that PFC takes place in, and the circumstantial influences from the environment PFC is provided in. In context, the physical environments PFC is taking place in are geographically remote from well-resourced (equipment and practitioners) health services (collectively identified as prehospital environments); that is, evacuation to health services or the option of resource resupply is greater than how long available resources to meet patient health needs will last for. Circumstantial remoteness is caused by natural or sociological influences, such as extreme weather or conflict.

Many of the environmental complexities, such as extreme weather and conflict, are not within the control of the PFC provider, which underlines the necessity for dynamic clinical decision-making abilities. Clinical decision-making can be extended to overall leadership of the activities taking place in the environment, hence the advocation of PFC providers informing those in leadership positions. It follows that the environmental influences pose uncontrolled risks to health and, therefore, compound the complexity of PFC clinical decision-making and risk mitigation. This level of complexity reiterates the need for pre-deployment training of PFC to introduce and consolidate the level of decision-making required to provide PFC and mitigate risks to health in multiple and dynamic environments. Moreover, the requirement for an explanatory, evidence-based theory of PFC in remote environments is similarly highlighted by the need to inform PFC provider's decision-making in highly complex and dynamic environments.

The synthesis of PFC relevant terms and phrases with the definitions of PFC distinguishes the conceptual understanding of military PFC and civilian PFC. The vast majority of literature focuses on military use of PFC. One could argue that this means PFC is only used and, therefore, relevant to military health systems. However, references are clearly made to the valid application of PFC to civilian usage, which suggests that the use of PFC within civilian health systems is in different circumstances when compared with military health systems. In context, the situational influences of the environment that PFC is being provided in are the same for military and civilian health systems – for example, the associated risks to health from extreme weather and conflict are equitable for military personnel and civilians, both of which cause delayed evacuation. Furthermore, military and civilian personnel may be in geographically remote environments where access to health services is limited. However, the activities taking place in remote environments are different, therefore, with varying risks to health. The references to the valid utilisation of PFC for civilians identify expeditions as a relevant context. The detail of what constitutes an expedition and how this changes PFC utilisation is not provided in the literature, therefore, the concept of PFC during civilian expeditions requires further investigation.

Thus, the process of identifying and analysing the relative terms and phrases has identified how PFC is utilised, which provides more depth to the understanding of PFC in remote environment. The combination of the relative terms and phrases with PFC definitions enriches the understanding of this concept. However, further investigation is required to establish a deeper understanding of PFC; namely, the different interpretations and meaning of PFC in remote environments.

4.3.3 Data sources

At this stage of the concept analysis, the concept has been identified and the surrogate terms have provided understanding of how PFC is utilised in practice. The first two stages of the concept analysis process have also identified areas that require further investigation to achieve a complete understanding of the concept. The next step is to identify a relevant source of new data (described as an appropriate realm) that can be analysed to bridge the gaps in understanding the concept of PFC (Foley and Davis, 2017, Rodgers, 1989). For this concept analysis, the appropriate realm of data is the literature, due to signposts to other applications and interpretations of PFC that have been identified (for example, PFC provision during expeditions in remote environments has been referred to in the literature review). Alternative realms of data could involve primary research using interview or focus group data collection methods; however, the concept is not fully understood, therefore, there is a risk that the design of a primary research study may be (unintentionally) invalid and collect data that does not provide clarification of PFC. Thus, for this concept analysis, peer-reviewed literature will be the data realm.

4.3.3.1 Search strategy

To progress with this stage of the concept analysis, the search strategy is identified for transparency. The terms used to search the literature are the relative terms and phrases identified in the previous stage of the concept analysis. Use of relative terms and phrases to search the data realm is advocated by Foley and Davis (2017). Thus, the search terms used for the concept analysis are – *"PFC" AND (“Special Operation Forces” OR “Tactical medical” OR “Austere environment” OR “Field environment” OR Train* OR “Combat medic” OR “Independent Duty Corpsman”)*. Boolean operators ‘AND’ and ‘NOT’ were used to ensure the literature that was identified including the search term “PFC” and one of the relative terms or phrases. The relative terms and phrases were condensed to ensure the literature search was broad enough to capture relevant articles while remaining relative to the full-length term or phrase. (See 4.3.2 for full-length relative terms and phrases.) Truncation was used for the search term ‘train*’ to capture literature that referred past, present, or future PFC training. To provide consistency and maintain a rigorous approach to this research, the same inclusion and exclusion criteria used in the literature review (see 3.2.1) are applied to the concept analysis, except included articles in the literature review are excluded to avoid duplicate analysis. An overview of the literature identified is presented in Table 6.

Table 6 Concept analysis: literature review overview

Database	Number of articles identified	Number of articles included
Allied and Complementary Medicine Database (AMED)	1	0
Cumulative Index to Nursing and Allied Health Literature (CINAHL) Plus	9	4

Cochrane Library Database description	0	0
Elsevier: Science Direct Database description	31	17
E-Theses Online Service (EThOS)	4	0
Google scholar (including Open WorldCat, findit@UCL)	293	109
National Institute for Health and Care Excellence (NICE) Evidence[5]	0	0
ProQuest	225	34
PubMed (including MEDLINE, PubMed Central)	40	20
UCL Explore	272	106
Web of Science	20	3
Total	**895**	**293**
Total articles included after citation snowballing	**293**	

[5] Database closed on 31st March 2022

4.3.3.2 Analysis method

Foley and Davis (2017) state the objective of the concept analysis data analysis to understand what is known and unknown about the concept. This objective can be achieved by identifying if the concept is described the same, similarly, or inconsistently within the data realm (Foley and Davis, 2017). Thus, the literature that is identified needs to be critically appraised to discover new knowledge of the concept, or to question the evolving conceptualisation. To that end, data from other disciplines of health (see 5.3) can be included (depending on relevance to PFC) to provide insights of any variations of the concept (Rodgers, 1989). Thus, the findings of the concept analysis have been presented as equivalents, similarities, and inconsistencies.

4.3.3.3 Findings

The overall findings of the concept analysis are presented in Figure 2, a PRISMA Flow Diagram. Similarly to the literature review for this research, the concept analysis is not intended to be a systematic review; however, a systematic approach has been used to strengthen the robustness. The impact of a strengthening the robustness is the findings of the concept analysis are more reliable due to the transparency of the methods used, which enables more in-depth peer-review.

During the identification and screening phases, the duplicate articles that were removed were duplications between each database that was used to search for literature during the concept analysis (see Table 6). Ineligible articles include those that did not meet the SPIDER model (Table 1) and articles that were already included in the previous literature review (see Table 2). Automated and manual removal of duplicate and ineligible articles was managed using EndNote X9 software. The equivalents, similarities, and inconsistencies with the developing conceptualisation of PFC are critically appraised in the next three sections.

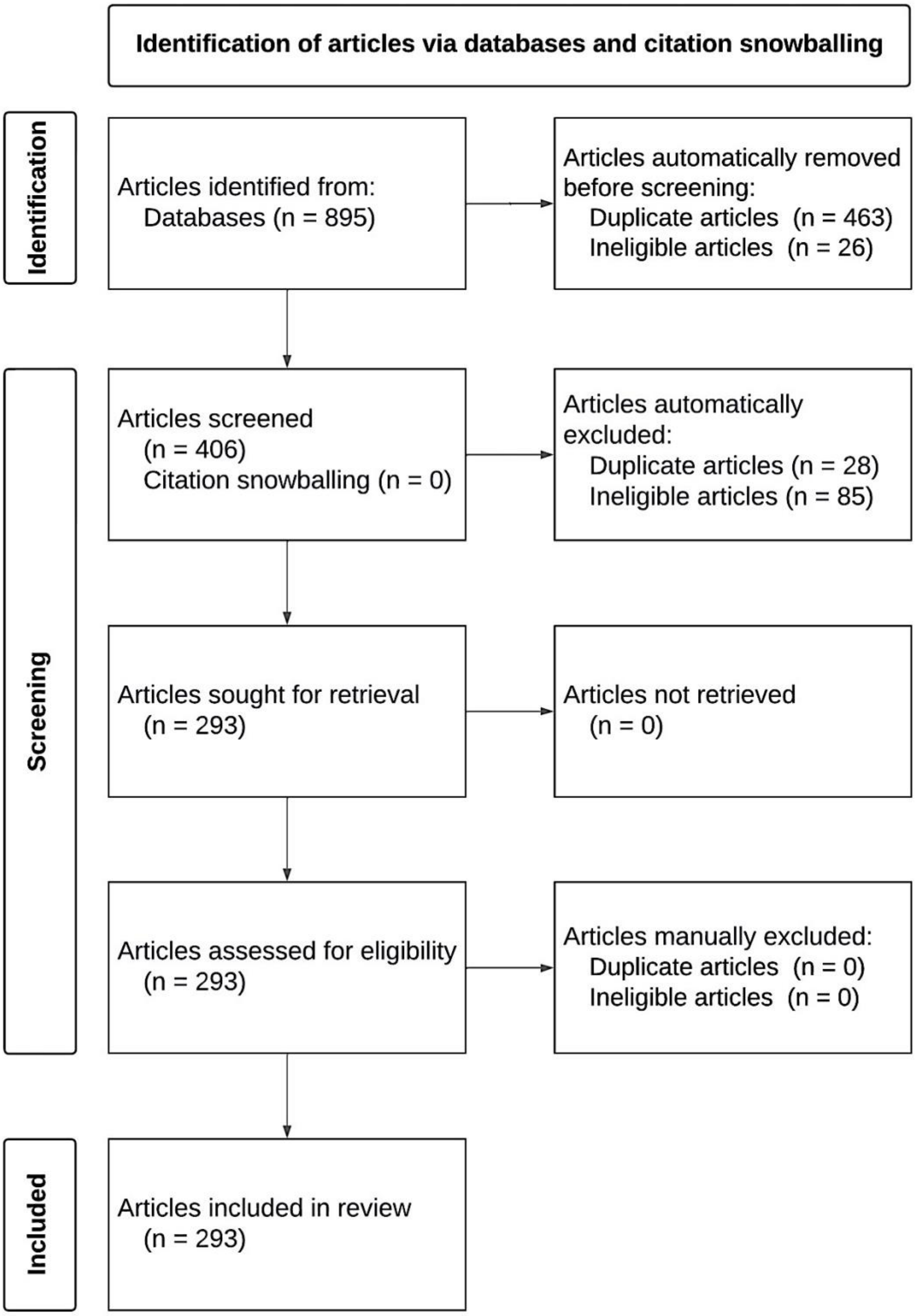

Figure 2 PRISMA Flow Diagram: Concept analysis

4.3.3.3.1 Equivalents

The term equivalents is used to describe findings from the concept analysis that confirm or provide new insights to the understanding of PFC that has been established thus far. The vast majority of literature that was included in the concept analysis similarly focused on PFC within military health systems (Reed and Bourn, 2018, Ieronimakis et al., 2021). PFC is described as beyond planning timelines – health care provided when evacuation is delayed and the resources available are limited while waiting for evacuation (Biesterveld et al., 2021). An objective of having PFC capability is to extend the amount of time care can be provided in the environment so activities can be continued (Corcostegui et al., 2018). In most articles, activities refer to military deployment – conflict, war, or humanitarian response.

A consistent aim of PFC that was identified throughout the literature was to decrease morbidity and mortality for patients in remote environments (Boutonnet et al., 2018). While PFC was frequently investigated within military health systems, the advocation that PFC can be applied to civilian health systems was similarly emphasised (Mould-Millman et al., 2022). It is, however, acknowledged in the concept analysis that the origin of PFC is from military health systems; namely, small SF units being deployed to remote environments (Jeschke, 2018, Luft et al., 2020, Mazarella et al., 2022). It is clear that more research is needed that focuses on civilian PFC to investigate the similarities and differences of how PFC is utilised to mitigate risks to health.

The recognition of risks to health in remote environments was another key point to the conceptualisation of PFC. Risks to health included the need of being capable to provide emergency care (such as stemming haemorrhage) through to managing health needs while in the environment (preventing a wound becoming infected) (Murray and Jones, 2016). This reiterates PFC providers require the knowledge, competency, and confidence to provide acute and long-term care for major and minor illness and injury when evacuation is delayed and resources are limited. Thus, the need for PFC providers to have critical thinking skills and be innovative is similarly emphasised to promote and protect good life beyond what would usually be anticipated in remote environments (Gaffley and Williams, 2022). Moreover, to be able to meet all health needs of the patient, and mitigate risks to their health, PFC capability is required to be interdisciplinary (D'Angelo et al., 2019). This leads on to acknowledge the importance of pre-deployment training, which was similarly emphasised in the concept analysis.

In the concept analysis, the importance of PFC training was strongly emphasised to mitigate risks to health of people in remote environments (Shackelford et al., 2021). The strong emphasis reaffirms the notion that PFC is complex and the demands on health care providers are substantial, including military and civilian PFC providers (Bedard et al., 2020). PFC pre-deployment training can, therefore, be described as a risk reduction strategy because it equips health care providers with the necessary knowledge, competencies, and confidence to meet patients' health needs in remote environments (Hudson et al., 2020). To make effective and efficient decisions in these circumstances is challenging, due to the large number of variables that effect patient's health. In addition to advocating the need for pre-deployment training, Lechner et al. (2018) highlight that wider knowledge is required. Mountain environments are used as an example to highlight the need for rigorous planning and preparation (which includes pre-deployment training) to be able to recognise and mitigate risks to health. Furthermore, training should include specific non-health knowledge and competency training to enable PFC to be delivered; the example of ropework in mountain environments is used to illustrate this point (Lechner et al., 2018). Similarly, this approach to PFC is advocated for military and civilian use, namely humanitarian response (Lechner et al., 2018).

The locations that PFC is provided in – namely, remote, and rural environments – are similarly identified in the included literature. The descriptions used confirm that the environments PFC is usually provided in are geographical remote and, or remote because of circumstances (Howie et al., 2020, Whiting et al., 2020). Outer space is also referred to as a relevant environment that PFC can be utilised in. It is highlight that many challenges and risks to health are in parallel, such as the needed capability to provide holistic care of major and minor illness and injury with minimal resources knowing that evacuation is delayed (Kirkpatrick et al., 2017). It follows that researching PFC in remote environments, and off-world, could, therefore, lead to new insights and knowledge of PFC that can inform clinical practice, policy, and pre-deployment training. It is important to note that no research has been identified that focuses on PFC in other locations than has previously been highlighted; therefore, the focus of this research on PFC in remote environments (which are terms used to be inclusive of all the environments thus far mentioned) is appropriate. Furthermore, broadening the focus of this research to include military and civilian PFC utilisation is necessary to conceptualise the concept in circumstances such as humanitarian and disaster response (Clemens et al., 2018, Reddoch-Cardenas et al., 2019).

The last equivalent of PFC identified from this concept analysis is how technology can aid PFC in remote environments. Telemedicine is the most frequently investigated technology, which is seen as a tool to extend the reach of supervision for high-risk clinical intervention, such as surgery (McPherson et al., 2022). It is strongly emphasised, however, that more research is required to fully understand the impact of telemedicine and other technological innovations. It is noted that that there is a technological gap between military and civilian health services (Stewart et al., 2017). This technological gap is likely to be even greater for small scale civilian expeditions to remote environments who are likely to have small financial budgets. As a result, the impact of technology for PFC and mitigating risks to health is an important research topic to inform decisions about how to prioritise spending for remote environment activities (Gómez et al., 2018). It follows that the PFC is a top research priority for many Western military forces, which also includes technological impacts (Glaser et al., 2018).

4.3.3.3.2 Similarities

There were two similarities that were identified in the concept analysis. Firstly, Dhillon et al. (2020) made a distinction between British and American dialect of the phrase PFC. It is claimed that the British use the term ‘prolonged hospital care’ to describe trauma surgery when evacuation is delayed, whereas

Americans used the phrase PFC to describe medical care beyond planning timelines (which suggests after TCCC, although this is not explicitly stated; however, TCCC is an American model of prehospital care) (Dhillon et al., 2020). Dhillon et al. (2020) claim does align with the majority of literature that refers to PFC within military health systems; however, no other literature was identified that described British military health systems adopting the term prolonged hospital care in place of PFC. All other literature acknowledge PFC is a phrase used by British and American military health systems and, furthermore, both forces have prehospital surgical capacity (Martin et al., 2021, Smith et al., 2021). Thus far, PFC refers to medical, surgical, and health care with limited resources in a remote or rural environment, which can include surgical care within the limitations of the resources available and amount of time before evacuation to an appropriate postoperative care setting is possible.

Confusion of how the phrase PFC is used leads to the second similarity identified in the literature. It is recognised that more research is needed about PFC and how it can mitigate risks to health in practice; however, Johnson et al. (2022) study focused on American health policy. The findings were that the understanding of PFC in policy and clinical practice did not correlate, which causes confusion for practitioners (Johnson et al., 2022). Johnson et al. (2022) highlights that confliction between policy and practice risks the safety of patients; therefore, advocates more research is needed to comprehend PFC. This concept analysis aligns with Johnson’s et al. (2022) consideration for future research; however, in addition to this, more policy research is required across all health systems, including military, civilian, local, and national policies.

4.3.3.3.3 Inconsistencies

In the concept analysis, there were no inconsistencies of the developing conceptualisation of PFC identified. No inconsistencies in the suggest that the trajectory of PFC research and clinical practice development is aligned and, therefore, the interpretation of PFC is within the realms that has been identified (see 4.3). It could be argued that it is unsurprising that the concept of PFC has few inconsistencies from the perspective of hyponyms because PFC is a phrase, rather than a one-word term that could have multiple meanings (for example, the term health can be used to describe one or more models of health, including biomedical and psychosocial health). In contrast, it is clear from the literature review and concept analysis that PFC is a term that is used in multiple contexts – physical and situational environments – and, therefore, PFC is a complicated concept. Thus, to provide more depth to the comprehension of PFC, further investigation is required.

4.3.4 Concept compartmentalisation

On completion of the concept analysis, inconsistencies in the understanding of PFC have been clarified. Next is to compartmentalise the concept to examine the constituent parts (Foley and Davis, 2017). This stage of the concept analysis investigates the nuances of the PFC, therefore, providing intricate detail to the understanding PFC. The concept compartmentalisation is an important stage to be able to recognise how the PFC relates to practice and knowledge but, moreover, the impact that PFC has on practice and knowledge (Rodgers, 1989, Rodgers and Knafl, 2000). The concept is compartmentalised into antecedents, attributes, and consequences of PFC. Antecedents describe what happens in practice before PFC is utilised, whereas attributes are the beneficial impacts of PFC practice, and consequences are what happens after PFC has been utilised (Foley and Davis, 2017). In this section, the antecedents, attributes, and consequences identified in the literature are critically appraised.

There is a lack of detail in the literature about the method of identifying antecedents, attributes, and consequences. Rodgers (1989) describes identifying the antecedents, attributes, and consequences if possible; however, provides vague guidance on how to conduct this. Rodgers (1989) advocates that a concept analysis is exploratory and does not need to adhere to a prescribed process, predetermined criteria, or ontological perspective. The guidance provided by Rodgers (1989) is to explore commonality in the use of the concept; however, this guidance applies to the overall phases of concept analysis, not the specific method of identifying the antecedents, attributes, and consequences. Rodgers (1989) does advocate a concept analysis should be robust, which this concept analysis is aligned with. For this concept analysis, the method of identifying the antecedents, attributes, and consequence is explicitly outlined to strengthen the robustness the method and the reliability of the findings. To distinguish the methodological differences, this stage of the concept analysis is labelled as concept compartmentalisation.

The concept compartmentalisation method used to identify the antecedents, attributes, and consequences was to examine evidence in the literature review and concept analysis from the following perspectives:

- Antecedents – the events or contexts that exist before the use of PFC
- Attributes – the causal effects of PFC provision
- Consequences – the events or contexts that exist after the use of PFC.

Thus, the concept compartmentalisation used for this concept analysis is informed by Rodgers (1989) and Foley and Davis (2017) work but demonstrates methodological development.

4.3.4.1 Antecedents

The antecedents are events that take place before PFC requires utilisation. In the context of PFC, this includes the activities and people related to the events preceding the need for PFC. The antecedents have been identified from the included articles in the literature review and concept analysis.

It is strongly emphasised in the literature that to be able to provide effective PFC that meets all patient health needs, PFC providers require bespoke pre-deployment training. The rationale for this is the demands of PFC are atypical in comparison to existing health systems (although, this refers to Western health systems, despite not being mentioned in the literature). There is currently no regulated curriculum for PFC; however, findings of current research from case reports and clinical guidance can be used to inform the content of pre-deployment training. Based on the findings of this literature review and concept analysis, the content of the training is not limited to medical knowledge and skills. The aptitude of providing holistic care for prolonged periods with minimal resources is advocated as a key element of PFC and, therefore, should be included in PFC training. Furthermore, the risks to health from the (geographic and contextual) environment increase the complexity of providing PFC in remote environments. Thus, clinical decision-making is inclusive of appropriate health care interventions and how to mitigate risks to health. Decision-making, therefore, is another topic to be included in PFC pre-deployment training; however, due to the variance of remote environments, the focus should be on enabling a decision-making strategy that can be adapted to multiple environments.

When in the remote or rural environment, exposure to health risks can be identified as another antecedent of PFC. Based on the literature, there are multiple risks to health that require assessment and mitigation, particularly the dynamic nature of austere environments. Austere environments refer to military activity, most commonly conflict or war but humanitarian relief and mass casualty events are mentioned (Pamplin et al., 2019). Pamplin et al. (2019) recognises that the exposure to risks is similar for military personnel and civilians and investigates the use of telemedicine (referred to a telehealth) to increase the capability of personnel in the austere environment. Capability is defined here as being able to meet operational needs in the field, therefore, capability is increased if telemedicine can reduce the need for evacuation. It is important to note that capability is bespoke to the environment and activities taking place in the remote or rural environment; however, it is clear that there increasing the capabilities of PFC providers can mitigate risks to health (Smith, 2017).

PFC providers are integral to mitigating risks to health by being capable to meet all health needs of patients in remote environments. It is important to note that all personnel are exposed to risk, therefore, more than one person may require PFC. In most cases documented in the literature, one person has been the PFC provider, which suggests others were involved in provider PFC too. In such circumstances, the delegation of care may be required to people who are competent to provide health care with supervision from the PFC provider (Ieronimakis et al., 2021). This circumstance echoes the antecedent of pre-deployment training, suggesting that more than one person in a team of people deploying to a remote environment require PFC training (or basic health care or first aid training) so they can support the PFC provider if required. In extension, basic health care training can also contribute to mitigating the risks to health by personnel being more able to provide self-care of minor injury and illness.

The use of technology is a research topic that is extensively researched. In addition to using telemedicine to increase the capability of PFC providers, integrating drone technology is an emerging area of research that suggest delivery of medical and health equipment may be possible in some environments (Mesar et al., 2018). Mesar et al. (2018) investigates the accuracy of automated drone delivery. The findings of this research suggest that drone delivery mitigates risks to health for people in remote environments by having access to more resources and for people who may have otherwise been tasked with the delivery of supplies (Mesar et al., 2018). Mesar et al. (2018) comment that this technology may be of use for military and civilian PFC; however, acknowledge drones can only be flown in calm weather conditions. Other technology, such as telemedicine, are tools that extend the reach of clinical supervision that similarly can be used by military or civilian PFC providers (Powell et al., 2016). However, telemedicine does not work in all environments and can be blocked by the topography of an environment. With this in mind, complete reliance on technology is a vulnerability in a health system that increases risks to health. This leads to the antecedent of the PFC provider having critical-thinking skills to inform dynamic risk assessments, knowing that the resources available to them are minimal (Christensen, 2018).

Critical thinking is a topic that is advocated to be in PFC pre-deployment training. The rationale is the (physical and situational) environment which PFC takes place in is atypical to urban health systems (for those who originate there), particularly the dynamic nature of the risks to health. Hawkins and Simon (2021) highlight that pre-deployment training is not supported by evidence to inform topics such as critical thinking. It can be argued that there is an emerging evidence-base from the case reports and clinical guidance being published; however, the volume of data is small and is based on experiential evidence of PFC. Thus, evidence-based pre-deployment training is identified as a PFC antecedent to inform clinical practice, policy, and risk management (Hawkins and Simon, 2021).

In relation to critical thinking, a strategy of PFC provision in remote environments is required to enable health care providers and those in leadership positions to identify and mitigate risks to health (Mellor et al., 2015). A strategy would inform PFC provider's clinical decision-making, supporting them to process the vast amount of information they need to understand to make an informed decision to mitigate risks to health. Mellor et al. (2015) emphasises that clinical practice in remote environments (described as wilderness environments) requires knowledge, competencies, and confidence in primary health care (community-based health services, including rural health systems), prehospital care, public health and health promotion (the protection and promotion of good health). These disciplines of health practice can be described as antecedents of PFC, all of which are required to meet the holistic care needs of patients in remote environments. Hawkins and Simon (2021) advocation of evidence-based pre-deployment training echoes Mellor et al. (2015) emphasis of an evidence-based planning process for PFC provision. Furthermore, Mellor et al. (2015) states that all personnel involved in PFC provision (health care providers, leaders, and organisers) should be involved in the planning process and their decision-making should be evidence-based. Mellor et al. (2015) also highlights that PFC providers do not need to be doctors but should be someone trained and experienced with the appropriate knowledge, competencies, and confidence to meet all patient health needs in the environment and mitigate risks to health. Thus, evidence-based planning and training in interdisciplinary clinical practice are antecedents of PFC that prepare health care providers for the challenges of PFC in remote environments.

One of the most significant challenges that has been identified in this concept analysis are the risks to health in a remote or rural environment. Risks are heightened in remote environments due to the exposure to physical and situational hazards. If a patient requires PFC, which is effectively provided, there are still risks to health overtime; namely, the long-term management of minor injury and illness. Without effective care of minor injury and illness, these conditions can escalate into acute, life-threatening health issues. One example is infection control during wound care – keeping the wound clean, dry, and protected so it can heal mitigates the risks to infection and ultimately sepsis (acute blood poisoning) (Murray, 2017). Risk management is, therefore, an antecedent of PFC that is required to protect and promote the health of people in remote environments (Smith et al., 2021).

Pre-deployment training is an antecedent that can be used as a tool to mitigate risks to health by upskilling PFC providers and rehearsing clinical protocol. In a different context, analogue missions (simulated space mission) can be used as a method to develop risk management strategies for spaceflight and (eventually) the exploration of other planetary bodies (Posselt et al., 2021). Specific risks can be simulated in a controlled environment on Earth; however, the fidelity of the simulation can be increased by the analogue mission taking place in a remote or rural environment; this increases the realism of the risk to health simulation during spaceflight (that is, minimal resources, limited access to health services, and delayed evacuation). Posselt et al. (2021) advocate clearly distinguishing the in-simulation and in-reality risks to, therefore, enable an effective risk management strategy. If an analogue mission takes place in a remote or rural environment, it is evident that PFC capability should be included in the risk management strategy. This demonstrates that risk management is a PFC antecedent that is a nexus of different approaches and tools before PFC is required.

4.3.4.2 Attributes

Leading on from the antecedents that occur before PFC is required are attributes. Attributes are what happens in practice due to the implementation of PFC. In other words, attributes are the causal effects of PFC utilisation. Analysing the attributes of PFC provide clarity about the impacts the concept in practice, which further aid the comprehension of PFC in remote environments.

It is clear from the literature that PFC is utilised to save the lives of patients in remote environments. PFC includes lifesaving clinical interventions for acute emergencies and life sustaining care of minor injury and illness. It has become apparent, also, that PFC includes the protection and promotion of health in remote environments, informed by the disciplines of public health and health promotion. Thus, holistic healthcare, inclusive of clinical treatment and the protection and promotion of health are consequences of PFC utilisation. A holistic approach to PFC benefits patients because their health needs are met and risks to their health are mitigated. Furthermore, if the incidents of illness and injury are reduced, the strain on the limited availability of resources is also lessened. To achieve this consequence, rigorous pre-deployment training and an evidence-based strategy of PFC are required to inform clinical decision-making and risk assessment in the field. Thus, it can be noted that to enable effective PFC utilisation, and the desired attributes, rigorous preparation for PFC must take place before being in a remote or rural environment. When applied to the context of sudden remote environments (due to vulnerability to natural hazards, conflict, or war), the capability of PFC should, therefore, be included in emergency planning as a risk management and mitigation strategy. If this is implemented, the attributes of PFC are likely to be enhanced, which is based on the attributes of historical cases of PFC from case reviews and reports.

4.3.4.3 Consequences

To complete the concept compartmentalisation, the consequences of PFC require identification. Consequences are the events and contexts that take place after the application of PFC. To clearly distinguish attributes and consequences, attributes are what occurs in practice when PFC is implements and the consequences are what happens after PFC has been provided.

In the immediate aftermath of PFC being utilised, for major or minor injury and illness, patient monitoring is requires to evaluate the efficacy of PFC (Liu and Salinas, 2016). The measures of PFC efficacy are the desired outcomes from the perspective of the patient and the mitigation of health risks. The desired patient outcomes are clinical, including biosocial and psychological health, and the ability to continue with the activities being undertaken in the remote or rural environment. Historically, clinical outcomes would be determined by the clinician, usually a medical doctor; however, in modern Western healthcare, patients are involved in the decision-making process about their care, including the desired outcomes of treatment. The rationale for this is to empower patients to have ownership of their health and to acknowledge their experience of living with the acute and, or long-term health needs. In other words, the modern approach to health services, including PFC, is person-centred care. It is important to note that these perspectives are Western. None of the included literature for this research focused on non-Western health perspectives, which highlights the importance of biosocial and medical anthropology to understanding different health cultures (see 4.3.5). Investigating PFC through the lenses of biosocial and medical anthropology is a consideration for future research.

The monitoring of patients is completed when the desired outcomes are achieved (such as being able to continue the activities in the environment), or the patient is able to be evacuated. At this point, there is a gap in the literature about other consequences from PFC. However, it has been acknowledged that the body of evidence about PFC is based on case reports and clinical guidance. Case reports suggests that other consequences of PFC have taken place but are not captured in the literature. Documentation and record keeping is likely to have taken place subsequent to PFC as a process of reflection to identify lessons learned from providing PFC. These consequences form the basis of content for case reports and review, which, when published, contribute to the conceptualisation of PFC and emerging evidence-base. Thus, documentation, recording keeping, and reflection are consequences of PFC; although, this is the choice of the PFC provider. It is acknowledged in wider literature that documentation, recording keeping, and reflection are good practices of healthcare; this can be applied to PFC as another health care discipline. No other consequences were identified in the literature review and concept analysis; therefore, the related concepts to PFC require investigation to complete the concept analysis.

4.3.5 Related concepts

Once the relative terms and phrases, then antecedents, attributes and consequences of the concept have been analysed, other concepts that relate to PFC need to be clarified from the data source (the literature) (Foley and Davis, 2017, Rodgers, 1989). The process of analysing related concepts is to provide clarity to any remaining areas of confusion about PFC and, furthermore, to identify considerations for future research (Foley and Davis, 2017). The related concepts to PFC are identified and critically appraised in this section.

The concept of military and civilian PFC has been compared and contrasted, differentiated by the nature of deployment and the activities undertaken. There are overlaps, such as a holistic approach to PFC so all patient health needs are met and, moreover, risks to health are mitigated. Shared practice between military and civilian PFC through case reports and research will strengthen the development of the PFC concept, which can be used to further mitigate risks to health in remote environments. An example of how military and civilian PFC concept can overlap is within the context of humanitarianism. Military services and civilian organisations are both involved in providing humanitarian aid to people in the aftermath of disasters or conflict, which often involves providing health care in remote environments with limited resources; this equates to PFC.

Medical doctors practice medicine and approach patient care using the biomedical model (physical and physiological health). It is well documented that patients may have emergency medical needs in remote environments; thus, is it evident that health care providers need to be able to provide emergency medical care. PFC, however, is from the point when the emergency medical care needs have been met until the patient can be evacuated to a sufficiently resourced health care setting or recovers. Although medical care is usually provided by a medical doctor, it is advocated that the concept of prehospital care can be provided by any practitioner providing they are competent and remain within their scope of practice.

The concept of prolonged prehospital care has been used many times in the literature. Prolonged prehospital care is most closely associated with nursing care, defined as the holistic care of people who are unwell, including the promotion of health, prevention of illness and the long-term care of people who are ill, disabled or dying (Barrett, 2002, Fukada, 2018). It could be said that nurses (including health care support workers providing fundamental nursing care, such as washing patients) are needed to provide PFC in remote environments; however, as previously noted, resources are limited in remote environments (which includes human resources). It is impractical to deploy a nurse and other representatives of each member of the health care multidisciplinary team, therefore, interdisciplinary clinical practice is another concept related to PFC. This reiterates the need for interdisciplinary PFC and clinical decision-making in pre-deployment training to ensure the PFC provider is equipped with the appropriate knowledge, competence, and confidence. In other words, there is overlap – doctors can provide nursing care and nurses can provide some medical care, providing they are competent and confident enough to do so within their scope of practice. There is clear evidence from the literature, however, that patient care is not divided neatly into medical and nursing care.

Another concept related to PFC in remote environments is the topic of health geography. Although no literature was identified with the term ‘health geography’, this sub-discipline of human geography is relative to the concept of PFC. Health geography is the study of how a geographical place effects people’s health. It is evident from the literature that remote environments have an effect on health, such as the altitude of mountainous environments or the cold of polar regions. Originally, health geography was it defied as medical geography and used a positivist approach to explain how physical environments effect health; however, it was recognised in the late 20th century that other biosocial factors influence health. In other words, there is not a linear, causal-effect relationship between physical geography and health. Health geography acknowledges that people’s health is effected by the physical geography of a place and their social behaviours. Health geography is relative to PFC because people are required to make critical decisions about their behaviour and actions they must take while in a remote environment to reduce the risk of disaster. This decision-making process is relative to the remote environment a person is in; thus, the concept of health geography is relative to PFC. In extension to studying how environments effect health and risks, space has been referred to as the ultimate example of PFC.

Space medicine is the most commonly used term to identify the health care of people in low-Earth orbit or space. Similarly to medical geography, space medicine focuses on the biomedical perspective of being in space, such as the additional exposure of ultraviolet light increasing the risk of cancer or muscular atrophy and osteoporosis caused by being in a microgravity environment. Space medicine is relevant to PFC because space is a remote environment in which health care takes place – there are limited resources to manage health care needs and evacuation is delayed. The term space health has been included in this concept analysis to accurately describe the biosocial and psychological effects of being in space on health. Some literature has focused on the holistic perspective of health in space and used the term space health, but this is much less common. Nevertheless, both space health and space medicine are concepts relative to PFC, which is an important consideration for future research.

Space health and medicine is, however, directly relevant to a small number of people who have trained as astronauts. It is anticipated more people will travel to space during the 21st century, due to the commercialisation of low-Earth orbit and space travel; however, aerospace medicine is closely related and is an established field. Aerospace medicine is described as inclusive of space medicine, but also includes the health of people before, during and after flight in aircraft. PFC is linked with aerospace medicine because if people require aeromedical evacuation from a remote environment, they will require continued care during the flight. Resources are limited, which links with PFC, but it is important to note that care during an aeromedical evacuation is a temporarily remote environment that likely has sufficient resources for the duration of the flight. The direct relevance for PFC in remote environments is patients need to be prepared for aeromedical evacuation, which mitigates further risks to their health.

Another related concept to PFC is disaster risk reduction, namely due to the emphasis on PFC pre-deployment training. The rationale of PFC training has been explained in detail, but the consequence of this training is identified as disaster risk reduction for the PFC provider and patient receiving the care. Whether a PFC provider is a highly qualified health care practitioner or a first aider, providing PFC in remote environments requires training to prepare the PFC provider to meet the demands of operating in a remote environment. PFC training, therefore, is a disaster risk reduction strategy because the PFC provider can be taught how to apply their clinical experience to PFC. This decision-making process links with another concept relative to PFC, medical anthropology.

A sub-discipline of social anthropology, medical anthropology is an area of study that concentrates on the biosocial culture of health (Singer and Baer, 2018). PFC has been identified as an approach to health care in remote environments that can mitigate risks to health; however, it is important to note that clinical practice is dependent on the PFC provider's socio-cultural influences of their decision-making process. In other words, the complexity of providing PFC in remote environments means every circumstance is different due to the dynamic nature of remote environments. An individual will prepare for and manage this unpredictability and uncertainty by replying on their training and their experiences, both of which are dependent on socio-cultural influences. In short, health care training in Western Medicine is vastly different in comparison to Eastern Medicine. Furthermore, the perception of health is subjective and is viewed differently by people dependent on their culture, backgrounds, and beliefs. People who require PFC may have different perceptions to health and risk in comparison to the PFC provider. Thus, medical anthropology is an important component of this research to investigate the biosocial and cultural influences of PFC in remote environments.

4.3.6 Model case study

A model case study provides a contextual example of the concept that has been analysed – PFC in a remote environment – which provides another layer to the clarification of the concept and consolidates understanding. In other words, the selection of a model case provides a clear example of PFC, which allows a more concrete notion of the concept and clarifies the direction of research. A model case study is identified in this section to illustrate how PFC could be used in a remote environment to mitigate risks to health.

The model case study for this concept analysis was going to be the British Services Mountaineering Expedition 2022 (BSME22). BSME22 was a military, tri-service mountaineering expedition to the Pakistani Himalayas. One team aimed to summit Broad Peak (8,051m) and another team aimed to complete a high-altitude trek to Broad Peak and K2 basecamps (4,850m and 5110m respectively). Both teams were undertaking mountaineering activities in geographically remote locations with multiple risks to health; namely, altitude (low concentration of atmospheric oxygen), hypothermia (cold temperatures), and infection control amongst the expedition teams. The activities both teams were participating in similarly cause risks to health – very high-altitude trekking (above 3,500m) and extreme-altitude climbing (above 5,500m). Due to logistical restraints, the resources available to both teams are limited to what they can carry; therefore, resources are minimal. Access to health services is limited by the physical geography of the remote environment and evacuation is likely to be delayed due to poor weather conditions. Thus, this expedition would have been an ideal model case study of PFC.

BSME22 would have provided an option for fieldwork for this research to test the model case study; however, due to COVID19, this fieldwork option was cancelled. Nevertheless, an alternative fieldwork option was designed, which is presented and critically appraised in Chapter 8.

4.4 Summary

The literature review for this research identified broad research gaps of PFC, including PFC in remote environments to mitigate risks to health, and highlighted there is no evidence-based, standardised definition of PFC. The lack of definition suggests PFC is an emerging area of research that is not fully understood. In contrast, PFC is regularly utilised in clinical practice in remote environments to mitigate risks to health; however, this practice takes place without a clear definition, evidence-base, or theoretical foundation.

It was purposefully decided not to include a standalone discussion section in this chapter because the synthesis of concept analysis findings took place in the presentation and critical appraisal of the findings, 3.3.2. It was necessary to synthesise the findings with the included literature, rather than a separate section, to evoke and demonstrate theoretical sensitivity. A consideration for future publication of this concept analysis is to have the finding synthesis within its own section. However, for the purposes of this research, the current presentation of findings and synthesis is necessary for theoretical sensitivity.

The concept analysis has provided clarity to PFC in remote environments to mitigate risks to health. The concept analysis has not provided a definition of PFC (this was not the aim); however, analysing the concept of PFC elucidates the meaning in remote environments to mitigate the risks to health. The findings of this concept analysis contributes to the emerging body of evidence and, furthermore, provides a more rigorous framework to conduct this research. Systematically developing theoretical sensitivity of PFC in remote environments has contributed to the reliability of the overall research findings (see Chapter 7) and supports the application to practice.

Part II Theoretical contributions: grounded theory study

Chapter 5 Methodology

5.1 Introduction

In this chapter the philosophical landscape of this research and the conceptual framework of health are outlined. Presenting the philosophical landscape provides transparency about the researcher's beliefs and approach to investigating the identified phenomenon, and how knowledge is discovered and understood within reality (Mjøset, 2009). Transparency of these philosophical perspectives defines the scope of rigour and validity, trustworthiness, and applicability of the findings, and ultimately the research impact. Identifying the conceptual framework of health provides an accurate placement for this research within the philosophical landscape that is outlined. This chapter concludes with the mapping of the philosophical landscape with the conceptual framework of health; thus, the research paradigm of this research is presented.

5.2 Philosophical landscape

In this section the philosophical landscape is articulated and critically appraised. The philosophical landscape accounts for the following beliefs about the research paradigm that has been utilised for this research. Providing a transparent and explicit description and critical appraisal of the research paradigm strengthens the trustworthiness of the research findings and, therefore, has the potential to increase research impact. This section identifies the ontology, epistemology, and methodology of the research paradigm for this research, which are defined as:

- Ontology – the nature of reality.
- Epistemology – knowledge of reality and how it is studied.
- Methodology – the approaches to studying phenomena.

5.2.1 Ontology

Ontology considers the nature of reality, namely if reality exists independently from human consciousness, existence, and perception, or if reality exists only within human consciousness (Howard-Payne, 2016). In other words, the ontological debate is between a single and verifiable reality, or multiple perceived realities. The ontology for this research is contextualism, which bridges the space between (1) realism with a positivist philosophy, and (2) relativism with an interpretivist philosophy (DeRose, 2011).

Realism ontology is a standpoint that advocates a singular, objective, and verifiable reality that exists independently from human consciousness and existence (Madill et al., 2000). This ontological perspective is associated with a positivist philosophy, namely a traditional approach to research that advocates all phenomena is statistically verifiable. The beliefs of realism ontology can be applied to natural and social sciences; however, a limitation of realism is that not all social phenomena can be appropriately understood by quantification. This critique led to the acknowledgement of critical realism, which has a foundation of post-positivism philosophy.

Critical realism is a belief that reality does exist independently of human consciousness, but the observation of reality is determined by sociological influences (Vincent and O'Mahoney, 2018). Sociological influences include researcher's ontological and epistemological beliefs. These beliefs can be explicit or implicit, hence the transparency of ontological and philosophical perspectives defines the rigour and validity, trustworthiness, and applicability of research findings and impact. Physiological phenomena of health are most appropriately investigated with realist and positivist assumptions; however, health is a broad discipline (see 5.3) and includes psychosocial health. Psychosocial health phenomena require a different ontology to be appropriately understood.

Relativist ontology is the belief that reality is perceived through human experiences; thus, human consciousness is reality and, therefore, there are multiple realities in existence (Mills et al., 2006). It is important to note that relativist ontology rejects the notion that reality exists independently from human consciousness *and* within human consciousness – multiple realities are within human consciousness. In other words, relativist ontologists advocate that there are as many realities as there are people's experiences (Howard-Payne, 2016). Relativist ontology closely aligns with an interpretivist philosophy, which advocates that reality does not exist independently from human consciousness because it is socially constructed. Relativism is, therefore, an appropriate ontology for psychosocial health because it acknowledges that experiences of health are relative to each individual. This research examines health from a holistic perspective (see 5.3.6); thus, an ontology that bridges the space between realism and relativism is necessary.

This research is an investigation of health that includes the biomedical (see 5.3.1) and psychosocial (see 5.3.2) models of health. The rationale is biomedical health is interrelated with psychosocial health, and vice versa. Adhering to one ontology would exclude the other and, therefore, exclude complementing models of health. Furthermore, this research examines health within the context of remote environments and considers the resultant risks to health. Thus, the reality of health is dependent on the person's holistic health (subject), in a remote environment (place), and in specific circumstances (time). The ontology that is most appropriate for this research is contextualism.

A contextualist ontology is a belief that reality is relative to the contexts of subject, place, and time. In other words, there are multiple realities that are dependent on the person and their health in one place at one time. Contextualism acknowledges that in some circumstances a positivist philosophy (realist ontology) and, or an interpretivism philosophy (relativist ontology) is most appropriate, dependent on the subject, place, and time. A contextualist ontology is appropriate for this research because it accommodates the multiple influences and determinants of health in remote environments, which is an appropriate perspective to investigate PFC from and generate a grounded theory. To generate a grounded theory, awareness of the nature of knowledge within reality, and how it is obtained, is imperative (Cutcliffe, 2000). Thus, the epistemology of this research is critically appraised in the next section.

5.2.2 Epistemology

Epistemology considers the interrelations between knowledge, how knowledge is understood (that is, interpreted), and how knowledge obtained (Pynn, 2015). The two ends of the epistemology spectrum are objectivism and subjectivism (Walsh and Downe, 2006). In this section, it is explained that this research requires a contextualism epistemology, which provides common ground between objectivism and subjectivism.

Objective epistemology is a belief that knowledge exists independently from human consciousness (Chamberlain, 2015). Objectivists reject the contextual factors of observing and understanding knowledge. Thus, it is advocated there is one verifiable truth of knowledge that exists regardless of human perception and partiality. It is acknowledged that results of research from an objective epistemological perspective are affected by the accuracy of measurement tools, and the independent and confounding variables of a study, hence a p-value is used to quantity the probability of the results being inaccurate. However, objectivism is the firm belief that there is a singular, verifiable truth of knowledge regardless of the reliability of results (Rehman and Alharthi, 2016). Objective epistemology is associated with realism ontology due to the belief that reality exists as a single entity, regardless of human consciousness. Thus, research from an objective epistemology position investigates phenomena with a predetermination that the outcome will be an absolute, universally applicable truth of knowledge. This belief is in juxtaposition with a subjective epistemology.

Subjective epistemology is the belief that knowledge can only be examined through sociological lenses and, therefore, cannot (and does not) exist without influence of researcher's interpretation (Bilau et al., 2018). Interpretation of knowledge from a subjective epistemological perspective is, therefore, based on the researcher's psychosocial-economic background and prejudices (Duggleby and Williams, 2016). Thus, there are multiple truths of knowledge relative to individuals and there is not correct or wrong because everyone has a unique psychosocial-economic background (Saliya, 2023). The endpoint of research from a subjective epistemological position, however, is to understand knowledge relative to the subject (person or people) and to increase sensitivity of knowledge with emancipation from wider sociological influence of the subject (for example political, cultural, or historical influences). The knowledge of health, however, includes objective and subjective knowledge; thus, this research requires a comprehensive epistemology.

Contextualism epistemology is a belief that knowledge is objective, but relative to and dependent on the circumstances of subject, place, and time (Madill et al., 2000). In other words, the nature of knowledge is dependent on the circumstances and context (Brendel, 2014). In relation to the health in remote environments, biomedical health can be measured from a realism ontology and objective epistemology perspective, whereas psychosocial health can be accurately understood from a relativist ontology and interpretivist epistemology. Contextualism ontology and epistemology enables this research to investigate holistic health within the context of remote environments, which have dynamic risks and influences of health. Thus, with a contextualism ontology and epistemology in mind, the methodology of this research identifies the process of research that is required.

5.2.3 Methodology

The methodology of research considers the overall approach to the process of research, namely if theory or hypotheses are tested, or if theory is being generated. In this section it is explained that this research largely adopts an inductive qualitative methodology; however, deductive methodology is used during data analysis.

Inductive qualitative research is the methodology used for this research because the research process (utilisation of research methods) flows from data about the identified phenomenon to theory generation (Charmaz, 2008). In other words, an inductive research methodology gathers data to generate knowledge about a phenomenon (Walker and Myrick, 2006). On the other hand, deductive qualitative research is used when a theory or hypothesis is tested in order to prove or disprove the theory or hypothesis (Corbin and Strauss, 2015). The absence of a grounded theory of PFC is the identified research gap; thus, an inductive qualitative research methodology is used for this research. Chapter 6 provides more detail about grounded theory as a research method; however, it is important to note that this research design does include some deductive qualitative methodology.

In grounded theory (see 6.2), data is collected from a variety of sources until theoretical saturation has been achieved (see 6.4.1.2) (Glaser, 1992). Data collection and analysis takes place simultaneously and constant comparative analysis is used to determine the point of theoretical saturation – when data collection does not produce new data codes (see 6.4.3). Thus, deductive qualitative methodology is used during this research when constant comparative analysis takes place to determine if new codes are being identified; however, the overall methodology is inductive qualitative research. Table 7 provides an overview of the philosophical, which is followed by the next section outlining the conceptual framework of health.

5.3 Conceptual framework of health

Health is a broad discipline that can be researched from multiple perspectives. This section identifies the conceptual framework of health for this research that sits within the philosophical landscape that has been outlined. Six models of health are explored, and the interrelations with PFC are critically appraised. A mapping of the conceptual framework of health is presented in Table 8.

Table 7 Philosophical landscape

Grounded theory method	Ontology	Epistemology	Philosophy	Methodology
Glaserian	Realism	Objectivism	Positivism	Deduction
Charmaz	Critical realism	Objectivism	Post-positivism / Constructivism	Deduction
Straussian	Realism	Subjectivism	Interpretivism	Induction with deduction
This research	Contextualism	Contextualism	Contextualism	Induction with deductions

Table 8 Conceptual framework of health and philosophy mapping

Model of health	Philosophical premise			Grounded theory methods
	Ontology	Epistemology	Philosophy	
Biomedical health	Realism	Objectivism	Positivism	Glaserian, Charmaz, Straussian
Biopsychosocial health	Realism	Objectivism	Post-positivism	Glaserian, Charmaz, Straussian
Alternative/Complementary health	Realism	Subjectivism	Interpretivism	Charmaz, Straussian
Rural and remote health	Critical realism	Subjectivism	Post-positivism	Charmaz, Straussian
Health geography	Critical realism	Subjectivism	Post-positivism	Charmaz, Straussian
Holistic health	Critical realism	Subjectivism	Interpretivism	Straussian

5.3.1 Biomedical model of health

The biomedical model of health has been the primary focus of Western health care systems since the 19th century (Borowy, 2014). According to this model, health is defined as the absence of illness or disease, therefore, the removal or control of pathology restores good health (Wade and Halligan, 2004). The biomedical model of health is predominantly concerned with anatomy, physiology, and pathophysiology; or in other words, the physical health of people (Westerhaus et al., 2015). When applied, the biomedical model of health can be described as allopathy (Borowy, 2014). For these reasons, the biomedical model of health is most closely associated with realism ontology, objectivism epistemology, and a positivist philosophy – a quantifiable approach to health. It follows that biomedical health phenomena are typically investigated using a deduction research methodology.

Deduction research methodology mirrors the procedural approach that the biomedical model of health advocates – complaint, history, physical examination, tests, diagnosis, treatment, prognosis (Wade and Halligan, 2004). The rationale for this is systematic approach is more efficient and effective at diagnosing an illness or disease. While the treatment of pathophysiological issues is paramount, a critique of the biomedical model is the rejection of societal influences of health.

The biomedical model of health dissociates health from psychosocial, cultural, and economic influences of health (Lyng, 1990). The social determinants of health are well documented; however, they do not have significance within the biomedical model (Dadi et al., 2023). Investigating PFC from the perspective of the biomedical would require a realism ontology, objectivism epistemology, and a positivist philosophy to this research. In other words, the biomedical model of health presumes a causal relationship between treatment and outcome. However, this research investigates health through a holistic lens within the context of remote environments; thus, this research includes biopsychosocial health.

5.3.2 Biopsychosocial model of health

The biopsychosocial model of health considers the interconnections between biological (physical), psychological (intrinsic) and social (extrinsic) health (Lehman et al., 2017). Psychological health can be defined as health conditions that effect the mental health of people, whereas social health considers the social determinants of health (Andersen et al., 2019). Biopsychosocial health acknowledges the complex interactions between these three perspectives of health, which is important for understanding health and the design of health systems (Bolton and Gillett, 2019). Similarly, the three perspectives of health are important considerations for research.

The biopsychosocial model of health acknowledges a biomedical approach to health; however, accepts that there are intrinsic and extrinsic influences of health. Thus, studying biopsychosocial health requires a critical realism ontology, objectivism epistemology, post-positivism / constructivism philosophy, and a deduction methodology.

When applied, the biopsychosocial model of health is mainly utilised in psychological and mental health practice (Alvarez et al., 2012). This approach to health is relevant to and important for PFC due to the extreme environmental challenges and risks to health; however, in many local communities in remote environments, the belief systems of health may differ from Western concepts. Thus, complementary and alternative medicine (CAM) can be considered as a predominant model of health.

5.3.3 Complementary and alternative medicine

CAM refers to medical and health practices that are complementary or alternative diagnostic and treatment therapies to biomedical and biopsychosocial health. CAM is not a model of health per sé but a collection of applied practices. Examples include acupuncture, aromatherapy, and herbal medicine. CAM are important to acknowledge because they are the preferred health care practices in many rural and remote communities (Cevik and Selcuk, 2019, Teow et al., 2021, Weinert et al., 2021). This preference is likely due to limited access to urban health services and a greater belief in a local cultural approach health (Robinson and Chesters, 2008, Robinson and

Cooper, 2007). CAM are often specific to individual communities or people; thus, to understand the belief system of CAM service users, qualitative research is imperative. To investigate CAM, relativism ontology, subjectivism epistemology, and an interpretivism philosophy is needed for an induction research methodology. Deduction research methodology is not impossible to research CAM; however, rural and remote communities often have unique health beliefs, systems, and practices.

5.3.4 Rural and remote health

Rural and remote health refers to health, health systems, and health care services in rural and remote environments (Wakerman et al., 2017). Rural and remote health is an interdisciplinary field that can include medicine, nursing, allied health, geography, sociology, economics, and telemedicine (Farmer et al., 2012). The rationale for this discipline is health in rural and remote environments is the unique experience of health in rural and remote environments, namely the communities who live there (Nimegeer et al., 2016). In other words, urban health systems cannot be applied to rural and remote environments due to the limited accessibility to services and resources. Thus, people living in rural and remote environments experience socioeconomic inequality, which is a social vulnerability to the contextual health risks (Humphreys et al., 2006). In other words, people in rural and remote environments experience disproportionate health inequalities in comparison to people to live in urban settings (Alty et al., 2023).

Researching rural and remote health phenomena requires a contextualism ontology, epistemology, and philosophy for this research due to the unique influencing factors of health from the remote environment. Induction research methodology is most appropriate; however, similar to the utilisation of CAM in rural and remote environments being bespoke, deductive methodology can be used but it is difficult to capture the unique influences of health from the remote environment (Chen et al., 2020).

5.3.5 Health geography

Health geography is the study of interrelations between health and the physical geography of specific environments (opposed to epidemiology which examines health within these environments) (Munoz, 2014). The origins of health geography stem from medical geography; however, medical geography was limited to the biomedical model of health (Rosenberg, 1998). The term health geography is representative of the multiple disciplines within this field, including biopsychosocial, cultural, political, and economic influences of health in relation to the rural or remote environment (Crooks et al., 2018). The socioeconomic disparity and resultant disproportion of health inequalities experience by people in rural and remote environments are the foci of this research. Thus, for this research health geography is a valuable consideration for the contextualism ontology, epistemology, namely that the reality and knowledge of health are influenced by the remote environment. To investigate phenomena such as these, a contextualism philosophy and inductive methodology are necessary approach to research to understand PFC and how health is influenced by remote environments.

5.3.6 Holistic health

In holistic health, the focus is on all aspects of a person's health, encompassing all models of health that are relevant to the individual (Lyng, 1990). Holistic health is the opposite to a reductionism approach to health, which can be described as compartmentalising aspects of biomedical health into constituent components of health. The focus of holistic health, on the other hand, considers all components of health and acknowledges that the health of the whole person is required to have good health (Cmich, 1984, McLeod et al., 2012). Holistic health can, therefore, be described as a person-centred approach to health (Mills, 2017).

A counterargument of holistic health is that it is an individualistic approach to health limits the ability to change health systems at large; however, a holistic approach to includes societal influences of health, which include health systems so positive change can be implemented (Lyng, 1990). Thus, holistic health recognises the many influencing factors of health, including the biopsychosocial model of health, social determinants of health, and any preferences of CAM people may have (Mullins-Owens, 2016, Picard et al., 2011). Holistic health can be applied within rural and remote health systems, therefore, is relevant to health geography (McLeod et al., 2012, Snyder and Wilson, 2015). Thus, holistic health is most appropriate for this research to investigate PFC in remote environments using a contextualism ontology, epistemology, and philosophy, with an inductive research methodology.

5.4 Research paradigm

This research is an original and innovative enquiry into PFC within remote environments that explores how risks to health can be mitigated. It has been established that remote environments are complex and have dynamic influences and effects on the health of people who live there. The research gap that has been identified is a theory of PFC in remote environments. The philosophical landscape and conceptual framework of health have been outlined to provide transparency to this research. Thus, the overall research paradigm that is used for this research is presented in Table 9, which demonstrates that the overall research paradigm is grounded in contextualism.

A contextualism research paradigm emphasises that objective knowledge (biomedical approach) and the dynamism of holistic care is dependent on the context (remote environments). The rationale for this paradigm is it provides a systematic structure for rigorous investigation and enough flexibility to account for the many situational influencing factors of providing PFC in remote environments.

Table 9 Research paradigm map

Conceptions of health	Philosophical landscape		
	Ontology	Epistemology	Methodology
Biomedical model of health	Contextualism	Contextualism	Inductive qualitative research
Biopsychosocial model of health			
Complementary and alternative medicine			
Rural and remote health			
Health Geography			
Holistic health			

5.5 Summary

In this chapter the philosophical landscape and conceptual framework of health within this research are outlined. Presenting the philosophical landscape provides transparency about the researcher's beliefs and approach to investigating the identified phenomenon, and how knowledge is discovered and understood within reality. Transparency of these philosophical perspectives demonstrates the rigour and validity, trustworthiness, and applicability of the findings, thus the potential for research impact. Identifying the conceptual framework of health provides an accurate placement for this research within the philosophical landscape that is outlined. This chapter concludes with the mapping of the philosophical landscape with the conceptual framework of health; thus, the research paradigm of this research is presented. The philosophical landscape and conceptual framework of health underpin the methods used in this research, which are outlined and critically appraised in the next chapter.

Chapter 6 Research methods

6.1 Introduction

This chapter will build on the research paradigm that has been outlined in Chapter 5. The research methods of sampling, collection, and analysis are identified and critically appraised. In doing so, the robust, systematic approach of this research is presented. The research methods are used scrupulously and meticulously throughout the research process, within the identified research paradigm, to ensure systematic and rigorous research. Thus, the research findings do not have statistical significance (which is inappropriate for this research) but validity and trustworthiness. The transparent and explicit appraisal of the research methods and process defines the applicability reach of the findings of this research. The limitations of the research methods are defined in this chapter and, therefore, the limits of research findings rigour and validity, trustworthiness, and applicability. Lastly, this chapter includes diagrammatic illustrations of the research design, which provides delineation of the research methods used in grounded theory generation.

6.2 Grounded theory

Grounded theory is a research method that is used to generate an explanatory theory from the discovery of emerging patterns in data (Glaser and Strauss, 1967). In other words, the grounded theory is a conceptualisation of phenomena. Data patterns are analysed using a coding process that informs researcher memo-writing (Bryant and Charmaz, 2019). Memo-writings are the building blocks of the research output – a grounded theory; a theory grounded in data. Each component of the grounded theory, however, should be traceable back to individual data that was collected (Charmaz, 2014). Grounded theory has a predominant inductive methodology to the research process; however, deduction methodology is used to refine the emerging grounded theory during constant comparative analysis (Chun Tie et al., 2019).

This section identifies the process, methods, and design for this research, as well as the selected grounded theory approach.

Grounded theory was originally developed by Glaser and Strauss in 1967 during a period of discourse from traditional social science methods that tested existing theory to the empirical development of theory (Glaser and Strauss, 1967). In other words, grounded theory was established to be a legitimate research method, in juxtaposition with the perception that qualitative research was an inferior step towards quantitative research with a positivist paradigm (Glaser and Strauss, 1967). The original purpose of grounded theory was to generate theory from data (not with data) that is provides evidence-based explanation of phenomena. Thus, the emergent PFC grounded theory is measured by its usefulness, not truthfulness, to acknowledge that theories evolve overtime (Glaser, 1998, Glaser, 2001). The method of grounded theory itself has been reshaped many times since its establishment, namely by different research paradigms informing the research process. However, there are common fundamental components of all approached to grounded theory.

The predominant approaches to grounded theory are explored in 6.3; however, it should be acknowledged that grounded theory can be used in mixed methods research, although this disaggregates from the original purpose (Flick, 2018, Moore, 2009). Much literature has been published to debate what constitutes grounded theory research; however, there are some fundamental components of grounded theory. Table 10 outlies the fundamental components of grounded theory; adapted from (Hood, 2007, Sbaraini et al., 2011).

Table 10 Grounded theory fundamental components

GT Component	Explanation
Open mind to serendipity	Researchers should maintain an open mind before and during grounded theory research so the emergent theory is generated from the data, not with the data. Strict adherence to some grounded theory approaches – namely, Glaserian grounded theory (see 6.3.1) – literature should not be engaged at all until theoretical saturation has been achieved.
Theoretical sampling	Initial purposeful sample, followed by theoretical sampling informed by data analysis (see 6.4.1.1).
Immediate data analysis	Data analysis begins as soon as data has been collected and continues throughout the research process until theoretical saturation has been achieved. Immediate data analysis is required for theoretical sampling.
Coding analysis	The data is analysed through an iterative coding process. Codes emerge from the data, rather than codes being imposed on the data, to identify the building blocks of the emergent theory (see 6.4.3).

Constant comparative analysis (CCA)	The codes from data analysis and memo-writings are comparative analysed with one another throughout the research process to inform theoretical sampling. Constant comparative analysis continues until theoretical saturation has been achieved.
Inductive research process	Overall, the research process is inductive; that is, data is collected, analysed, and a theory is generated (opposed to deduction when theory or hypotheses are tested via data collection and analysis). A Straussian approach to GT uses induction and deduction to refine the emerging theory (see 5.2.3).
Memo-writing	The researcher records memo-writings throughout the research process, noting salient points of theory generation and the decision-making process (which presents reflexivity, see 6.4.1.1). Once theoretical saturation has been achieved, the memo-writings are used to construct the grounded theory (see 6.4.3.5).
Theoretical saturation	Theoretical saturation is the point that no new codes that change the conceptual model of the grounded theory are being generated from data collection (not new insights into the data). Theoretical saturation determines the sample size needed for data collection (not statistical significance); therefore, the exact sample size is unknown at the beginning of grounded theory.
Production of a grounded theory	The research output of grounded theory is a theory grounded in data (in the evidence-base) because it has emerged from the data. In other words, the theory has not been generated or tested with data.

The fundamental components presented in Table 10 are unique to grounded theory. Grounded theory is appropriate to use when there is no theoretical explanation; thus, the outcome is a theory that conceptualises phenomena (not simply describe it) (Walker and Myrick, 2006). The phenomena that grounded theory can be used to investigate are within the social sciences – namely, to examine what happens and how people interact. This inquiry investigates to symbolic interactionism within social science (Flick, 2018). Symbolic interactionism is an underpinning theory of social science that refers to the action and interaction of people with objects or circumstances based on their interpretations (Blumer, 1986). In relation this research, the line of inquiry encompasses PFC provision in remote environments to mitigate risks to health and promote good health; the contextual and holistic approach to PFC and health (see 5.3).

Grounded theory is an appropriate method to use for this research because PFC already exists in practice and the research gap is a theory to this practice; thus, grounded theory provides the tools to bridge this research gap. Grounded theory has an integrative research process, which enables data to be collected and analysed to generate a grounded theory. As explained, PFC in remote environments is complex and dependent on individual circumstances (hence a contextualism research paradigm). Grounded theory enables the collection of data from multiple sources, which is necessary in order to generate an applicable grounded theory (see 6.5.3). Alternative research methods could be used but their primary aim is to develop new knowledge, prove or disprove a hypothesis, whereas grounded theory is the most suitable method to establish theory (Levers, 2013).

Grounded theory can be described as a research strategy that is malleable, shaped to suit the context of the phenomena being investigated (Flick, 2018). The nature of grounded theory may appear pliant and vulnerable to biases, but the systematic robustness of grounded theory is evident by explicitly defining the data sampling, collection, and analysis methods (see 6.4.1 to 6.4.3) (Hall and Callery, 2001). In other words, grounded theory is intended to be flexible to ensure the research design is apposite and pertinent to the research aim, while maintaining the standards of rigorous systematic inquiry to produce a grounded PFC grounded theory (Chun Tie et al., 2019, Corbin and Strauss, 2015).

There is a misconception that grounded theory uses a reductionist approach to research (Bryant and Charmaz, 2007). A reductionist approach presumes a phenomenon has a simple explanation that can be determined by the research process. Reductionism has a sequential research design that excludes flexibility in research, whereas grounded theory enables a dynamic and systematic research process. Grounded theory, therefore, acknowledges the complexity of the identified phenomena and research gap, and will enable rigorous data collection and analysis methods to establish a robust, applicable PFC grounded theory (Heath and Cowley, 2004). The next section of this chapter outlines grounded theory approaches, and the approach used in this research.

6.3 Grounded theory approaches

Grounded theory is a broad research method and a variety of approaches have evolved overtime from 'The Discovery of Grounded Theory' (Glaser and Strauss, 1967). In this section, the Glaserian, Straussian, and Constructivism approaches are critically appraised in relation to investigating PFC in remote environments. The selected grounded theory approach for this research is Straussian, and rationales for this selection are explained in this section.

6.3.1 Glaserian

Glaserian grounded theory, also referred to as classic grounded theory, has a realism ontology, objective epistemology, and inductive methodology (Glaser, 1992). Glaserian grounded theory is advocated by Barney Glaser as the method to produce a pure and unobstructed grounded theory, free from prejudices and bias (Glaser, 1998). Glaser claims this is achieved through researcher impartiality as an observer of data, rather than manipulated the data in any way. Theoretical sampling is used to determine subsequent data collection and there is no prescribed sample size or duration of the study

(Glaser, 1978). The rationale for this approach, according to Glaser, is to avoid the influence of bias. While bias should be mitigated, Glaserian grounded theory is a passive and exploratory approach to theory generation; therefore, it is not suitable for this research. Exploratory research has its place; however, when considering health, it is important to adopt an evidence-based approach. While some remote communities have traditional health systems of heuristically learnt practice, this approach exclude the opportunity to identify more efficient and effective health practice. Thus, Glaserian grounded theory is appropriate for investigating social practices but not health practice within the context of this research.

6.3.2 Constructivist

Constructivist grounded theory has a realism ontology, a postmodern epistemology, and inductive methodology (Charmaz, 2014). Postmodern epistemology is the belief that knowledge cannot be separate from human consciousness, which is a step away from Glaserian grounded theory but still accepting knowledge a realism ontology (Clarke, 2005). Constructivist grounded theory was pioneered by Kathy Charmaz, a PhD student of Glaser and Strauss, as a method used to generate a grounded theory but acknowledge the experiences, perceptions, and beliefs of the researcher (Mills et al., 2006).

Constructivist grounded theory has an inductive methodology, but emphasis is on the construction of theory from the data being collected (Charmaz, 2008). Furthermore, Constructivist grounded theory enables a co-production of theory via a rapport between the researcher and participants. In other words, connections are identified between data to inform theoretical sampling, whereas Glaserian grounded theory prohibits any influence on data collection and analysis (Glaser, 2001). Constructivist grounded theory was not selective for this research because PFC is a developing area of practice (despite a long history of utilisation), and some practitioners are not aware of this term. As a result, the researcher would need to explain PFC to participants before data collection, exposing participants to confirmation bias – this would severely hinder the rigour and validity, trustworthiness and applicability of the findings.

6.3.3 Straussian

Straussian grounded theory was developed by Anselm Strauss and Juliet Corbin to modify the approach of grounded theory methods (Corbin and Strauss, 2015). Straussian grounded theory has a pragmatist ontology and epistemology, meaning appropriate ontology and epistemology to the phenomenon should be used. This research uses a contextualism ontology and epistemology (see 5.2.1 and 5.2.2). Inductive methodology is used in Straussian grounded theory; however, during data analysis, deduction is used to enhance theoretical sensitivity and sampling (see 6.4.1.1) – this research similarly has an overall inductive methodology, with deduction during data analysis (see 5.2.3).

A unique feature of Straussian grounded theory is the endorsement of researcher insight and experiences of the phenomena to inform the research methods (Pawluch and Neiterman, 2010). Furthermore, Straussian grounded theory accepts some interaction with literature before data collection is necessary to establish boundaries of data collection, which is distinctly opposite to Glaserian grounded theory. This enables an evidence-based approach to grounded theory, which is integral to safe clinical practice. Thus, Straussian grounded theory approach has been selected as the most appropriate approach to achieve the research aim, answer the research question, and provide an explanatory theory of PFC in remote environments.

The next sections of this chapter focus on the Straussian grounded theory approach research methods used in this research. The recursive cycle of data collection, data analysis, and theoretical sampling used in this research is explained. The rich and in-depth data analysis methods of coding, constant comparative analysis, and memo-writing are explicitly outlined to present how the building blocks of the emerging theory are used to write the PFC grounded theory. To begin, the sampling methods used for this research are critically appraised.

6.4 Straussian grounded theory approach

6.4.1 Sampling

Sampling within grounded theory is unique to grounded theory and is used specifically to foster the emergence of theory (Morse, 2010). Sampling methods are a common thread through all grounded theory approaches (Howard-Payne, 2016). Firstly, purposeful sampling is used to gather initial data; namely, to establish if the data collection methods enable appropriate data to be collected (Flick, 2018). Initial purposeful sampling provides an opportunity for the researcher to adapt the data collection methods to ensure the data being collected is relevant (Corbin and Strauss, 2015). Moreover, data collected via the initial purposeful sample enables theoretical sampling to take place.

6.4.1.1 Theoretical sampling

Theoretical sampling is the predominant sampling methods used in grounded theory (Morse, 2010). Theoretical sampling is the collection of data based on the relevance to the emerging theory, which is determined by the simultaneous analysis of data (Corbin and Strauss, 2015). Initially, purposeful sampling is used to collect the first data set, therefore, enabling theoretical sampling to take place subsequently (Cutcliffe, 2000). In other words, grounded theory emergences from the first building block of data collected using a purposeful sampling method (Levers, 2013).

The process of theoretical sampling is based on theoretical sensitivity – the researcher’s awareness of how relevant *a priori* (data that has not been analysed) data and the products of grounded theory data analysis is to the emerging theory (Glaser, 1978). Theoretical sensitivity determines if new data is being collected, based on data coding (see 6.4.3). In other words, theoretical sampling is the process of data collection based on new data contributions to the emerging theory which are determined by theoretical sensitivity (Walker and Myrick, 2006).

Theoretical sampling is appropriate, relevant, and necessary for grounded theory because it enables an incisive and inductive approach to the research process. Furthermore, theoretical sampling enables the researcher to ensure comprehensive data collection that fulfils the research aim, which increases the robustness and generalisability of the emergent PFC grounded theory. Alternative sampling methods that are determined by proportionate representation of a population, such as stratified or randomised sampling methods, are more replicable (Morse, 2010). A replicable sampling method can strengthen the reliability of research findings because the accuracy sampling can be quantifiably verified. It could be argued that theoretical sampling can be less replicable because data collection is determined by theoretical sensitivity, not a predefined approach as seen in stratified or randomised sampling methods. A precisely replicable sampling method would not provide inductive, data driven sampling and is, therefore, not appropriate for grounded theory. Thus, initial purposefully sampling, followed by theoretical sampling is required and utilised for this research.

The quality of theoretical sampling is determined by the reflexivity of the researcher (Mruck and Mey, 2007). Reflexivity is the examination of the decision-making process, and any potential influences, during the data collection and analysis methods used in grounded theory (and other qualitative research methods) (Hall and Callery, 2001). The influences may be due to bias or prejudices; thus, to mitigate this reflexivity is used. Reflexivity is attuned during memo-writing, which provides a transparent record of the decision-making process during data collection and analysis (Corbin and Strauss, 2015). Thus, memo-writing is a tool to enable rigorous and trustworthy theoretical sampling that strengthens the reliability of the grounded theory (Hall and Callery, 2001). Memo-writing provides a narrative of the data collection decision-making process; however, Memo-writings are also the building blocks of the emerging theory (see 6.4.3.5).

It is important to note that in grounded theory, there is no predetermined sample size. A representative sample of a population is not relevant to the efficacy of the research output – a grounded theory. Rather, the number of research participants is guided by theoretical sensitivity (Glaser, 1978). There is some literature that identifies the average number of research participants (based on a sample of one hundred grounded theory studies) is approximately

10-30 interviews; however, it is emphasised that data collection is only completed when theoretical saturation is achieved (Thomson, 2010). (See 6.4.2 for data collection methods.) It is also advocated that planning for 30 interviews in the research approval process (such as ethics review) is recommended, which was adopted for this research (see 6.5.4 for ethics). Thus, theoretical sampling continues until the point of theoretical saturation and not when data has been collected from a predetermined sample size.

6.4.1.2 Theoretical saturation

In numerically focused sampling methods, data saturation is defined as the amount of data that is representative of the population. However, as established, grounded theory is not numerically driven, but concentrates on theoretical sampling for analysis to establish an explanatory, evidence-based theory (Sbaraini et al., 2011). Therefore, data saturation is not applicable to grounded theory. When using grounded theory, theoretical sampling ceases when theoretical saturation has been achieved (Flick, 2018).

Theoretical saturation is when no new codes or memo-writings are being identified from data analysis (Corbin and Strauss, 2015). In grounded theory, predetermining the sample size needed to achieve theoretical saturation is avoided because this would influence the data collection methods and prevent the emerging theory from being grounded in theory (Glaser and Strauss, 1967). Thus, theoretical sensitivity guides data collection and ceases when theoretical saturation has been achieved. The point of theoretical saturation for this research is defined as:

1. No new open coding concepts, axial coding categories, or additions to the selective coding conditional matrix (see 6.4.3.1 to 6.4.3.3).
2. No new memo-writings based on data collection, or constant comparative analysis (see 6.4.3.4 to 6.4.3.5).

6.4.1.3 Inclusion and exclusion criteria

The inclusion criteria for participants of this research must be a registered health care professional or certified first aider with experience of PFC in remote environments. The exclusion criterion is aged 17 years or younger. See Appendix 6 for a detailed explanation of the inclusion and exclusion criteria.

6.4.1.4 Recruitment

The recruitment of participants for this research was conducted via the networks of the two collaborating organisations – Remote Area Risk International (R2Ri) and the UK Ministry of Defence, Royal Centre for Defence Medicine (RCDM). R2Ri are a civilian remote environment risk consultancy and education provider, whereas RCDM are a military organisation researching and training personnel in military health. Both collaborators have subject matter experts of PFC in remote environments within their networks and provide PFC pre-deployment training. Thus, R2Ri and RCDM provided ideal collaborators for the purposes of recruiting research participants.

There was one purposeful sample for the initial pre-interview survey and semi-structured interview (from R2Ri), followed by theoretical sampling of data collected during subsequent semi-structured interviews. The initial pre-interview survey and semi-structured interview was conducted as a pilot study. The rationale for this was to trial the survey and semi-structured interview questions to determine their efficacy. It is important to note that the pilot study did not affect the data collection methods – doing so would be breaching the Straussian grounded theory approach for this research. Rather, the pilot enabled a critical review of the questions used based on the relevance to the research aim and question, and the theoretical sensitivity (developed from the literature review and concept analysis; see Chapter 3 and Chapter 4). Thus, the pilot study enabled effective and efficient data collection from the research participants, who are summarised in the next section. See Appendix 7 for an overview of the included participants, and 7.2 for a critical appraisal of the impact for this research.

6.4.2 Data collection

In this section, the data collection methods used for this research are outlined and critically appraised. Data was collected using a variety of data collection methods, as per endorsement from grounded theory literature. Data was collected from the two collaborating organisations of this research to include data about PFC practice in each context. The first stage of the data collection methods to be critically appraised is the use of a survey.

6.4.2.1 Survey

Research participants were asked to complete a tick-box survey of their background (see Appendix 7 for the survey questions). The survey is hosted in Microsoft Forms, as required by UCL Data Protection Office. The survey questions have been adapted from Faculty of Pre-Hospital Care, Royal College of Surgeons of Edinburgh, updated guidance for medical provision for wilderness medicine (Mellor et al., 2020). The rationale for using this guidance as the basis for the pre-data collection survey is it is the most comprehensive document on providing health care in remote environments. The pre-data collection survey data was collected to (1) inform the evaluation of the data collection regarding principles of equality and diversity, and (2) will inform the evaluation of professional backgrounds and experiences of participants included in this research who have provided PFC in remote/austere environments.

6.4.2.2 Semi-structured interviews

In grounded theory, there are no prescribed data collection methods – it is emphasised that the data collection methods should be appropriate to collect data that will answer the research question (Cutcliffe, 2000). To understand PFC in remote environments, semi-structured interviews of PFC providers were chosen as the primary data collection methods to understand the social science practices. In some literature about grounded theory, unstructured interviews are advocated as the most appropriate method to enable participant-led data generation (which mitigates the risk of selection bias by the researcher) (Glaser, 1998). However, PFC is a developing area of practice with a growing body of literature (Keenan and Riesberg, 2017). Explaining PFC in interviews would expose data collection methods to influence of confirmation bias, so semi-structured was used to provide enough of a structure to keep interviews focused but enough flexibility to allow participants to share their experiences.

Semi-structured interviews were utilised only to collect data from health care providers with PFC provision experience in remote. There were three data sources of participants – R2Ri (civilian) and RCDM (military) for theoretical data contributions, followed by semi-structured interviews from PFC providers during case studies for empirical contributions. The questions of the semi-structured interviews were based on the literature review, concept analysis, and pilot interview with a purposeful sample to ensure the questions were evidence-based. The semi-structured interviews were automatically transcribed but Microsoft Teams and amendments were made to ensure accuracy by the researcher. The data was securely stored on internal UCL data storage systems, including back-ups, as approved by UCL Data Protection Office (see 6.5.4). The semi-structured interview questions are outlined in Appendix 8.

6.4.3 Data analysis

Data analysis for grounded theory research is unique as it enables the conceptual analysis of qualitative data (Clarke, 2005). It is important to note that grounded theory analysis is not the same as qualitative thematic analysis (Glaser, 1992). Grounded theory data analysis is a systematic immersion into the data to identify conceptual meaning followed by a progressive development of theory emersion from the data. For this research, Straussian grounded theory data analysis is used.

Straussian coding is complex, having three stages of coding – open, axial, and selective coding – which provide in-depth and active analysis of the data; although, each stage of analysis is utilised sequentially and concurrently (Corbin and Strauss, 2015). Initially, open coding is used to infer concepts from the raw data. (In original Straussian grounded theory, open coding identifies categories; however, for this research, the product of open coding has been identified as concepts to distinguish between the product of axial coding.) Then, axial and selective coding are used to identify categories and a conditional matrix. Simultaneously, there is a constant comparison of concepts, categories, and the conditional matrix to further analyse the data, while memo-writing of each stage of data analysis takes place. The memo-writings are the building blocks of the grounded theory; thus, they are grounded in the data being collected. In other words, grounded theory data analysis is a method that enables the generation of theory *from* data (Walker and Myrick, 2006). The headline stages of grounded theory data analysis and memo-writing are outlined below in Table 11; however, in practice, this linear outline is cyclical and is repeated via constant comparison until theoretical saturation is achieved.

Table 11 Grounded theory stages

Stage 1		**Stage 2**		**Stage 3**	
Open coding	→	Concepts	→	Memo-writing	↓
Axial coding	→	Categories	→	Memo-writing	↓
Selective coding	→	Conditional matrix	→	Memo-writing	↓
PFC grounded theory					

In grounded theory data analysis, the concepts, categories, and conditional matrix should not be predetermined or presumed before or during the data collection and analysis (Howard-Payne, 2016). The researcher's preconceptions are excluded from the data collection and analysis methods to ensure the coding, analysis, and memo-writing are developed from the data, enabling the emergent theory to be grounded in the empirical evidence (Corbin and Strauss, 2015). In other words, the concepts, categories, and conditional matrix are generated from the data, and not applied to by the researcher, to ensure the grounded theory is rooted in data; thus, the trustworthiness and rigour of the findings are enhanced (Hall and Callery, 2001). The next three sections present the details of open, axial, and selective coding used in this research and a critical appraisal of the data analysis method. Figure 3 illustrates the process of open, axial, and selective coding of the data from semi-structured interview transcriptions, and the outputs from each stage: concepts, categories, and a conditional matrix.

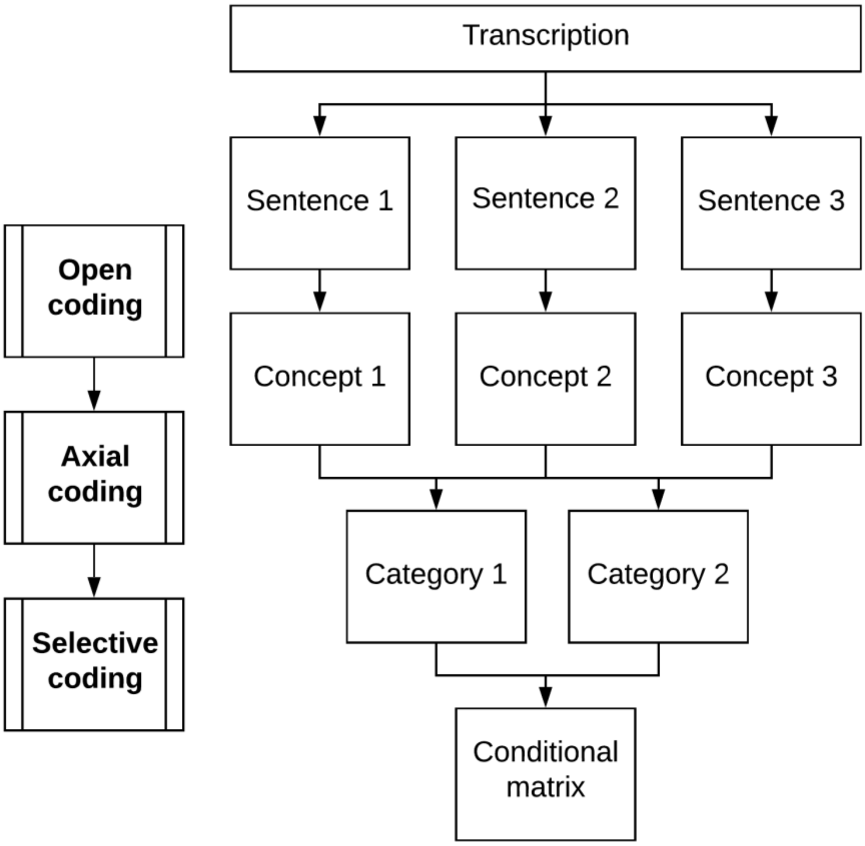

Figure 3 Data analysis process

6.4.3.1 Open coding

Open coding is the first stage of grounded theory data analysis in grounded theory. In open coding, each sentence of the semi-structured interview transcripts is assigned a concept that represents the meaning of what the interviewee has said (Corbin and Strauss, 2015). If the sentence contains more than one concept, segmentation is used to distinguish between the different concepts. Segmentation is the separation of sentences (the data) into the smallest concepts of meaning, which is completed by using superscripted number codes. Segmentation enables the researcher to fractionate complex data and accurately establish concise, specific, and accurate concepts from open coding. The aim of open coding is to establish conceptual meaning of the data, sentence by sentence, until the data set is analysed into concepts. Analysing the data sentence by sentence ensures the analysis is systematic and comprehensive. The concepts should be concise, specific, and accurate.

Open coding is an engaging analysis method that enables the development of the researcher's theoretical sensitivity, which is then developed during the second stage of grounded theory data analysis – axial coding (Cutcliffe, 2000).

6.4.3.2 Axial coding

Axial coding is the categorisation of concepts from opening coding; thus, producing categories. The process of axial coding, according to Strauss and Corbin, is the identification of four categories: the cause, context, strategy, and consequence (Corbin and Strauss, 2015). The aim of axial coding is to categorise the concepts in order to map the conceptual influences of the concepts. Thus, categorising the concepts from open coding maps the influencing factors of the PFC in remote environments which deepens the conceptual understanding of the emerging grounded theory (Glaser, 2001). On completion of axial coding, the last stage of grounded theory data analysis takes place – selective coding.

6.4.3.3 Selective coding

Selective coding is the final stage of grounded theory data analysis, which aims to achieve conceptual profundity and comprehension (Corbin and Strauss, 2015). The categories from axial coding are assimilated into a conditional matrix that displays the network of fundamental variables of the developing theory on micro and macro levels. In other words, the conditional matrix holds the core components of the theory that can be traced back to individual concepts that were produced from open coding. Thus, when theoretical saturation is achieved, the emergent theory is clearly grounded in evidence. In Straussian grounded theory, selective coding involves identifying the storyline, a chronology of the categories that provides a rigorous conceptual understanding of the social science of PFC in remote environments (Flick, 2018). Often, the social science phenomena is complex and unlikely to be a linear process; therefore, the product of selective coding is a conditional matrix that represents the complexity.

It is important to note that the three-stage grounded theory data analysis method is the vehicle that drives theory generation; however, meanwhile, there are two other data analysis processes taking place. Between each stage of grounded theory data analysis, memo-writing is undertaken (see 6.4.3.5), and constant comparative analysis of the concepts, categories, and conditional matrix is utilised to enrich the data analysis and increase the validity and confirmability of the emergent grounded theory (Corbin and Strauss, 2015). (See Figure 4 for an illustration of the overall data collection and analysis process.) It can be noted, that grounded theory data analysis is a vehicle that drives theory emergence, which is fuelled by constant comparative analysis, and memo-writings are the blocks to build the PFC grounded theory that are collected throughout the process. The next sections of this chapter critically appraise constant comparative analysis and memo-writing to provide transparency in how these tools are used within this research.

6.4.3.4 Constant comparative analysis

Constant comparative analysis is the comparison of data and all concepts, categories, and conditional matrix as they are identified during the grounded theory data analysis process (see 6.4.3) (Corbin and Strauss, 2015). Constant comparative analysis takes place simultaneously with grounded theory data analysis (similarly to memo-writing; see 6.4.3.5) using a concept indicator model – a the identification of relative open coding concepts with axial coding categories and selective coding conditional matrix (Chun Tie et al., 2019). Thus, the concept indicator model is a tool to promote the accuracy of theoretical sensitivity. Simultaneous comparative analysis is necessary because this process identifies conceptual similarities, differences, and anomalies between the data and concepts, categories, and conditional matrix. In other words, constant comparative analysis enables the PFC grounded theory to systematically emerge from a descriptive account of practice to a theory rooted in empirical evidence. Constant comparative analysis also enhances theoretical sensitivity as the PFC grounded theory emerges until the point of theoretical saturation.

Constant comparative analysis demonstrates that data analysis is grounded theory is a rigorous and in-depth examination of data; however, it is important to note that constant comparative analysis is not data triangulation (Heath and

Cowley, 2004). The utilisation of triangulation is primarily to investigate new insights into the data, findings, and grounded theory (Flick, 2018). Triangulation can be used to confirm results and findings, or conduct a quality assessment; however, this utilisation of triangulation is apt for positivist quantitative research that aims to test theory or hypotheses (Flick, 1992, Flick, 2017). The output of grounded theory, however, is a grounded theory and memo-writing is the tool used to build the theory based on empirical data.

6.4.3.5 Memo-writing

Memo-writing is a tool to document notes about the processes of data collection, grounded theory data analysis, and constant comparative analysis (Lempert, 2007). Memo-writings can be written notes, figures, or tables – these notes are the building blocks of the grounded theory (Mills et al., 2006). In other words, data collection, grounded theory data analysis, and constant comparative analysis are the vehicles that drive theory emergence, whereas memo-writing is the tool used to build the theory from empirical data.

A purpose of memo-writing is to document an account of the conceptualisation of the data from the point of purposeful sampling to theoretical saturation (Lempert, 2007). Memo-writing is also tool to develop and attune research reflexivity and theoretical sensitivity during the research process and provides a transparent record of theory emergence (Glaser, 1978). Thus, the process of memo-writing leads to the emergence of the PFC grounded theory. For the Straussian grounded theory approach used in this thesis, greater emphasis is on the association of data with the emergency grounded theory – that is, the open coding concepts, axial coding categories, and selective coding conditional matrix. However, to provide transparency of memo-writing, an example is provided in Table 12.

6.4.3.6 Data analysis management

The primary tool used for grounded theory data analysis is Microsoft Excel. Excel is traditionally a numerical data analysis software; however, it can be used for qualitative data analysis (Meyer and Avery, 2009, Ose, 2016). It is noted in the literature that using Excel as a tool for qualitative data analysis can be time consuming, which is similar to a critique of grounded theory (Guerrero et al., 2019). Grounded theory has been described as time consuming due to the extremely detailed and rigorous data analysis (Mruck and Mey, 2007). Excel enables the high-level of detailed analysis needed for grounded theory, whereas alternative qualitative analysis software is limited in scope for grounded theory data analysis. Furthermore, Excel functionality is flexible enough to enable theoretical sampling and, moreover, memo-writing as a record of the coding process decisions. This is of great importance for ensuring the integrity of the systematic data analysis approach. Lastly, Excel enables the researcher to interact with the data when analysing, which is advocated when using grounded theory, providing memo-writing takes place.

Alternative qualitative analysis software, such as NVivo, was considered as an analysis tool for this research. NVivo is a widely used software and is a valid, reliable tool; however, NVivo has prescribed data analysis functions, albeit many options, and is, therefore, deemed not suitable for this research. A prescribed data analysis method introduces predetermined influences of data collection and theoretical sampling, therefore, preventing the results theory being grounded in empirical evidence. Furthermore, researcher interaction with data analysis is needed for Straussian grounded theory approach data analysis to enable the identification of concepts, categories, and conditional matrix. Figure 4 provides an illustration of the overall data analysis process. The subsequent section explores the quality assurance of this research.

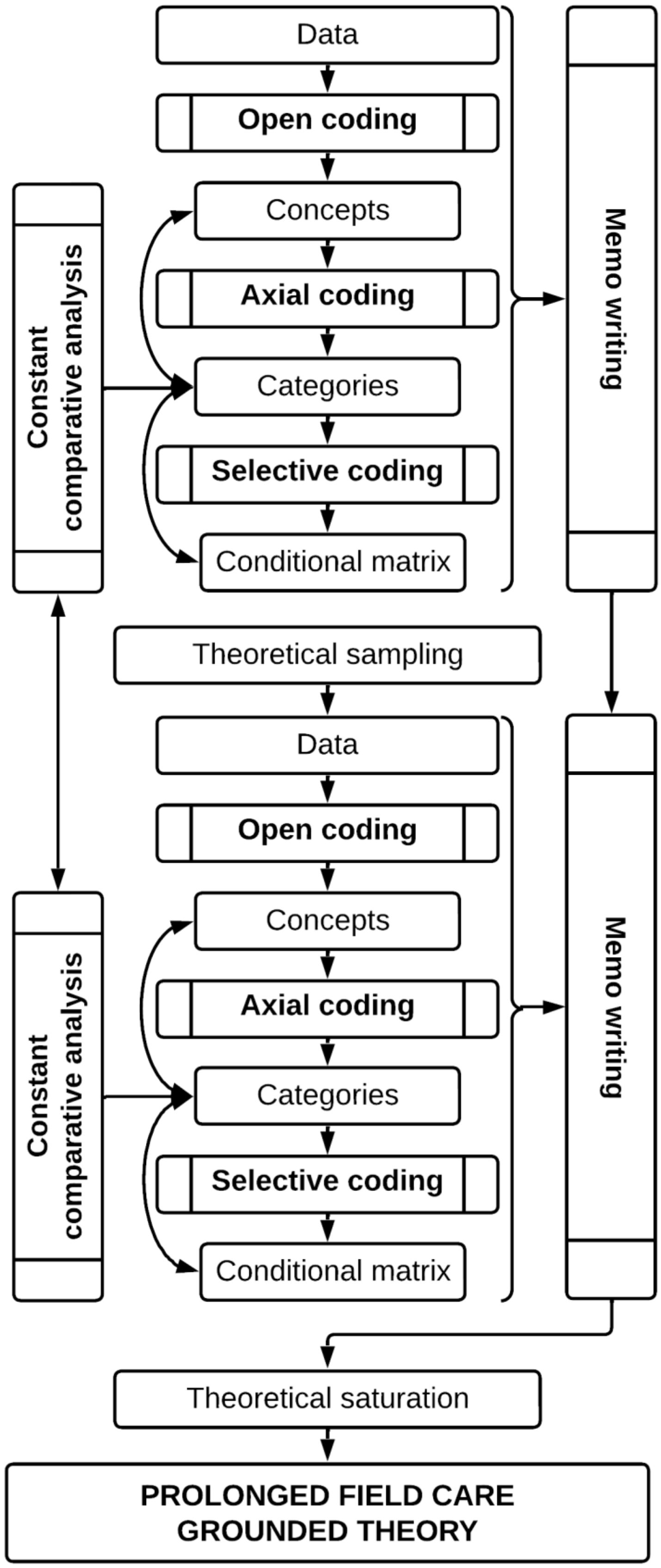

Figure 4 Grounded theory data collection and analysis flow diagram

6.5 Quality control and indicators

Grounded theory can be described as a research strategy that is malleable, shaped to suit the context of the phenomena being investigated (Howard-Payne, 2016). The nature of grounded theory may appear pliant and vulnerable to biases, but the rigour of grounded theory is evident by explicitly defining the data sampling, collection, and analysis methods (although other studies using grounded theory may apply slightly different methods that are applicable to their identified research gap). In other words, grounded theory is intended to be flexible to ensure the research design is apposite and pertinent to the research aim, while maintaining the standards of rigorous systematic inquiry. Thus, the quality of research requires explicit evaluation (Flick, 2018).

In this section the components of quality control are identified. There are no generic criteria for the evaluation of all qualitative research, including grounded theory (unlikely quantitative research) (Cutcliffe, 2000). For this research, this is due to the contextualism ontology and epistemology of this research, whereas the quality of research with a positivist paradigm can be quantitative evaluated through a *p-value* (probability of results being incorrect). In the literature, it is acknowledged that the evaluation of quality in qualitative research is bespoke to each study and the quality indicators should be defined (Corbin and Strauss, 2015).

Quality control for this research are based in Corbin and Strauss (2015) components that promote quality in qualitative research – rigour and validity, trustworthiness (constituted by credibility and confirmability), applicability, ethics and data protection, and ownership of the limitations. In this section, these components of quality control are critically appraised to evaluate the quality indicators of this research.

6.5.1 Rigour and validity

Rigour is defined as the systematic utilisation of research methods (Chun Tie et al., 2019). Grounded theory has many approaches and the approach used for this research is outlined in 6.3 – a Straussian grounded theory approach. Some adaptations have been made to the original Straussian grounded theory for this research, namely the contextualism ontology and epistemology; thus, maintaining a consistent and accurate utilisation of the methods identified in this research determines the rigour. A high standard of rigour in this research complements the high-level of validity.

Validity refers to the accuracy of the methods used to bridge the research gap and answer the research question (Creswell and Miller, 2000). The validity of research is determined by external and internal influences of the research process (Flick, 2018). The external influences determine if and how the emergent grounded theory can be applied in practice. This research has a contextualism ontology and epistemology, which presumes that reality and knowledge is relative to subjects, places, and time; thus, it is presumed that the findings of this research are only applicable to specific subjects, places, and time, rather than the PFC grounded theory being generalisable. The internal influences of validity for this research consider how the accurate use of the identified research methods can be maintained. For this research, reflexivity is used to monitor rigour and theoretical sensitivity.

Reflexivity can be defined as methodically developing awareness and insight into the research process (Mruck and Mey, 2007). In grounded theory, reflexivity is complemented by the development of theoretical sensitivity (the awareness of how relevant *a priori* data, concepts, categories, and conditional matrix is to the emerging theory; see 6.4.1.1) (Hall and Callery, 2001). Reflexivity involves demonstrating how decisions were made and how the researcher's own assumptions and personal interests were managed. For this research, reflectivity and theoretical sensitivity is developed and maintained by memo-writing and constant comparison analysis (Corbin and Strauss, 2015). Thus, the critiques of grounded theory (and qualitative research at large) being too subjective and having limited reliability are accurate up to a point – grounded theory does not aim to be reliable; grounded theory aims to produce a valid and trustworthy grounded theory (Glaser and Strauss, 1967). In the next section, the constituents of trustworthiness are presented.

6.5.2 Trustworthiness

The trustworthiness of qualitative research is dependent on the credibility, confirmability, and truthfulness of the findings (Creswell and Miller, 2000, Lewis-Beck et al., 2003, Lincoln and Guba, 1985). On the other hand, credibility refers to the genuine account of lived experiences. The data collection methods used for this research are designed to enable participants to have a voice and empower them to share their story. To mitigate the influence of selection bias, direct quotes from the semi-structured interviews are presented and they are mapped with the open coding concept, axial coding categories, and selective coding conditional matrix. Thus, each component of the emergent grounded theory can be traced back to the data; therefore, demonstrating it is a grounded theory. It follows that the confirmability of research findings refers to the delineation of the PFC grounded theory to the *a priori* data. Microsoft Excel is used as a data analysis management tool and provides a record of data analysis and the generation of concepts, categories, and conditional matrix.

The generalisability of findings is another measure of quality in qualitative research, which considers how widely the findings can be applied. However, this is not an appropriate measure for this thesis because the emergent grounded theory does not intend to be globally generalisable – the intension is for the PFC grounded theory to have rigor, validity, trustworthiness, and applicability for use in remote environments. The applicability of this research is critiqued in the next section.

6.5.3 Applicability

An indicator of quality for research with a qualitative methodology is the applicability to practice (Corbin and Strauss, 2015). In grounded theory, there are four constituents to applicability that determine quality in grounded theory research (Glaser and Strauss, 1967).

Firstly, the emergent grounded theory should be from and be relevant to the area it was generated from. For PFC, the ‘area’ is remote environments and data is collected from PFC providers with experience of PFC provision in a variety of remote environments. Secondly, the PFC grounded theory should be understandable to all. The theory has been synthesised into a PFC model, which is presented in Chapter 7 in language that is accessible and succinct. Thirdly, an emergent grounded theory should be dynamically relevant, applicable to a variety of contexts and situations. The research design ensured that data was collected from a variety of remote environments, thus the findings encompass a broad spectrum of remote environments and the challenges that are presented there. Lastly, a grounded theory should inform the user's decision-making in making change to their practice. The results PFC grounded theory is relevant to PFC provider's practice and, furthermore, informs policy, training, and clinical practice; thus, PFC grounded theory informs PFC providers at multiple points.

Thus, the applicability quality of this research findings is a strength within the contexts of remote environment health services, military and civilian. The limits of applicability for this research are within the conceptual framework of health (see 5.3).

6.5.4 Ethics and data protection

All research, including this thesis, needs to be ethically reviewed. To ensure the principles of research ethics are upheld, applications to UCL Research Ethics Committee (REC) and Royal Air Force Scientific Advisory Committee (RAFSAC) were submitted for independent ethical review. In this section, the ethical considerations are presented.

An ethical issue to be mindful of is maintaining confidentiality of research participants, particularly registered health care practitioners who have treated patients in remote environments. To mitigate the risk of exposure, all data is collected anonymously and securely stored on UCL N drive (primary storage) and UCL Data Safe Haven. UCL Data Protection Office approval was provided for the data management plan, reference number: Z6364106/2020/03/121.

During survey or semi-structured interview questions participants may have been reminded of challenging situations when they provided PFC in remote environments, evoking anxiety or stress. It is important to note that participating in this research may provide an opportunity to reflect of the provision of PFC in remote environments, thus participating in this research may be beneficial. Nevertheless, evoking distressful memories is not the intension of the surveys or interviews; however, in this circumstance:

- Participants will be reminded that the interview or survey can be paused or stopped at any time of their choosing, thus empowering the participants to be in-control
- Participants will be signposted to occupational health support networks within their organisations and, or the mental health charity Mind, who can provide professional mental health counselling if required
- Participants will be reminded that they can book an appointment with their GP for mental health care and referral to alternative professional mental health services on recommendations from the participant's GP
- Participants will be reminded they can withdraw some or all of the data they have shared and request some or all of their data to be securely destroyed.

As all participants of this research are registered health care practitioners or qualified first aiders, all participants are subject to maintaining patient (PFC recipient) confidentiality in their governing body or qualification provider; therefore, the risk of patient's identity being revealed in the surveys or interviews is minimal. However, should patient confidentiality be purposefully breached, the participant's detailed will be passed on to the participant's governing body or qualification provider, who are experienced in managing breaches of confidentiality. UCL REC reference number is 17853/002 and RAFSAC reference number is SP2111.

6.6 Summary

This chapter has been built on the methodological foundations outlined in Chapter 5. In this chapter, the research methods that have been used in this research have been outlined and critically appraised. The Straussian grounded theory approach which is used has been explicitly outlined to provide transparency of the methods used to investigate the PFC grounded theory. It has been acknowledged that there are multiple approaches to grounded theory. It is important to recognise that no approach is superior. Rather, the Straussian grounded theory approach has been identified as the most appropriate for this research because it enables the research aim and objectives to be completed and the research question answered. Lastly, the measures of quality and control have been presented to demonstrate how the high standard of academic research and rigour are being held in this research. The next chapter presents the findings of this research and critically appraises the emergent PFC grounded theory.

Chapter 7 Findings

7.1 Introduction

In this chapter the research findings are presented. The findings are systematically presented as theoretical, methodological, and empirical findings to demonstrate the robustness and substantiality of this research. All findings from the surveys and semi-structured interviews that were utilised to develop a PFC grounded theory. The PFC grounded theory is known as the theoretical finding to distinguish it from the methodological and empirical findings of this research. The PFC grounded theory was then studied methodologically and empirically. The methods used to study the PFC grounded theory are outlined and critically appraised in this chapter. The rationale for this decision (opposed to including the methods of methodological and empirical test in the methods chapter) is to ensure the methods of this research are explicitly outlined and critically appraised to demonstrate robustness. Outlining and critically appraising the methods of methodological and empirical studies in this chapter clearly demonstrates that these studies were designed and carried out once the grounded theory study was completed; thus, the grounded theory was not influenced by pre-empting the methods of methodological and empirical tests.

It is important to note that testing newly established grounded theory is not a requirement of Straussian (or any other) grounded theory methods (Glaser, 2001, Glaser, 1992). However, the aim of this research was to make an original and significant contribution to PFC theory, knowledge, and evidence. It was, therefore, decided that the newly established PFC grounded theory could be tested to explore the scope of application and research impact – this would satisfy the research aim. Thus, a methodological and empirical test of the newly established PFC grounded theory was designed and carried out.

For the findings of grounded theory, excerpts from the surveys and semi-structured interviews of the research participants are used to evidence the analysis of data and are direct quotes from the semi-structured interview transcripts. Excerpts from semi-structured interviews have had minor editing to remove filling words (such as, “um,” or, “you know,”) or repetition, (such as, “I thought, I thought that,”). Squared brackets [ ] are used to highlight where words have been added to clarify the research participant’s meaning. Lastly, segmentation is used to compartmentalise long phrases and identify specific points of meaning (see 6.4.3.1). Segmentation is used by a number and forward slash for each point of meaning; for example, “1/”. All data has not been edited to change the salient meaning of the research participants in any way – reflexive practice has been used to preserve the meaning of data shared by research participants. Table 12 provides an example of an original and edited except to demonstrate the editing process of data. An example of how memo-writing is used is also provided, which was consistent throughout the data analysis process.

Table 12 Data editing example

Original excerpt	Edited except	Memo
Question asked: what is your understanding of PFC in remote environments?		
OK, so, I guess from my perspective it's anytime that we've either got a medical or trauma casualty where we're going to have prolonged evacuation times for whatever reason that maybe – whether that's weather-related location related, state of the casualty, etc.	~~OK, so, I guess~~ from my perspective it's anytime that we've either got a medical or trauma casualty 1/ where we're going to have prolonged evacuation times for whatever reason that maybe – 2/ whether that's weather-related location related, state of the casualty, etc. 3/	This data suggests there are several layers to the understanding of PFC, which may be interpreted differently by each person based on their own experiences of providing PFC.
Segmentation:	1/ Biomedical health needs 2/ Delayed evacuation	

	3/ Multiple influencing factors of delay

Excerpts have been selected for inclusion in this thesis based on relevance to the key findings of this thesis. Including directly quoted excerpts ensures the story and experiences of all research participants are accurately presented, thus providing a transparent record of what data has been analysed. All data from included participants were analysed using the methods outlined (see 6.4.3) to reach the findings presented in this chapter. Firstly, an overview of the included research participants is presented in 7.2.

7.2 Research participants

Included in this research were 1 participant for the pilot study, 10 participants for the PFC grounded theory generation (until theoretical saturation was achieved), and 2 participants were interviewed as part of two case studies to empirically test the PFC grounded theory (see 9.1). A summary of the participant's backgrounds who informed the PFC grounded theory is presented in Appendix 7.

Information about the participant's backgrounds were collected via a pre-interview survey that was completed anonymously. Collecting background information about the research participants was necessary to (1) ensure participants met the eligibility criteria (see 6.4.1.3), and (2) understanding the commonalities and differences between other research participants. Understanding the commonalities and differences is required to have awareness of how the experiences of each participant has been informed. Having this awareness is required because each participant's story and experiences is unique, which may affect how their approach PFC in remote environments. The aim of having this awareness is not to quantify 'better' or 'worst' experiences but to have an in-depth understanding of the participant's story and experiences. Nevertheless, the pre-interview survey questions were designed not to be excessively invasive, and no questions were included that were not necessary for the purposes of this research. Thus, the principles of ethics that have been outlined for this research are upheld to the highest possible standard (see 6.5.4).

7.2.1 Participant's demographics

Section 1 of the pre-interview survey focused on collecting data about the demographics of the research participants. All participants were young adults to middle-aged (one participant would rather not say, but confirmed they are aged 18 or older, which is an eligibility criterion). Age could have an influence on their PFC experiences – being of older age provides the opportunity to have more PFC experiences; however, older age does not guarantee the quantity or quality of PFC experiences. Thus, data about participant's ages was collected only to ensure participants met the eligibility criteria and did not contribute to data analysis. Data about participant's gender was collected to monitor the diversity, equality, and inclusion of this research. There was a 3:7 split between women and men. No research participants described themselves as having an alternative gender to male or female, although there was an option for research participants to do this. Ethnicity was not asked for in the pre-interview survey because this chrematistic does not mean that the participant grew up or lived in the country and culture of their ethnic heritage; therefore, ethnicity is unlikely to influence the participant's PFC experience. To adhere to GDPR, data that was not required for this research was not collected.

7.2.2 Participant's background experiences

Section 2 of the pre-interview survey focused on collecting data about the participant's experiences that are relevant to this research. Experiences relevant to this research are:

1. Being in a remote environment (to provide health care or for leisure).
2. Activities in a remote environment (that are not health care related).
3. Leadership and team working in a remote environment.
4. Training for providing health care in a remote environment.
5. Registration with a health care professions governing body.

Questions about experiences in section 2 of the pre-interview survey are relevant to this research because the data that participants shared define the scope of their background experiences related to PFC in remote environments. The questions that section 2 of the pre-interview survey were based on Royal College of Surgeons of Edinburgh, Faculty of Pre-hospital Care, 'Updated Guidance for Medical Provision for Wilderness Medicine' (Mellor et al., 2020). The rationale for this is there is no standardised definition of PFC that could be used to determine if participants had relevant experiences to PFC. Mellor's *et al* (2019) matrix of the qualifications and experiences required by health care practitioners to practice safely in remote environments is an evidence-based tool that can be used to define the qualifications and experiences relevant to remote environments, which is the context of this research. A limitation of this approach is the research participants may be included that do not have relevant experiences to PFC in remote environments; however, irrelevant data would be excluded during data analysis based on theoretical sensitivity to the emerging PFC grounded theory (see 6.4.1.1).

The questions referred to remote environments within the UK, overseas, or outer space. The UK was referenced due to this research taking place in the UK. Geography was not an eligibility criterion for this research so anyone that met the other eligibility criteria could participate. Overseas refers to overseas from the UK; however, the salient point is activities in remote environments (in the UK or overseas). The questions also referred to outer space. Comparatively few people have ventured to space; therefore, both simulated and in-reality outer space environments were included. (Simulated space environments refer to analogue missions; see 9.3.1.) The rationale for including outer space environments is due to the relevance of space to this research, as identified in the literature review (see 3.3.2.4) and concept analysis (see 4.3.2). Thus, all remote environments were included in the scope of the pre-interview survey.

80% of the participants had experience of working, volunteering, or living in a remote environment to provide health care, opposed to being in a remote environment for non-health care related reasons (10%) or leading health care provision (10%). This demonstrates that the 90% of participants had directly relevant experience of health care in remote environments, whereas one person stated they had experience of non-health care related activity in a remote environment. This experience may not be relevant; however, it is likely that the experience is relevant to this research because clinical practice was identified as not the only way to mitigate risks to health in remote environments. Leadership, team working, and resource management are relevant experience to have; therefore, this participant remained included in this research.

The question regarding activities in a remote environment that are not health care related illustrate that was written to collect data to experiences that are transferable to PFC in remote environment but not directly related to clinical practice. 40% of participants had completed at least one training or awareness course in a non-health care remote environment activity. Examples of this from the literature include outdoor instructor or leadership qualifications, such as the Mountain Training UK qualification of a Mountain Leader or Royal Geographic Society off-site safety management course (Hardy et al., 2019, Warrell and Anderson, 2014). While non-healthcare training or awareness courses are not directly involved in health care, they do equip participants with knowledge and skills to assess, manage, and mitigate risk in remote environments (Charnell and Rainey, 2019).

30% of participants had a training or awareness course and one hundred hours or more of documented experience. In other words, a qualification and substantial experience in activities in remote environments; therefore, they are more likely to have consolidated their learning from training or awareness courses. At the other ends of this spectrum, 20% of participants had not completed a training or awareness course but had experience of non-health related activities and 10% identified as a subject matter expert working as a professional guide or instructor, or an elite professional sportsperson. This data demonstrates that there is a variety of experience levels in non-health care related activities in remote environments. Having a statistical representation of the population of people with experience in remote environments is not necessary for this research because the quality of their experiences is more significant to develop an evidence-based grounded theory of PFC.

According to Mellor et al. (2020), experience of leadership and teamworking is important for health care providers in remote environments because they form part of the leadership team. In context, the person responsible for health care during deployment to remote environments contributes to decision-making on how to mitigate risks to health. Thus, data was collected about participant's experience of leadership and team working in a remote environment. 60% of participants had experience of leading teams in overseas remote environments, opposed to 30% with experience of being a team member. 10% of participants identified as having experience of leading teams in remote environments within the UK, whereas no participants identified as being a team member in remote environments within the UK. This data suggests that the majority of participants were in an official leadership role when in a remote environment; however, others did not identify as having a leadership role. This reflects the diversity of how activities in overseas remote environments are managed; or, in other words, the combined experience of the participants is diverse and rich, which strengthens the validity of the data collected during the semi-structured interviews.

The penultimate question on the pre-interview survey asked about experiences of training for prehospital health care provision in remote environments. This question was written to explore the experiences of training about the niche area of prehospital health care, or if there was no training and participant's experiences were heuristic. The phrase prehospital health care was used with PFC in brackets due to PFC being a developing area of clinical practice, especially outside of military healthcare systems. A definition of PFC was not provided to minimise the influence on what experiences the participant's shared for this research; therefore, strengthening the trustworthiness of the findings. (Providing a definition of PFC could exclude some findings due to the unstandardised definitions of PFC (Keenan and Riesberg, 2017).) 80% of participants identified as being a health care practitioner on a professional register with experience of providing health care in remote environments. 10% of participants has completed an advanced first aid or prehospital health care course specific to remote environments, whereas the remaining 10% identified as a health care practitioner on a professional register who can prescribe medications and have four months or more experience. Thus, 100% of participants have had training in health care provision related to remote environments; therefore, their experiences of clinical practice in these environments is informed by training. Questions in the semi-structured interview explored this training in more depth. Data related to this pre-interview survey question also highlighted that 90% of participants identified as being on a professional register, which is in contrast to data collected from the final question.

The final question of the pre-interview collected data about the participant's professional backgrounds. An eligibility criterion was having experience of health care provision in remote environments; however, this question explored whether participant's experiences were based being a member of a professional governing body or not. Being a member of a professional governing body is important data about the participant's experience because when they were in a remote environment, they are still required to meet the standards set by their governing body. How they did this, where relevant, is important experiences of decision-making about PFC in remote environments to mitigate risks to health. 40% of participants were registered with the UK Health and Care Professions Council, which includes all health care professions that are not a dentist, medical doctor, pharmacist, or nurse. 20% were medical doctors, and 30% were nurses. 10% of participants identified as being on a professional register but not in the UK. No dentists or pharmacists volunteered to be participants of this research, which suggests that their scope of clinical practice is not recognised as needed in remote environments at the time of this research, despite the recognition for a holistic approach PFC. It is likely that dentists and pharmacists would similarly require additional training to be able to provide PFC in remote environments due to the challenge and unfamiliarity of these clinical settings.

7.3 Findings

In this section the theoretical finding of this research is presented. Theoretical findings refer to the findings from the surveys and semi-structured interviews of participants that lead to the emergency of the PFC grounded theory. Initial theoretical sampling (a pilot semi-structured interview) took place in February 2021. The pre-interview survey enabled the collection of data to check the eligibility of the research participants based on the criteria (see 6.4.1.3), and to enable the analysis of their background that informed their experiences of PFC in remote environments. The subsequent theoretical sampling (semi-structured interviews) between March 2021 – July 2022. Meanwhile, grounded theory data analysis (that takes place simultaneously to the data collection; see Figure 4) took place from March 2021 – October 2022.

In total, 10 participants participated before theoretical saturation was achieved. Theoretical saturation was identified. Theoretical saturation was identified when no new concepts were identified from open coding the data (data analysis – see 6.4.1.2). It is important to note that new insights into the data could be identified from further data collection; however, new insights do not contribute to the PFC grounded theory in the form of open coding concepts (see Table 10 for fundamental components of grounded theory). The theoretical finding from the semi-structured interviews are presented in this section, which formulated the building blocks of the PFC grounded theory. The questions used in the semi-structured interviews were based on findings from the literature review (see Chapter 3) and the concept analysis (see Chapter 4). The first semi-structured interview that was conducted was a pilot interview.

7.3.1 Pilot semi-structured interview

A pilot interview was conducted with a purposefully selected participant who has experience of providing PFC in remote environments. The rationale of conducting a pilot interview was to trial the semi-structured questions that were developed to explore research participant's experiences of PFC in remote environments. The participants was purposefully selected, in recognition of the potential influence of selection bias, because it was identified this participant has substantial experience of PFC. Collecting data from someone with substantial experience of providing PFC in remote environments enabled the efficacy of the semi-structured interview questions to be tested. Thus, the findings of the pilot interview were used to critically review the semi-structured questions and evaluate the efficacy of generating data relevant to the emerging PFC grounded theory. The questions were based on the findings of the literature review and concept analysis (see Chapter 3 and Chapter 4), and the amendments to the question wordings were based on the findings of the pilot interview. Open coding concepts identified from the pilot interview data were not included in the final dataset to mitigate the risk of selection bias in the results PFC grounded theory. The amendments to the semi-structured interview questions were –

1. Use of technical language was re-worded; for example, “biomedical health,” and, “psychosocial health,” were changed to, “physical health,” and, “mental health and wellbeing.”
2. Reminding participants of maintaining patient confidentiality when they describe the PFC that they provided at the beginning of the interview was sufficient and was not required to be mentioned after every question (this made the question too long).
3. To break down the question about resources into smaller pieces namely, ask what resources they had available, then ask if they felt they needed to use the resources sustainably (if they felt this).

7.3.2 Open coding concepts

At the point of theoretical saturation 1,396 pieces of transcript data were assigned an open coding concept to identify specific concepts from the data. Once duplications were removed, 348 unique concepts had been allocated during the data analysis. Appendix 9 outlines the open coding concepts, which are original data collected for this research.

To ensure that the research participants maintain their authentic voice in this research, and to mitigate the risk of selection bias, direct quotations from the semi-structured interviews are presented. The quotations are anonymous to protect the confidentiality of the researcher participants, as approved in the data management plan (see 6.5.4). The quotations have been edited to provide clarity (as per data editing example provided in Table 12); however, no other changes have been made to ensure the meaning of each quote is not altered. For this reason, the quotations are provided in full to mitigate the risk of small phrases being taken out of context. As a result, including full-length quotations ensure the research participant's experiences are shared transparently and their authentic voice is maintained.

During the data analysis, segmentation was used to identify salient data that research participants shared. As per the example provided in Table 12, individual pieces of data that were relevant to the emerging PFC grounded theory were assigned an open coding concept. It is important to note that segmentation has been used according to a Straussian grounded theory approach. A deviation from pure Straussian grounded theory is the allocation of open coding concepts to salient phrases that have theoretical relevance. Two phrases that have theoretical relevance would be allocated two open coding concepts. In this research, as per the outlined methodology, the contextualisation of data is significant – see 5.4 for the research paradigm. As a result, open coding concepts were provided to phrases that have theoretical significance when they had collective context. In other words, data that could have had meaning individually were not brought out of the context that they were presented by the research participant. Rather, open coding concepts were allocated to data according to the context that they were presented by the research participants. Open coding decisions were based on the researcher's theoretical sensitivity that was developed through the literature review and concept analysis (see Chapter 3 and Chapter 4).

For this chapter, research participant's experiences have been compiled into themes in the sections 7.3.2.1 – 7.3.2.10 to present the research findings. Throughout the themes, it is indicated what open coding concepts have been allocated. Open coding concepts are indicated by being listed as bullet points below the direct quotes, whereas the direct quotes are formatted accordingly. This provides an explicit demonstration of how open coding concepts have been allocated, which strengthens the trustworthiness of the findings. Not all codes are included in the thematic compilation. The compilation of open coding concepts into themes was conducted after theoretical saturation had been achieved; therefore, the thematic categorisation of the open coding concepts did not influence the Straussian grounded theory approach used in this research. Rather, the thematic presentation of the open coding concepts is provided for clarity the open coding data analysis methods that were used for this research.

7.3.2.1 Understanding of PFC experience

This research did not aim to define PFC in remote environments; however, it does include exploring the experiences of PFC being provided by people in remote environments. In other words, exploring the understanding of PFC from perspectives of the research participants is included in the scope of this research. The first semi-structured interview question asked the research participants what their understanding of PFC in remote environments was. The responses were diverse, which suggests that the experiences underpinning the research participant's understanding of PFC in remote environments is distinct. One participant explained that,

> "[PFC is] anytime that we've either got a medical or trauma casualty 1/ where we're going to have prolonged evacuation times for whatever reason that maybe – 2/ whether that's weather-related location related, state of the casualty, etc. … in resource poor environments. 3/"

- 1 – Biomedical health needs
- 2 – Delayed evacuation
- 3 – Influencing factors of delay

This explanation was segmented into three salient points and, therefore, three open coding concepts (see listed below the direct quote from the research participant). From the perspective of this research participant, PFC in remote environments is required when someone has physical injury or illness that requires evacuation, which is delayed due to influencing factors at that time. Another research participant explained that,

> "My understanding of PFC would be that you are providing first aid, or psychological care, or some kind of clinical intervention for longer than necessary, longer than is taught [in] classical medical and first aid terms, definitely beyond the scope of kind of civilian emergency medical service system."

- Providing physical and psychological care for longer than expected, beyond the level of training

This explanation of their understanding on PFC identifies that PFC is not limited to meeting the physical health needs of people in remote environments, but it includes psychological care too. Furthermore, the research participant highlighted that PFC in remote environments was required for longer than what is usually taught in pre-deployment training. (See 7.3.2.3 for duration of PFC.) Thus, this direct quote was not segmented because the research participant emphasised that the collective components of their understanding of PFC constituted PFC in remote environments. In other words, meeting physical and psychological care outside of a hospital environment does not automatically become PFC, unless the demand of health needs exceeds the expected duration of care based on the pre-deployment training. Another participant explained,

> "We went to a refugee camp to put some put satellite system up. 1/ The helicopter would drop us off with all the kit and then come back four hours later – the idea was to get us in and out quite quickly. One of my colleagues fell out of the helicopter and he sprained [his arm and] the issue was that we (the team) couldn't lift (the equipment needed for the task). The helicopter … wasn't coming back until the next day, so we were a long way away from help. 2/ It was only a minor injury [but] … we didn't have the analgesic capability needed … to manage pain relief … for the 24 hours. 3/"

- 1/ Refugee health = humanitarian health = PFC in remote environments
- 2/ Time = influence of health
- 3/ Risk to health = musculoskeletal injury

In this vignette, the research participant explained that they were part of a humanitarian health system, which included humanitarian response. Their colleague's injury was fortunately minor (it was highlighted the injury could have been significantly worse); however, the impact of this effected the injured person and the team. The helicopter contained analgesia (pain killers) and would not return for 24 hours while the team were meant to install a satellite communication system for the refugee camp. Thus, the person with an immobile arm could not fulfil their role and, furthermore, they needed help with personal hygiene. This experience highlights that a minor injury can have cascading impact of the activities in remote environments. Another participant explained that,

> "During an expedition to Indonesia, [we were] working remotely in a small village on a conservation project. 1/ There were scientists from the ecological community, so it was my role to keep people safe 2/ as well as having students trying to help with their research. 3/ It was a four-day travel from the UK to get to the village. 4/ On arrival to the village myself and a college tutor are presented with this student who has made a declaration of suicide in the rainforest. The student told me and [their] teacher exactly the methods, means, when, and where he would be found in the middle of the rainforest. 5/ This took me by surprise. 6/ When you go on expedition, you're expecting trips and falls, cuts, diarrhoea and vomiting, dehydration. But now, it was more one to one when you don't have to take (physiological) observations, you don't have to treat rashes, or replace fluids – you just make sure the person isn't alone. 7/ This was not an immediate evacuation but a relatively quick evacuation out of the jungle. … And being in Indonesia, we [were] in the middle of Ramadan, so pretty much everything was closed during day. 8/"

- 1/ Clinical practice in remote environment
- 2/ Protect life
- 3/ Multiple roles in remote environment
- 4/ Multi-day travel
- 5/ Mental health needs
- 6/ Expect the unexpected
- 7/ Clinical practice in atypical environment
- 8/ Limited evacuation options

This vignette exemplifies the rationale for including full-length direct quotes from the transcribed data – the experiences researcher participants have is rich in detail. This research participant explains that they had multiple roles during the expedition to Indonesia, which adds a layer of complexity. That is, the multiple roles requires prioritisation to fulfil expectations. Notably, the research participant firstly explains that their role was to, "keep people safe," which suggests this was their priority. The open coding concept, "Protect life," was allocated as a component of PFC provision in remote environments. This research participant also identifies that people have physical and psychological health needs, which a PFC needs to be prepared to meet during the time spent in the remote environment. The example of local cultural and religious beliefs influenced the capability of evacuation; therefore, local practices are important to consider when planning for PFC. The greatest emphasis from this research participant was allocated the open coding concept, "Expect the unexpected." This is an integral component of PFC and difficult to prepare for knowing that resources are limited. Another research participant explained,

> "PFC is doing what you can with what you have. 1/ And that's depending on how well prepared you were initially, or whatever situation you find yourself in, is how you're going to hold the patient that you have with you (care for the patient), whatever their illness or injury [they have], and how you do that as effectively as possible to the highest standard possible. 2/"

- 1/ PFC = what you can do with what you have

- 2/ In x-environment doing y-activity treating z-health needs to a high-standard

Including this research participant's experience, PFC involves clinical practice in an atypical environment for an extended duration with resources limited to what is available at the time. This research participant explained that the resources are limited because they are either transported by the team in the environment (that is, they can only carry a limited amount), or from a basic healthcare service that usually cater for a small population. Thus, the research participant experience of PFC was allocated the open coding concept, "In x-environment doing y-activity treating z-health needs to a high-standard." In other words, PFC in remote environments is multifaceted. To draw out a deeper meaning and understanding of PFC, research participants were invited to share specific experiences of PFC in remote environments. (Research participants were reminded to maintain patient confidentiality during their semi-structured interviews.)

7.3.2.2 Example of PFC practice

When inviting research participants to provide an example of their PFC practice in remote environments, it was highlighted that the experiences they chose to share should represent PFC most accurately (in comparison with their day-to-day clinical practice). Collecting data about what the research participants considered to be an accurate example of PFC provided an opportunity to enrich the data about the contextualisation and context of PFC in remote environments, which was analysed using grounded theory data analysis methods. One research participant explained that,

> "A member of the party managed to fracture [their] radius and ulnar (lower arm). 1/ Because we were there in the wet season, 2/ we had land transport with us as part of any kind of evac [evacuation] plan, 3/ but the roads are washed out because of the weather. 4/ So, although not a life-threatening injury per se, we were having to hold the person whilst the weather improves, which … was around the 36-hour mark before we could get out.

> 5/ When we did eventually get out, [it] was actually on the back of a donkey to get down to a road head where we could access wheeled transport to actually get them to a proper medical facility. 6/ Because it was their right arm and they were right-handed, it obviously had an incapacitating effect on them, 7/ plus the pain that was there. 8/ So, it got into the whole feeding, toileting, washing all that sort of the nursing aspects of what we now refer to as PFC. 9/"

- 1/ Fracture
- 2/ Weather risk
- 3/ Define evacuation capability
- 4/ Environmental influence of health and risk to health
- 5/ Evacuation possible but delayed
- 6/ Change of plan
- 7/ Holistic health needs
- 8/ Pain management for long duration
- 9/ Extended duration of care

In this example, the research participant explained that the injury was relatively minor (a fracture, also known as a broken bone), although it was painful. The in environmental and circumstantial risks, however, caused challenges in meeting the holistic care needs of the patient. In other words, managing the pain and keeping the arm immobile duration an evacuation that was delayed was exceptionally challenging. Thus, from this example, it is evident that the research participant required clinical skills and the ability to make decisions within challenging circumstances. Another research participant explained,

> "I was working on a checkpoint on day three of a five-day ultramarathon race. It was the shortest date in terms of distance for the runners, but the hardest day in terms of the terrain that they were running on. There were a lot of altitude changes, multiple river crossings, the densest jungle of the week, so really hard going for them (the race participants). We were at checkpoint three, which was the furthest point out on the 'U'

shaped course, and we were right at the pinnacle of that U shape. A person came in not looking very well and then collapsed on the checkpoint. Their temperature was 40ºC, so they were really unwell, really confused, tachycardic (fast heart rate) – all the usual signs of a heat stroke. 1/ We managed to stabilise them, and then we got into the PFC phase where it was getting dark, and all of the other runners had gone through the checkpoint. 2/ It was PFC on the move. We weren't anywhere near definitive care, so we needed to make progress towards it. 3/ Essentially it was a prolonged evacuation with care over really challenging terrain that would take at least a day driving. Then we had all sorts of logistical issues with the evacuation. We were offered a shortcut option of walking about halfway back the way we'd gone in order to get across the river where we could then get a boat across to the overnight's camp. We did that because it would have been about 10K walk out of the jungle in the night with this person, 4/ but then the boat didn't come because they hadn't paid enough money. 5/"

- 1/ Climatic injury = risk from environment and activity
- 2/ PFC began from point of stabilisation
- 3/ No access to health services
- 4/ Transporting patient to health service
- 5/ Unexpected longer duration of care

The environmental risk of climatic injury appeared to be severe in this circumstance. The injury of heat stroke was treated; however, similarly to the previous vignette, a delayed evacuation caused an extended requirement of providing holistic care needs in challenging circumstances. Furthermore, the research participant experienced additional unexpected delays. This demanded the research participant to adapt their evacuation plan and strategy for a second time. In this circumstance, the patient was stable; however, this experience is evidence of delayed evacuation and further delays to an evacuation. For another patient more critically injured or ill, extended delay to their evacuation to a setting that can meet their holistic care needs is a risk to their health and life. In another example, a research participant explained,

> "These weren't battle casualties, these were as more of a humanitarian response. 1/ We were [providing] health screening identifying issues and issuing medications. They'd come to the environment with those existing health care issues; they were not new presentations and there were minor injuries more than anything else. 2/ These were not critical patients but there were lots of them. PFC maintained [their health] for the duration that we were looking after them. 3/"

- 1/ Humanitarian health = PFC
- 2/ Existing health needs when in environment
- 3/ Health needs over longer duration prehospitally

This research participant emphasised that although they were in a remote environment in a military capacity, the health care that they were providing was part of a humanitarian health system. The salient point the research participant wanted to make was that military forces are not purely about conflict, but they can be involved in humanitarian response too. Furthermore, they emphasised that their experience of providing PFC in a remote environment was not limited to treating illness and injury that occurred while they were there. It also involved the management of long-term health needs too, which also have the same challenges of decision-making with limited resources and the risk of delayed evacuation if the scope of PFC capability could not meet patient's health needs. From the perspective of another military research participant,

> "I haven't deployed on OP HERRICK (see 3.3.2.2), where the mindset was, 'and then the helicopter comes,' and so there's a big thing of expectation that the patient is sick, you will have them, and then the helicopter comes and takes them away. When we're looking at potentially prolonged timelines, as in the case from the delayed patient evacuation, then and there is just not necessarily possible. We ended up having to have that

> person for longer than we expected, and you have to look at how you're going to manage [that]. 1/ Things like considering patient dignity is a bit more challenging if you're in an open environment where the facility is designed for, for example, damage control surgery. You still have to consider how you are going to manage that patient's dignity when they're not there for surgery, and it's not, 'all things go.' Things aren't as crazy as you are expecting to be, the person is not coming in and having their abdomen opened up, but they're still unwell and they still deserve to have that same level of patient dignity applied when they're trying to go to the loo when your facility is an open room with … different bays, and there's people, not necessarily even medical people, milling around. 2/"

- 1/ PFC = military health system, role 1 - 4, when that system does not work
- 2/ Maintaining patient dignity and privacy

This research participant vignette highlights a shift in military healthcare systems, from a 'golden hour' model of rapid response and evacuation for patients with traumatic injuries (see 1.1) to having the capability to meet health care needs in remote environments for extended periods of time. In this example, sometimes unexpectedly. The research participant highlights that the health care needs are not limited to physical or psychosocial needs, but also involve protecting the patient's privacy and dignity while in the remote environment. This is evidence of PFC having a broad scope of practice, including meeting health needs, and maintaining the best standard of care. Another research participant highlighted that,

> "We couldn't get [the patient] out when we needed to. So, for looking after them, there was no option for this particular person but to wait for an evacuation to be possible. 1/ The involvement of the team meant that as I was planning, because if that evacuation would have taken even longer, I'm not going to stay awake for two days on my own to look after this individual. So,

> PFC is about planning and looking at not only how long are we expecting to hold [this patient, but] what is the reality of that hold? 2/ Obviously, you're working with whatever your facilities stated capability is, so whether that's we can hold this person for another two days because we've got enough drugs, for example. 3/ And then then you're looking at we're running out of whatever, so how do we ration what we've got to make them last because resupply is not an option. 4/"

- 1/ Evacuation possible but delayed
- 2/ Team involvement enabled other actions/planning
- 3/ Resource management
- 4/ Need to sustainably use resources

Evacuation in this example is similarly possible but delayed. The research participant emphasised that PFC was possible because of effective teamworking and resource management. Thus, this research participant provides evidence that PFC practice also includes being able to work within a team and manage resources in the remote environment. This requires careful thought and consideration because the duration of PFC can be unexpected.

7.3.2.3 Duration of prolonged care

Research participant's experience of providing PFC in remote environments varied in duration. There is little supporting literature to define the length in time that 'prolonged' is (see 3.3.2.1); however, evidence from the research participants suggests that there is no universal rule on how long health care is provided before PFC becomes the primary focus. One research participant explained that,

> "My understanding of [PFC] would be that you are providing first aid, or psychological care, or some kind of clinical intervention 1/ for longer than necessary, longer than is taught kind of classical medical and first aid terms, definitely beyond the scope of kind of civilian EMS (emergency medical services) and civilian [healthcare] systems. 2/ We look at going into hours of care,

> greater than 4 – 6 hours, and in extreme cases more than a day. 3/ That's when you're really getting into the into the wilderness 4/ where retrieval is limited, access is limited, telecommunications to support is restricted, 5/ and you're a sole provider of all of the first aid and nursing care to their patients for the duration of the injury. 7/"

- 1/ PFC provider needs to be able to provide interdisciplinary care
- 2/ Providing physical and psychological care for longer than expected, beyond the level of training
- 3/ Extended duration of care
- 4/ Time can = remote = PFC
- 5/ Limited communication and evacuation routes
- 6/ First aid and nursing = acute care and continuity of care

The data shared by this research participant provides evidence about the interdisciplinary approach to health care in remote environments, opposed to a multidisciplinary team approach that is more common in other health care settings. According to this research participant's experience, the duration of PFC is measured in hours, but it is acknowledged that in some circumstances PFC can extend to more than one day. The extended duration of care is as a result of the challenges within the wilderness environment (meaning, 'remote' – this phrase was clarified during the semi-structured interview). The challenges that this this research participant experienced were evacuation options (described as retrieval), limited access to their location and health services, and support via telecommunications. Thus, in remote environments, technology can be an aide; however, it is clear from this evidence that it should not be relied upon due to the unreliability of staying connected for long periods of time. Another research participant emphasised that,

> "They [the casualty] does not have to be 'big sick' for it to be a PFC situation. Purely because of location and, or whether transport you're having to hold a patient in the field in a remote location for an extended period of time."

- Time can = remote = PFC

This research participant explained that PFC includes the care of minor illness and injury in a remote environment, and that this can be over an extended period of time. Having the capability to meet these health needs, as well as major injury and illness, is important because not doing so increases the risk of minor illness and injury becoming worse overtime. In other words, PFC includes meeting minor health needs, which mitigate further risks to health. Capability of managing major injury and illness, however, is still important.

> “In trauma I would suggest that if it's a big enough trauma that you've made the decision to evacuate, if that evacuation can't happen within the hour, then it's PFC. 1/ [But] it's not black and white … it's just a rough guide for me. 2/”

- 1/ Greater than one hour
- 2/ Autonomous clinical decision-making and practice

This research participant provided a specific time of not being able to evacuate a patient from a remote environment, who has traumatic injury, within one hour (referring to the golden-hour), then that circumstance requires PFC. It follows that the research participant highlighted ‘greater than one hour’ is a guide, not a rule. This suggests that there is a spectrum of how long PFC is required to last for until evacuation, versus the severity of injury or illness. Thus, it can be noted that PFC providers are required to use critical-thinking skills to determine what PFC can and should be provided based on (1) the severity of the patient’s injury or illness, and (2) the length of time until they can be evacuated if this is required. Another research participant explained,

> “[The] jungle is very dirty … so [there are] lots of complex issues. A patient had some nasty insect bites. We didn't really know what it was that was biting them, but they spent a lot of time in the water. 1/ [The patient] had tried self-help and it didn't work. They took some out-of-date antibiotics that they brought them with them because they thought they might be useful, [without telling anyone in the team and their infection got worse.] 2/ The

evacuation process had been gone through and the planning and had all been done. We could utilise the medical emergency response plan that we'd written on the reconnaissance missions. We knew exactly what we had to do, how to get them out, where we're going to go to, and the phone links were all made. 3/ But then a tropical storm came in, which meant the helicopter couldn't get to us to get him out. The boat transfer, which would have been about an hour and a half, was probably going to be very unsuccessful because of the sea conditions [and] the weather state. 4/"

- 1/ Environmental risks
- 2/ Self-help is a risk – unconsciously incompetent
- 3/ Forward planning for PFC before deployment and when it is needed
- 4/ Influencing factors of delay

In this circumstance, the research participant explained that there were risks to health from the environment itself. An attempt to self-help exacerbated the risks to health, which were then catalysed by transient environmental risks (the weather conditions) causing a delays to the evacuation. It is clear from this research participant's experience that the detailed planning for PFC required flexibility when applied in practice. In other words, some of the risks to health and the series of delays could not be predicted (and, therefore, planned for), which requires the PFC provider to have the ability to consistently adapt their strategy to mitigate risks and to protect and promote health. Another research participant separately complemented this buy saying that,

> "My understanding of PFC is effectively looking after someone in a remote environment for longer than you particularly feel comfortable doing, and for longer than you would normally expect."

- Providing healthcare for longer than expected

In this vignette, the research participant explains that the duration of PFC is longer than anticipated, which correlates with literature that defines PFC as beyond doctrinal planning times (Keenan and Riesberg, 2017). However, it is important to note the effect on the PFC provider that the extended duration of care has. The research participant emphasises that the PFC they were giving in a remote environment was, “longer than [they] particularly [felt] comfortable doing.” The research participant was required to manage all of the challenges, mitigate all of the risks, and meet the health needs of the patient, on top of managing their own discomfort for the duration of time PFC was required. Thus, the PFC provider is under huge pressure and must make effective and safe decisions to protect and promote the health of people in their care. Other research participants, however, advocated that the duration PFC is required cannot be predicted.

> “PFC is after that initial point of somebody having an injury or an illness, [followed by an] initial assessment … and a treatment plan. 1/ [Then,] we need to do something with them, but we can't necessarily do what we need to do in terms of an evacuation. So it is that point of whilst we're waiting for that next step to happen, that's where PFC really kicks in. 2/ You can't really put a time frame on it because that process takes as long as it takes. 3/”

- 1/ Care of injury or illness
- 2/ PFC while waiting for next step (evacuation, resupply, or recovery)
- 3/ PFC not time dependent

The experience from this research participant suggests that the duration of PFC is difficult to measure. This is in juxtaposition with other research participants; although, the advocation that the duration of PFC cannot be measured was made by multiple research participants. The number of research participants advocating ether perspective is immaterial to this research (based on the qualitative contextualism methodology – see 5.2.3). What is important to note is that each perspective is valid; therefore, collectively there is evidence that suggests the duration of PFC is dynamic due to the uniqueness of each context. In other words, ever circumstance that PFC is required is unique and the influencing factors of how long PFC could be provided for are similarly difficult to predict. An alternative methods to calculate the duration of PFC is to measure it against an existing healthcare system.

> “My understanding is in [Western] military systems, we've got a rigorous operational patient care pathway and traditionally, we've demonstrated it working really well from the point of injury through to Role 1 (first aid), Role 2 medical treatment facility, Role 3 field hospital, and then back to Role 4 at the UK. PFC is us preparing for when that doesn't work properly. [That can be] for a whole variety of reasons, whether they are logistical reasons or tactical reasons, we're not able to use the normal timelines that we would usually. So, PFC is also how we train our patient facing personnel to actually deal with how to hold a patient for hours or days, rather than the minutes that we've had to deal with historically.”

- PFC = military health system, role 1 - 4, when that system does not work

From the perspective of this research participant, PFC occurs when the healthcare system in place for patient care in remote environments fails (in this case, military healthcare system) due to influencing factors that cannot be controlled or mitigated. From the experience of this research participant, the duration that PFC lasts is flexible, depending on what part of the healthcare system is broken through the challenges faced. This measure of PFC duration is useful if there is a healthcare system in place; however, in some remote environments, no healthcare system exists. This can be due to how remote the environment is, which is another transient theme throughout the findings of this research.

7.3.2.4 Remote environments

Remote environments are conceptually explored in 2.2 and 3.4.1. Through the semi-structured interviews, data was collected about the remote environments that PFC was provided. The rationale for this data collection is to be able to analyse the evidence of what constitutes remote environments that PFC is provided in. The context of this research is how PFC mitigates risks to health in remote environments; therefore, collecting data about the remote environments that research participants had experiences in is essential to enable the production of an applicable PFC grounded theory.

> "Even with a good track and access to wheeled transport, you were still talking probably 6 to 8 hours to get to any kind of clinical facility 1/ – certainly, with an X-ray to look at broken bones, although this one was quite an obvious one (broken bone)! 2/"

- 1/ Extended duration of care
- 2/ Health needs surpassed what resources were available

In this vignette, the research participant provided evidence that even though the remote environment they were in had vehicle access, it would still take multiple hours to access the healthcare service needed to meet the health needs of the patient. This links the remote environment with the theme of PFC duration; namely, geographical remoteness equates to long durations before access to health services is possible. This includes evacuation via transportation, rather than on foot, which another research participant provided evidence of.

> "It (the remote environment) was [remote because of the] location where we were based, and partly the restrictions on air evacuation – the road evacuation wasn't an option, air evacuation was limited, and dependent on multiple different influencing factors, including weather and security. So, getting anything resupplied was a significant challenging."

- Managing risks to health – conflict, limited evacuation options, no immediate access to health services

This research participant's experience was related to PFC within the military. It was identified that there were multiple compounding risks to health, including being in an active conflict zone and having limited evacuation options to necessary health services. Thus, this environment is remote due to not being able to escape and access the appropriate health services. It follows that geographical remoteness may not be the only defining feature of how remote an environment is. Rather, the place and circumstance (time and activity) of the events in the environment constitute the remoteness. Another research participant (independently[6]) added to this evidence by explaining,

> "[It] was remote geographically because it was a jungle island in the middle of the Ocean – literally a long way from anywhere. 1/ But in stark contrast, I've been in the Middle East where an explosive incident [resulted in someone loosing] a leg. 2/ The hospital was only 10-15 miles away, but we couldn't get out because we were locked down under fire. 3/ So, we had a combination of care under fire, then developing into PFC because once the firefight stopped, we were still stuck because we had no vehicles left. 4/ In terms of geographic location [it] wasn't too bad, but in terms of, remoteness, I felt fairly remote to be honest – there was no help coming. 5/"

- 1/ Remoteness = geographical distance
- 2/ Care of injury or illness
- 3/ No immediate access to health services
- 4/ Conflict is a circumstantial risk to health
- 5/ Remote can be closer to home than one would think

The experiences this research participant had highlights that both geography and circumstances can result in a remote environment that PFC needs to be provided in. A common thread is having no immediate access to health services and limited resources available to meet the needs of patients, while managing the risks to health from the environment (place) and circumstance (time and activity). Based on the evidence provided, collectively, this constitutes a remote environment; however, an environment can also feel

[6] Experiences shared by research participants were not shared with other research participants – all data shared remained confidential and was only combined with other data after anonymisation for data analysis.

remote. The research participant explained that they, “felt fairly remote [and] there was no help coming,” which aligns with the experience of another research participant.

> “I think there are times you can be remote, or you can feel remote pretty close to home.”

- Remote ≠ physical distance only

The open coding concept allocated to this datum identifies that the remoteness the research participant experienced had multiple constituents and is not limited to geographical remoteness. The circumstances (time and activity) that PFC is required makes an environment feel more remote, according to the research participants. In context, the challenges of providing PFC in geographically or circumstantially remote environment are similar – namely, there is no access to health services, there are limited resources, unreliable communication, and evacuation can be delayed due to the conditions. Another example of a remote environment that a research participant shared their experience of PFC provision about was off-shore.

> “One [example is] when we had to look after multiple casualties on a converted whaler. The space was limited, the resources were limited, the ability to get back to where our base was also limited, and we were relatively exposed to the elements. A second example was on board a ship where we made a makeshift medical treatment facility and we had to look after someone who had had a surgical intervention. We looked after that casualty for a prolonged period of time while we try to get to a firm base. 1/ There was a lack of space and we … did not have any means of a quick resupply, which meant that we had to deal with the casualties there at that point in time. 2/ We could only take what we could carry in a Bergen (rucksack), which was the limitation when getting to the ship. We had to work out of the bag, as there was nowhere to put anything. 3/”

- 1/ Maritime = limited space = limited resources = exposed to weather = environmental risk
- 2/ Resupply of kit not an option so sustainable use of resources
- 3/ Limited resources available

For this research participant, this experience referred to being off-shore. The research participant explained that onboard a ship is a remote environment because the space available to provide PFC is limited; therefore, the supply of resources is consequently limited. The research participant described they, “had to work out of a bag,” which is incomparable to a hospital environment (the research participant’s usual place of work). Combined with the challenging weather conditions during their sailing course, this off-shore environment has parallel challenges to remote environments that have been critically analysed so far. A challenge that is a common thread through all remote environments is the unpredictability of the circumstances, which another research participants shared their experience about.

> “The variables are too unpredictable. You may have a temporary medical facility with four medical packs, you may be a lone medical provider with the medical pack on your back, you may be working in the jungle, you may be working in the Arctic, you may be working in the desert.”

- Multiple risks and challenges to manage

This vignette provides evidence of PFC provision being applied in a large variety of remote environments; however, a common theme is the unpredictable conditions that are experienced there. In other words, PFC providers needs to be prepared to provide health care in a broad range of environments (examples based on the experiences shared by research participants including hot, cold, and at altitude environments) and expect the conditions there to be evermoving. Thus, the place, time, and activity evoke risks to health that require the PFC provide to mitigate so that the health of people are protected and promoted. According to some research participant, the people in remote environments can also be a risk to health.

"I can think of one patient where the nature of the environment that they were involved in, and the fact they didn't necessarily adhere to what they were instructed to do by the medical staff, led to them becoming more ill. Sometimes, patients are inclined to think that necessarily they know best, or they're just going to do something anyway. That led to being back at square one with their infection. 1/ The wound opened up again because they were doing something they weren't supposed to be doing. 2/ I think because the environment they were in – a sweaty, jungle environment – and definitely the nature of the role that they're doing, [led to them becoming more unwell]. For example, if an individual's role is a chef, or the radio operator, and there's many of them trained to do that job, the pressure on that individual to go back to work is disproportionate to if you would come in a bigger setting where it doesn't really matter if somebody has a day off sick. So, I think certainly from a work perspective, than having the pressure of being the only one of their trade there can certainly have an impact on them choosing to see a medic and going sick, which they probably should have done sooner. 3/"

- 1/ Infection control = risk to health
- 2/ Minor illness and injury that can deteriorate, e.g., infection
- 3/ Team management can be a challenge

From this research participant's experience, it appears that a small infection in a remote environment can deteriorate into a more severe illness; therefore, infection control is an important risk management intervention. Notably in this example, the deterioration was as a result of the patient choosing not to follow the advice from the PFC provider. The reason was the patient did not want to take time to rest and recover because they were the only person in the team that could carry out their role. In other words, the patient did not want to effect the team, so they continued their role at the expense of their health. Unfortunately, despite good intensions from the patient, the deterioration of their health caused more of an impact on the team in comparison to if they had taken the time to recover in the first place. This is an example of another role the PFC provider has in a remote environment – to manage the team in their care to protect and promote their health. Team management, therefore, can be described as a PFC intervention to manage risks to health in remote environments. Furthermore, this provides evidence of the psychological influence of being in a remote environment, similar to another research participant's experience.

> "For the remote environment they're starting in, it goes back to the psychological thing, but in terms of the non-physical health needs, you have to think that if anything bad happens to you and you're at home with the people that are your support network, that's one thing, but if you're in a remote setting with potentially limited phone or Internet in that environment, and something bad happens, or you get some bad news, it's a completely different setting, and your ability to cope with that may or may not have been tested prior to that. Having had my personal experience of receiving bad news when you're thousands of miles away from your family, it does change how you feel about things and it's very different to it being just day to day. I think that's a distance thing but also communications comes into that as well and that can also impact the physical element because your reach back might be affected – if you've got no internet linked to [back home], you're going to be limited as to your reach back options as well as communication with family and friends."

- Team management and communication

In this vignette, the research participant provides evidence of the psychological effect of being in a remote environment in two ways – (1) the influence from the remote environment, and (2) the influence of being in the remote environment. The influence of psychological health from the remote environment refers to the exposure to risk that is experience in the remote environment (the conditions or the activity, for example). Whereas the influence of being in a remote environment can affect the psychological health of team members as a result of not being able to spend time with loved one, or even talk with them. This influence of psychological health also applied to the PFC provider. It can be noted, therefore, that there are psychological health needs in a remote environment, and a PFC is required to provide psychological care, and self-care to manage the psychological risks to health. The psychological risks, however, are not limited to the influences of being in a remote environment – the activities taking place in a remote environment may also evoke psychological health risks.

> "Often [PFC is needed] during operations that are covert or clandestine, when you don't necessarily have the support of the of the country that you're in, or certainly their central government. 1/ So having to undertake covert missions and then covert medicine when injuries are sustained in your own force or coalition partners. 2/ So, it's remote because of restricted airspace and restricted movement due to hostile forces. 3/ I've also come across cases where people have been cut off from evacuating casualties due to environmental issues, like sandstorms. 4/ You're almost always logistically challenged in that you might have a small amount of medical kit so that you are flexible and can move rapidly, and then it turns out that actually you've got the patient for much longer than you'd like to have on an operation, and you then have to enter PFC. 5/"

- 1/ Lack of support from in-country services to provide health care for team
- 2/ Covert of clandestine reasons for deployment
- 3/ Restricted airspace
- 4/ Vulnerability to natural hazards are risks to health
- 5/ Single points of failure = logistics, communication, circumstance, environment

The activities taking place during the experiences from this research participant suggest the environments were geographically remote and became further remote due to geopolitical limitations on air space (that remove the option of aeromedical evacuation). Being in a remote environment covertly adds another layer of complexity for risk mitigation on top of the high-risk activities taking place and the vulnerability to natural hazards. Thus, being able to problem-solve to make effect and safe decisions about PFC for risk mitigation is an essential skill to protect and promote health. As suggested by this research participant, the medic kit available is likely to the limited; therefore, resource management is a factor of decision-making for PFC providers.

7.3.2.5 Resources

Another theme that transcends the data collected during semi-structured interviews is resources and how they are managed in a remote environment. Being able to use the resources (namely, medical and health equipment) is important for PFC provision; however, decision-making about how and when to use the amount of limited resources available is also a requirement of PFC providers. One research participant explained that,

> "We always build that into the medical intelligence assessment [MIA]. So, whenever I'm going to take a trip away that forms part of that. [Ask yourself] – what's the medevac (medical evacuation) plan? How do we resupply if we use up what were physically carrying and everyone is very much trip dependent, so, you know yourself here are you on foot you in vehicle, even boats? Have you got access to rotary or fixed wing aircraft? How do you get to them? What is your plan? And test it (the MIA) before you need it. If you've done your online research for your MIA before departure, make sure you phone that hospital number and somebody's actually going to answer it. And if you can get a named person within that facility again, so, much the better. Have the conversation before you need to rely on an external resource.

- Medical intelligence assessment

This research participant explained the process they take to conduct a medical intelligence assessment that defines the scope of PFC that is required and, moreover, what PFC can and cannot be provided within the limitations. The evidence provided suggest that planning is an essential stage of PFC because it provides information about the options, or not, for resupply of resources, evacuation routes, and modes of transport. This vignette also suggests that people are also important in defining the scope of PFC. This may include the team members going to a remote environment and also the people who are already there who can provide healthcare services. Defining what equipment, also identified as 'kit' by some research participants, is required for PFC is also required.

> "You always start an expedition with a full kit list of various different bits and pieces, from antibiotics to stethoscopes to fluids and everything in between. I may be looking after 60 people, including myself. 1/ If one becomes injured or ill, I still have a duty of care to the other 59 people. [In that circumstance] I am asking myself how do we survive now if 5 people come with infected blister problems? 2/ In the back of my mind, I'm thinking how I can order stock in. 3/ Can I trust medicine that comes in potentially from places I don't know? If I ask for medications in jungle or other remote settings, I may not get what I've asked for. It may be because there's a cultural issue where local people don't want to give you bad news, so they give you some pills that look like what you need but potentially could be multivitamins. So, then I need a translator to make sure that these are the pills we need. 4/ But this costs money, which bosses may not have. 5/ It's a case of manage resources, making sure we don't over resource, but making sure that everybody unwell for whatever reason they are unwell, is looked after. 6/"

- 1/ Kit for likely illness and injury (e.g., marathon = foot care)
- 2/ Balance of enough kit with capability of activity
- 3/ PFC while waiting for next step (evacuation, resupply, or recovery)

- 4/ Rapport and trust
- 5/ Reliant on financer of deployment
- 6/ Duty of care to everyone, including self

Based on the experience from this research participant, planning for what kit should be brought to a remote environment is balanced between what is logistically possible and what are the realistic health needs in the remote environment doing which activities. Defining the options of resupply is contributes to deciding what kit to bring; however, promoting trust and a rapport with local health service providers is an influence of access to additional kit. Thus, resource management for this research participant providing PFC in a remote environment involved planning, organisation, and people management. The emphasis was on working with people, rather than attempting to micromanage them. It follows that having respect for local culture is paramount to a support network in a remote environment, especially when managing resources over a large geographic area.

> "I worked at a 24-hour motorbike endurance event out in the Outback in Australia. We were about a 6-hour drive to the closest major trauma hospital and about a 3-hour drive to the closest accident and emergency department, which was run by a single GP and one nurse. The hospital had no in inpatient department – it was effectively a GP surgery with a couple of beds. 1/ We had a bloke who was going through a wooded area and … came off his motorbike and ended up puncturing a lung with the branch of a tree and having a couple of other injuries, including a few fractures and some fairly deep lacerations. 2/ We had quite a lot of paramedics and other medical staff around, but they were all spread out – it was 100-kilometre motorbike competition course. It wasn't particularly like there was mountains or anything, it was all pretty flat but about as far as you can get – it was just the sheer distance. We had to manage our resources really effectively, including defibrillator batteries. We had to keep

swapping them and putting them charged because he needed to be monitored constantly. 3/”

- 1/ Health service that was next available had limited resources
- 2/ No immediate access to health services that would be needed to meet the patient's health needs
- 3/ Resources were spread out

This research participant’s experience was about major trauma in a remote environment; therefore, the health needs of the patient were required rapidly. It was explained that the geography made their location remote and although there was a healthcare service, it would take a long time to get there and the limited resources that were available would not meet the health needs of the patient. The research participant was required to provide PFC in a remote environment with very limited resources until evacuation to a suitable care setting was possible. It follows that resources may be available in a remote environment; however, they may not be sufficient or in the correct place when they are required. Thus, the sustainable use of resources is a requirement of PFC.

> “We needed to use resources sustainably. It was a concern because [the injury happened] on day one of a ten-day expedition. I was concerned about using up resources like altitude sickness tablets [and] pain relief tablets, quite early in the trip when we still had nine or ten days ahead of us in a remote area. 1/ I’d already dealt with casualty, and if they were to insist on coming further, they would start eating into those resources. They would start putting themself in a situation where the altitude would become an absolute concern, and the fact that my attention then change from the rest of the group to be solely focused on his care – this took away the safety net for the other participants, which was a concern for me. 2/ I was starting to eat into analgesia, paracetamol, oxygen – we put him on 2 litres of oxygen for a couple of hours through the night. Oxygen was a

finite resource, and we hadn't even reached above 3000 meters yet where we would be relying on that maybe to get us out of a bigger issue further on in the expedition. 3/

- 1/ Need to sustainably use resources
- 2/ Responsible for managing team safety and health needs
- 3/ Critically think about the sustainable use of resources

This research participant emphasised that use of resources should be sustainable, based on the requirement to meet health needs of all team members for the duration of time in the remote environment. In this vignette, the research participant explained that the patient had minor injuries and wanted to continue with the activity they were doing in the remote environment. The research participant explained that by doing so they would increase the health risks for other team members because the patient would need to use more of the medical and health equipment. It was emphasised that using resources was necessary; however, continued use of the limited resources available at the expense of other's was not necessary. To mitigate the risk of not having sufficient resources, the team member was evacuated despite them wanting to continue in the remote environment. Thus, the PFC provider needed leadership skills in this circumstance to make decisions for the patient and on behalf of the team members to mitigate unnecessary risks to their health. Another research participant highlighted that it may not be members of their team that become unwell and require PFC.

> "We had progressed into rural countryside and one of the supporting guides had a tonic seizure (convulsions) one morning loading the bags into the back of the wagon. Everyone started screaming and pulled me over. You don't know what's going on – you've had a medical history and completed basic assessments, but you've only met they two weeks ago. 1/ We placed him in a support wagon, and with the help of the local guide, drove him to a Bush hospital. That's where I saw how

> limited the resources were for the locals, and we were impinging on that. 2/"

- 1/ Locals have health needs too
- 2/ Health service that was next available had limited resources

This PFC provider emphasised that the unexpected event on this occasion was being asked to care for someone not within their team. Local people may require PFC too; however, this research participant highlighted that providing care in this circumstance made them realise how little resources were available for local people. This emphasised that if one of their team members became unwell and required resources from local healthcare services, this would put an additional drain on their already limited resources. The salient learning point that this research participant took away from their experience was to be as self-sufficient as possible, and to be prepared for the unexpected. Another research participant explained that,

> "The logistics of medical care in remote environments is really important and often an overlooked aspects of medical planning – as in, the patients do need to be moved and evacuated. Commonly it is said, "we'll do it somehow," but there is never any set plan in terms of how that's going to happen. 1/ I think that's been massively drilled into me through the laws of remote area training. If someone says they can do something, make sure they can actually do it. 2/ It's an aspect of forward planning for if you end up in the scenario of PFC, how are you going to provide it, and how that changes the equipment you carry. 3/ You need to be conscious of your resource management as well if you're in a PFC scenario because there is always a possibility that the second patient could turn up, or a third, or a fourth, or if the whole team goes down with something. I think logistics is the probably the key part of PFC … and be prepared for that. 4/

- 1/ Logistics is part of providing person-centred care

- 2/ Awareness of risk management from training
- 3/ Forward planning for PFC before deployment and when it is needed
- 4/ Thinking ahead to how health needs change

According to this research participant, the logistics of resource management is integral to PFC mitigating risks to health. Awareness of this requirement is based on their experience and pre-deployment training. The salient points that this research participant made was to think- and plan-ahead. By doing so, the scope of PFC to mitigate risks to health, and protect and promote health are defined. Thus, it is possible for the PFC provider to plan for some realistic eventualities that may come to pass. Similarly, as previously alluded to, planning on how to promote effective teamwork is an essential component of PFC also.

> "We had a great team. I think a big part of PFC is … small teams working together, and I think PFC ropes in the people that may not feel it necessarily applies to them. For example, perhaps people like a radiographer who thinks that their job, I mean not to disparage, but obviously everyone just thinks they take pictures, but our radiographer was very busy and would be very involved in monitoring the patient. That helped us to manage all the different challenges of how we were going to keep hold of this patient and what we needed to go and do. So, [in PFC] you might need people from other disciplines that aren't necessarily nursing or medical in that sense, but they can still be part of PFC."

- Team requirement to be able to provide PFC to meet patient health needs

In the experience of this research participant, they emphasised that establishing a team approach to PFC is best practice and helps to mitigate the risks to health. Risks to health are mitigated by effective teamwork because it increases capacity to manage the, "different challenges," associated with PFC in remote environments. It was highlighted that people who may not realise they have skills that are relevant to PFC could still contribute to PFC, directly or indirectly. They could be involved in patient care (directly) or caretake other tasks while PFC is being provided by others (indirectly). In both circumstances, the health needs of the patient are being met and the risks to health are being mitigated because important tasks are not neglected. Moreover, this approach reduces the pressure on team members not wanting to declare health needs, such as the example onboard a ship. For effective teamwork to be enabled, however, the team need to be trained in the roles they may assume.

> "When I teach about setting up a safe place for your patient, I talk about making sure you've got things in the right position, but also about what have you got there infrastructure wise that you can adapt or improve to help your patient. Things like if you, for example, have a patient needs to be positioned at a 30-degree incline (lying on their side), we're not necessarily going to have a bed that can do that. I encouraged others to consider what else have they got that they can improvise and use. I always teach that improvisation is a key part of what we do. 1/ [We've developed techniques like] opening packets and keeping them because it's a clean area in a limited environment, and I always pass those tips on to people so they can choose to do the same … [because] you don't want to find out that you need something after you've just thrown it on the floor! In my PFC practice, I'm always looking at things like, well, what else could we use that for? I think that's a really important for conserving resources. 2/"

- 1/ Improvisation is key to meet patient health needs
- 2/ Optimum use of resources, based on patient's health needs

This research participant explains that to ensure resources are used sustainably – repurposed, or to have multiple purposes – the team need to be trained to improvise. By doing so, the usage of resources is optimised and, therefore, the risk of resources running out it mitigated. Training is another theme that emerged from open coding (see 7.3.2.9); however, the salient point related to resources is to have the mindset of improvisation. According to this research participant, improvisation for the optimum use of resources is not relatable to their usual place of work (a hospital) because the resource can be resupplied. This aligns with another research participant's perspective of adapting their clinical practice to remote environments.

> "I think being innovative with resources is a big part of [PFC] for me. [It] is to do with my own clinical confidence and competence, which I think has evolved partly through the NHS... I think learning to cope in an environment where working in a hospital where resources are limited, and things are not as you would want them to be, set me up well for working in a remote environment. / When I'm under pressure and in a small team, I have to be confident and competent and credible to do what I do because I have to be able to care for my patients.

- Learn from past experiences, self and others
- Confident, competent, and credible

This research participant's experience of innovative resource management within the NHS was applied to their PFC practice in remote environments. It follows that PFC involves critical thinking and decision-making about resource management, which is obtained through applying lessons learned from training and experience. It was emphasised by this research participant, however, that sustainable resource management in remote environments is a completely different mindset to other environments because resources are so limited and the risks to health are greater. Another research participant explained that,

> "I only had what I could carry on my back. Sometimes we'd go out on patrols (during military deployment) that were expected to last for a few hours, and then we'd go back to base. 1/ But you learn very quickly the hard way that that often a few hours can

turn into in days. 2/ So, although you might want to take huge amounts of medical kit with you, if it means that you're then looking that that that medical equipment in and out of irrigation ditches for a period of days, you realise that actually you need to still be agile enough to be able to keep up with the rest of the formation. 3/ Often people end up deploying with medical equipment that's great for dealing with the initial stages of damage control, resuscitation, and stabilisation, but absolutely not scaled for PFC. 4/ Part of what we teach for PFC … is that as soon as you realise that you are not going to be able to evacuate that casualty, you need to stop throwing things away that are single use items, unless they are beyond further use, and you need to take stock of what kit you do have and start looking at what improvisation of medicine you can adopt. So, not getting rid of empty fluid bags, for example, when you could cut a corner off and use it as a makeshift urine bag that has graduations already on it (for measuring urine output). Keep hold of kit where you can, so that if you do run out of a brand-new kit then you can start looking at ways to sensibly reuse kit, perhaps for another purpose. … So, PFC [requires] a little bit of an attitudinal shift. 5/ The best way to get the point across is to send someone into a PFC scenario with a medical bag, and then once they realise that they're holding a casualty for a long period of time, just watching them come to the realisation that they're not going to be able to throw equipment away and that actually they're going to have to rethink their strategy for using their medical equipment. 6/”

- 1/ Resources available were what could be carried
- 2/ Expect the unexpected delays
- 3/ Balance of enough kit with capability of activity
- 4/ Inappropriate equipment if not experienced/trained in PFC
- 5/ Use all resources / create resources intuitively and sustainably = repurpose kit

- 6/ Experiential learning to evoke PFC strategy

This research participant emphasised that only having resources that were carriable was typical of being in a remote environment because this was the most effective logistics management. The salient point they made was to prepare enough resources for unexpected delays in balance with being physically capable to participate in the activities taking place in the remote environment. In context, this approach to resource management results in defining what PFC can and cannot be provided within the limitation of the resources being brought. In other words, the scope of PFC can be widened by the sustainable and multipurpose use of resources. Developing this mindset can be achieved by scenario-based experiential learning and reflection on clinical practice, which contributes to strategy of PFC to mitigate risks to health in a remote environment.

7.3.2.6 Mitigating risks to health

This research focuses on how PFC can mitigate risks to health in remote environments. Risks in remote environments and how to mitigate them was a theme that was identified during open coding of the collected data. One research participant explained that,

> "Infection is one of the big ones. 1/ We all got quite used to taking traumatic injuries and getting them (patients) back to a main operating base by air, usually so that antifungal and antibiotics could be given in large doses and wound surveillance and antimicrobial stewardship could happen. Now, if a medic is holding a patient for two or three days in PFC, that's just not going to happen. Knowing those signs of worsening infection and early sepsis are something that's hammered on PFC training. 2/"

- 1/ Infection control = risk to health
- 2/ Clinical deterioration after injury/illness and longer in the environment

It is clear that this research participant has had experience of caring for patients in remote environments for longer than expected, which is a shift from the rapidly evacuate model of trauma care. The salient point this research participant wanted to make was to recognise the signs of worsening infection and, by extension, ability to recognise general signs of clinical deterioration. A tool to do this is to conduct a risk assessment.

> "[Risk assessment] is a formulaic process, as all HSE (health and safety executive) risk assessment processes are, so, again as there's templates for carrying out HRAs [health risk assessment]. Based on the outcome of your HRA, [it] gives you a level of risk against certain health concerns or exposure to potentially traumatic events. 1/ Other things that HRAs need to [consider] … is mental health, particularly for those operating for extended periods of time in remote environments. 2/"

- Risk assessment
- Holistic health needs

This research participant advocated using an evidence-base to inform risk assessment, and health risk assessment, such as a risk assessment template from the UK HSE. By ensuring the risk assessment is holistic, the PFC provider is equipped to prepare appropriate PFC equipment and protocol to mitigate risks to health in the remote environment that they are deploying to. Furthermore, a risk assessment informs their decision-making, which often needs to be conducted without supervision from an experienced supervisor.

> "[PFC providers] need to be able to make clinical decisions that are inherently autonomous. 1/ If they do have reach back (communications with) for other members of the MDT to advise them, they also need to be able to articulate what they're seeing in front of them with the resources that they have. If they nail that skill, then a lot of the fears of delivery of PFC then go away. For example, you can have a casualty that has got acute abdomen pain, but if the medic can't articulate that over a broken telecommunications, then it doesn't matter because they can't deliver the effect and they can't get the advice they need. 2/"

- 1/ Autonomous clinical decision-making
- 2/ Single points of failure = logistics, communication, circumstance, environment

In the experience of PFC providers, they had access to senior supervisors in typical work environment – in person or virtually. It was explained that in remote environments, this was not always possible due to limited human resource and unreliable communication. This research participant explained that succinct and explicit communication was required when they did have telecommunication with clinical supervisors to mitigate the risk of misdiagnosis. Furthermore, it follows that reliance on remote supervision is a vulnerability that exposes the team – patients and PFC providers – to additional risks because telecommunication is unreliable. It was advocated that this risk should be mitigated by appropriate planning and preparation.

> "Because you planned for it, you prepared for it, you've got a mind set for it, you've got a framework, however loose that might be. [If you have prepared,] when the bad thing happens, you don't suddenly go, "eek – where did I put that pocket guide?" 1/ If you've practiced it, if you've exercised for it, if you train for it, and you keep your knowledge and your skills up to speed, when the bad thing happens, you shouldn't have that eek moment. 2/ [When] that happens, because you plan for it, the chances of successful outcome for your patient and yourself have vastly improved. 3/"

- 1/ Plan A, B, C
- 2/ Training = preparation
- 3/ Specific training in PFC increased feeling of preparedness

Planning and preparation was emphasised strongly by this research participant; namely, shift the mindset from planning for 'if' something goes wrong to 'when' something goes wrong. Based on the experience of this research participant, this subtle difference in mindset reduces the effect of surprise when something unexpected occurs in a remote environment, which enables action to be implemented more effectively and efficiently. Thus, planning and preparation for risk management and disaster management mitigates risks to health and enables the protection and promotion of health in remote environments. Another research participant explained that,

> “I have a series of presentations that I take with me. I [focus] on preventative medicine. 1/ I [educate them on the importance of] brushing their teeth properly or drying in between their toes and other [sensitive areas] properly. By doing that, when they are looking after themselves in their own time, that they can check themselves for rashes and bites, lumps, and bumps. They then also have confidence to come to me to check that a scratch from a plant then doesn’t turn into something more sinister [that] then requires evacuation. 2/ I’ve always found that the preventative lectures works. 3/

- 1/ Training days to mitigate risks to health
- 2/ Promote awareness of health needs and when to seek advice
- 3/ Promote self-care = resource management

Training is another theme that was identified in open coding (see 7.3.2.9); however, training was advocated as a risk mitigation tool. This research participant explained that training the team in basic health care techniques mitigated the risk of minor injury and illness. Furthermore, educating team members on when to seek advice from the PFC provided mitigated the risk of minor illness and injury deteriorating into something more critical that could unnecessarily use resources or require evacuation. Thus, promoting self-care indirectly contributed to sustainable resource management. Not doing so unnecessarily exposes the team to additional risks to health. Another research participant highlighted that,

> “With feet problems, blister problems, where people have known about their injury ... for a while but they have not said anything because they didn't think it would be worth it. 1/ It’s quite easy to start screaming and shouting, saying, “if you had come to me a

> week ago, we could have done something about this," but it that doesn't help. It doesn't build trust [and] the relationship is gone then as a health care provider. 2/"

- Monitor health risks
- Rapport and trust

This research participant emphasised that monitoring and managing minor illness and injury – autonomously and with support from the PFC provider – contributes to mitigating risks to health in a remote environment. It follows that promoting rapport and trust between the PFC provider and the team is a component of mitigating risks to health too. The rationale for this, from the perspective of this research participant, is if team members feel that they can seek advice from the PFC provider regarding their self-monitoring and management of their health needs and minor injury and illness, early intervention to manage these risks to health can be applied. Thus, early risk management inhibits minor illness and injury escalating into a critical situation. As a result, the health of team members is protected and promoted. Health protection and promotion was another perspective of research participants within the theme of mitigating risks to heath.

> "I am very much a promoter of prevention is better than cure. For example, providing continual hand washing advice, foot care advice, hydration advice, dietary advice. Particularly during ultramarathons where after day three you do see runners start to let their standards slip – they're not cleaning their feet at the end of the day, so then the day after they get riddled with horrendous blisters that mean they just can't run, letting their hydration slip, not using their hydration salts and electrolytes properly. I think prevention is absolutely key."

- Prevent of illness and injury is safe approach

The salient point that this research participant wanted to make was that promoting the protection of health was itself a risk mitigation intervention. It was highlighted that due to not having access to health services, resources being limited, communication was unreliable, and evacuation often being delayed, reducing reliance on active PFC mitigated the risks to health in remote environments. Thus, “prevention is better than cure,” and, as this research participant advocated, the interventions that were advocated to protect and promote team member’s health were relatively basic and did not require much effort. For example, general personal hygiene, especially hand hygiene, was highlighted as essential to mitigate the risk of cross-infection. Part of the PFC provider’s role is to remind team members of these health protection and promotion interventions, highlighting that they would mitigate the risk of having additional health needs.

7.3.2.7 Health needs in remote environments

During the semi-structured interviews of the research participants, they were asked about the common health needs that required PFC during their experiences in remote environments. This research does not aim to produce clinical guidelines; however, awareness of the common health needs in remote environments is necessary to understand how PFC can mitigate risks to health. One research participant explained that,

> “I've seen a lot of disease, non-battle injury. There's quite a big amount of things like infection because people get sick and they don't want to go sick, and they can be quite stubborn about it, and so they don't land on your doorstep until they're really quite sick. That’s fairly common.

- Minor illness and injury that can deteriorate, e.g., infection

This vignette echoes the experience from another research participant regarding the reluctance of team members to seek advice or care from PFC providers because they do not want to relinquish their role within the team. In addition to this point, this research participant emphasised that much of the minor illness and injury that they witnessed in remote environments was preventable through health protection and promotion interventions. It was emphasised that actively protecting and promotion health mitigated risks to health for individuals, the team, and local communities because the reliance on the limited resources (such as – equipment, time, people, finance, local health services) would be lessened. Another example that was provided was maintaining sufficient hydration.

> “I was able to highlight to the members of the team [that] when we were above 3000 meters, [they would have] shortness of breath, and explain why they were waking up at night with kind of apnoea (temporary pause in breathing), [and] that these are all normal findings – the headaches, the dehydration. A lot of them are quite panicked [because] they're waking up in the middle night gasping for air. They didn't know what was going on [because] this never happened to them before. They realised they weren't invulnerable, this wasn't just another holiday, there was bigger, bigger forces at work that they had no control over.”

- Practice education of team members about health, risks to health, and self-care

This research participant explained that they were required to educate their team on the additional health needs that they were experiencing in the remote environment they were in – high altitude above 3000 meters. Prior to sharing this knowledge, team members had some anxiety about changes to their usual health experiences (such as breathing and headaches). The PFC provider explained that these health changes were to be expected, which reduced the anxiety experienced by team members. The predominant piece of advice given by PFC providers was about maintaining sufficient hydration. It was explained that at altitude the concentration of oxygen in the atmosphere is less; therefore, breathing rate increase. When people breathe, water is expelled so a higher breathing rate will result in greater water loss. The impact of this is an increased risk of dehydration, which can be initially presented as a headache. Thus, the PFC provider (research participant) encouraged team members to increase their fluid intake, which they explained was an intervention to protect and promote their health. Related to headaches, pain management was identified as another common health need in remote environments.

> “Analgesia would be one of the next big considerations. Our combat medics are very limited with what they can give – they can't really give anything on top of Penthrox, fentanyl lozenges, and IV paracetamol, and these medications are carried in very limited numbers. So, there are definitely some significant gaps… One of the things that we stress on PFC is that if there isn't a logistical a chain that can come and take your patient away, then there's unlikely to be enough of a logistical chain for extra medical kit to get to you. So, if we don't have a plan for getting extra kit from … friendly nations or from the host nation itself, then we can find ourselves delivering substandard care quite quickly. It's something that's immediately challenging.”

- Pain management capability for long duration

It is clear from the experience of this research participant that pain management is a common health need in remote environments due to the identification of effective pain management being a challenge. It was explained that the availability of analgesia (pain medications) is limited because the amount of resources to be carried is small, plus the legal considerations for medications. The legal considerations are what can be administered by a PFC provider and what medications are legal in the country that the team are in. Furthermore, the unlikely option of resupply is reiterated. This research participant explains that ineffective pain management is a known risk to health that can be planned for. In other words, they advocated a forward-thinking approach to mitigating the risks to health. Another advocation from research participants was the recognition of non-physical health needs.

> “One of the things in a patient that I had as a reasonably prolonged hold was the psychological impact of a road traffic collision (RTC) where people [were] killed. Dealing with that is something that you can give really good medical care and look after that person physically, but if you did that in silence from the point of them coming through your doors, to the point of them leaving, I think you failed as a health care provider. 1/ That

individual is going to be having all sorts of traumatic psychological things going on at that time. When I teach anything to do with PFC, I call it my hairdresser questions. I'll say to them, you've got somebody who potentially has had a horrible and traumatic psychological event, such as the one I just mentioned, which they may never recover from [that] could be the basis for horrible series of events afterwards. [When I am teaching,] I say, “how would you feel? What do you think about how that person is going to feel? [This event] might be a career showstopper, so put yourself in their shoes.” 2/ I always try and build in an element of the psychological care of the patient as opposed to just the come in, let's patch you up, let's keep you here for however long, let's plan how many paracetamols you are going to get, etc. That's important but I do think the psychological impact of the hold, particularly because I think it's usually just you and them for a long time. I always say to them you need to think about how much of a good a person you are to be locked in a room with for 12 hours, because you need to have some chat, you need to have the human element. … I remember getting told that it was a waste of time me wiping somebody's face that was covered in blood. I was like no, you're missing the point of why I'm doing this. [Yes,] it will get cleaned up when he gets to the next facility [but] I'm doing this because I'm forming a connection with this patient that had this severely traumatic event, and right now the only thing that's keeping him grounded in reality is me caring for him and having that eye contact. 3/”

- 1/ Psychological care after traumatic event (which may be related to the activity historically)
- 2/ Consider chain reaction impacts for patient
- 3/ Fundamental care is valid part of acute care and PFC

This research participant highlighted that their PFC role included meeting the physical and psychological health needs of patients. They advocated that physical and psychological health needs cannot be separated; therefore, PFC practice cannot be compartmentalised into physical and psychological health care. In other words, this research participant emphasised that a PFC provider must have an interdisciplinary approach to health care in remote environments to mitigate physical and psychological risks to health. This approach is in juxtaposition to health care providers being focused on meeting health needs from the perspective of their professional background and training. Another research participant reiterated that,

> “We've grossly overlooked [mental health] as health care professionals in our remote area settings for many years … particularly within the oil and gas industry, people away from their families for long periods of time. They do 12-hour shifts, get up in the morning, go to work, do the job, go back to their single person cabin, [and] they might have limited access to Internet communications with family and friends back home. All of that potentially has big impact. 1/ [It’s] really become apparent … [during the COVID19 lockdowns] and it's allowed me and my team to start introducing mental health awareness, self-care programs in the field. We now run those with the same priority as we would run weekly first day training sessions for the crews. So, it's got the same status now; that's really important. 2.”

- 1/ Risk to health = physical remoteness, not being able to go home quickly
- 2/ Practice education of team members about health, risks to health, and self-care

There was a clear emphasis on including psychological care from this research participant. Based on their experience of providing PFC off-shore, they advocated that psychological care is included in the duty of care to team members in a remote environment. This vignette provides evidence that psychological care is included in the training provided by the research participant as a tool to mitigate risks to psychological health. Another research participant highlighted that it is important to monitor these risks because they can change overtime.

> "I did start to notice some attitude changes, little mental health changes through the expedition where people became more grumpier, more volatile, a little bit shorter with each other as we got higher and more remote. Not that they had tempers, but we would certainly see more direct flip and answers to questions where a few days previously people would have brushed it off and had a laugh and joke. Now we were kind of getting serious answers, little sly digs each other, complaints about people holding others up and being too slow."

- Physical health affects mental health and vice versa

The salient point that this research participant wanted to highlight was that the remote environment they were in, and the associated risks (of being at altitude) were effecting the team member's physical and psychological health. The research participant explained that having awareness of this enabled them to monitor the team for signs of deteriorating health – physically and psychologically – and, therefore, implement preventative measures. Preventative measures reiterate the advocation that PFC includes mitigating risks to health before they escalate into critical situations. This was highlighted as a predominant component of the PFC provider role, which was also a theme that was identified during open coding.

7.3.2.8 PFC provider role

The evidence provided by the research participant included descriptions of what they thought the role of a PFC provide is in remote environments that contributes to mitigating risks to health. In other words, they advocated that PFC provider's scope of practice was not limited to directly providing health care – many components of their role indirectly contributed to health care and risk mitigation. One research participant explained that,

> “Every single person on a trip, on a field site, wherever [you] may be, whatever the setting is, the medic's got to be neutral you – you're the person that people have got to come through with all their aches and sprains, with all their worries. [For example, someone may say,] “I've got an itch down here Doc and I don't want talk about it.” So, you've got to have that level of trust. And if you have that … you will pick up on a lot of other underlying issues before they become major dramas.

- Rapport and trust

This research participant’s vignette provides evidence of the important to develop a professional working relationship, built on trust, between the team members and the PFC provider. The research participant highlighted that rapport and trust is integral to being enabled to mitigate and manage risks to health because team members are more likely to disclose sensitive details about their health. By sharing this information, the PFC provider was enabled to provide advice on how to manage these minor injuries or illnesses, thus preventing them from becoming worse. Trust is instilled into this rapport by protecting team member’s confidentiality and explaining to them if confidentiality needed to be broken (such as in the event of an emergency). It was explained by another research participant that developing this skillset had been possible through their wider experience.

> “My background … is an NHS paramedic, so I've always been ‘Jack of all master of none.’ That’s the mindset, that's how our training is – we dip our fingers into every aspect of health care. I think for me that 10 years of ‘street medicine’ gave me [a] strong background before moving completely to remote work. 1/ Previous to that [I spent] many years working in outdoor centres. And that's not an uncommon career pathway for a lot of paramedics who then go on to do remote area medicine. I think there's a there is definitely a whole tier of remote area medics who come from a very similar pathway to it to mine. 2/”

- 1/ Recognise other transferable training
- 2/ Relevant training/experiences to activities in remote environments

This research participant highlighted that their professional background as a paramedic, and previous to that an outdoor centre instructor, equipped them with knowledge and skills that were transferrable to PFC in remote environments. They explained that managing everchanging circumstances while working in an outdoor environment caused them to develop strategies to maintain their own safety so that they could provide PFC. The salient point that this research participant wanted to make was PFC providers often have lots of experience and can critically think about problems and use their intuition to develop solutions. Adopting this mindset while providing PFC in remote environments enables them to mitigate risks to health. Moreover, this mindset is something that cannot necessarily be taught in a course – rather, it is developed by the quality of experiences a PFC provide has. Another research participant explained,

> "There can be an element of being taught to pass a course, and as much as a course can give you some skills or ways of thinking about new things or whatever you need to be secure in your practice, I think that's dependent on the individual. I've met some exceptionally good nurses that have been qualified for a year, and I and I think I wouldn't mind you look after me, I'd be happy with that. So, I think it's not a time thing. I think perhaps even a self-assessment would be useful, a self-reflection. 1/ Are you confident? are you competent? are you credible? By nature of what PFC is, you will be working in small teams, and I think there's a personality element to it – you have to be somebody who can get on and just gets on with the job and doesn't flap up if you're out there on your own because potentially you are likely to be to be out there on your own. You do have to be competent and confident in what you're doing, but credibility, I think, is the most challenging thing to do and to measure. 2/"

- 1/ Self-reflection and awareness of PFC capability

- 2/ Confident, competent, and credible

This vignette echoes a previous note about being confident, competent, and credible in the PFC being provided. This research participant reiterated this point and added that the role of a PFC provider involves being able to reflect on their own practice to mitigate risks. They advocated that reflection was a useful learning tool that helped them to build on their PFC practice learnt from various courses and training that they had completed. Thus, PFC training was another theme.

7.3.2.9 PFC training

PFC training was a common theme identified during the open coding of data collected during semi-structured interviews. Training for PFC took place before deployment to remote environments, or during the deployment, which provided multiple opportunities to develop risk reduction strategies as part of PFC. The research participants provided evidence that there was variation in the formality of PFC training, which suggests that there is no standardisation, and that PFC is a phenomena not fully understood. One research participant explained that,

> "The first time I came across anything on a training course I would remotely now refer to as PFC was doing a medicine in remote areas course in 2008 – so, relatively recently. But it's only looking back at that course now that it's like, oh yeah, we were adding in nursing skills and holding our patients overnight in a woodland and doing all the other bits and pieces. I was reflecting on it the other day, and it was like oh yeah, we did do some formal training around that, we just didn't have a title for it at the time."

- Reflect on training to do date that may not be purposefully for PFC

This research participant explained that in their experience PFC has only recently been acknowledged; however, now knowing what PFC is, they could recognise elements of PFC from previous training. This suggests that PFC is a combination of existing knowledge, skills, and experience that are applied in remote environments to mitigate risks to health. Grounded theory is a method to produce an explanatory theory of practice; therefore, the PFC grounded theory aligns with this notion. In other words, the mitigation of risks to health through PFC is a newly recognised approach to practice in remote environments that required rigorous inquiry to understand. Another research participant highlighted the value of PFC training by saying,

> "I absolutely see the value in a formal, [at a] minimum, two-day PFC course for medics or those with the responsibility for any kind of … [PFC] – whether it'd be a school trip abroad, whether it you're going to go onto an oil rig in the North Sea where you might not be able to get the heli [helicopter] in for days on end. Because [PFC is] only covered in bits and bobs within other courses when it's not the main focus, and I just think to have a formal, standalone [course where] this is what we're going to concentrate on [for the] next 48 hours / 72 hours is PFC – the theory, the practice. So, when the bad thing happens, you've got your PFC framework and approach in your head."

- Relevant training/experiences to activities in remote environments

From the perspective of this research participant, PFC should be provided as a designated course rather than completing relevant training sessions. The rationale for this is that by having a specific course, participants are enabled to develop a, "PFC framework and approach," that can be used during deployment to remote environments to mitigate risks to health. In addition to bespoke PFC training, additional knowledge and skills learnt through other training was also highlighted as important learning for PFC risk mitigation.

> "I was fortunate enough to have a first career before medicine in the outdoors teaching people climbing, mountaineering, map reading as part of work within the mountain rescue team. My rescue training was a 7-day course up in [the Scottish Highlands] – a little but more than your bog standard first aid training. That

was an eye opener, having to perform medicine up on the top of Cairngorm (a 1,245m mountain in Scotland) on the icy slops. So, I'm confident what I knew, but also very confident in what I don't know.

- Relevant training/experiences to activities in remote environments

This open coding concept was also allocated to the vignette provided by this research participant. The evidence provided suggests that other training about keeping yourself and others safe in remote environments is a core part of PFC capability. In other words, ensuring the PFC provider is ready and able to provide PFC in remote environments is essential to mitigating the risks to themselves and others. Furthermore, this research participant advocated that knowing what they were capable of, and what they were not capable of, made them a safe PFC provider. This experience was similar to another research participant who explained that,

> "Before going on an expedition, I had no specific PFC training. It was a concept I was starting to come across in literature, primarily around military operations. My own medical training was civilian based paramedics – I had done Mountain Leader training, and I was used to being in remote areas and mountaineering trips. I was comfortable kind of on solo trips because I lived in the Middle East for a while and had done some hiking and trekking. I was used to a lack of communications, being remote being on my own– I was comfortable in those circumstances. I knew I could look after myself and that I wouldn't become a liability to the group. As the saying goes, I was comfortable in uncomfortable places, so I knew that would be an asset as an expedition medic. But, specifically to PFC, I had no training whatsoever in that context that we understand it now."

- No specific PFC training

Although this research participant did not have any specific PFC training, they advocated that their other experiences and training collectively prepared them for providing PFC in remote environments. Notably, this research participant highlighted that a PFC provider needs to have their own coping strategies to enable them to fulfil their role. Many research participants advocated that because the PFC provider role is so diverse, due to the varying remote environments there are deployed to, they needed to ensure they had continued professional development training to remain confident, competent, and current.

> “I'd like to do the PFC course again (with R2Ri) as a refresher in a year or two's time, particularly if I'm not in a position to actually be doing any sort of remote medicine as many of us find ourselves at the moment [during COVID19], maybe on a periodic basis. 1/ Doing an exercise where manage a patient for 24 hours, would be really, really good, including specific clinical skills that might feed into PFC like the nursing skills. 2/”

- 1/ Refresher training to maintain currency
- 2/ High-fidelity training

This research participant highlighted that maintaining currency was needed to maintain PFC capability. Some of the semi-structured interviews took place during the COVID19 pandemic, hence this research participant explained that they could not provide PFC due to being isolated. High-fidelity simulation training (highly realistic) was identified as a necessary tool to maintaining currency, and to develop PFC strategies for risk reduction. As another research participant explained, risk reduction also includes self-care.

> “It is just so different when you're in a tent or in a really basic accommodation providing any kind of care. [You need to make sure] you're able to look after yourself, that you don't need to be told to stay warm, to feed yourself, to toilet yourself. You need to anticipate what's going to happen next, to be always one step ahead of the problem, if you can. I think that really is not covered in standard kind of medical context, even an expedition course as we know them for the last decade or so, it's still very much

> based on treat the casualty, call the rescue services, and then wait till they come. If you're lucky, a [helicopter] will come out of sky and problem solved. When you're getting into the 6-7 hours, that's still a long time to look after somebody. You need to feed yourself, feed the patient, keep warm, keep them warm, think of nutrition, think of shelter. That’s just not covered in a medical context for what we want to do until recently. It's an important part of the PFC role.”

- Self-care

Based on the evidence provided in this vignette, it is clear that self-care is an integral feature of PFC. By the PFC provider ensuring their health needs are met, as well as any patients and the team, they are enabled to fulfil their role. This research participant highlighted that this approach to health care is not common in other training. This evidence was supported by other research participants having the same experience; therefore, some PFC providers developed their own training provisions.

> “I was responsible for delivery of training. We picked apart the different problems to work out what the true issues were that people experience and worked through the problem-solving so that the scenarios that we delivered as trainers were more focused to the individuals prior to them going out on an operation [to provide PFC].

- Experiential learning in classroom to evoke PFC strategy

This research participant led PFC pre-deployment training to support PFC providers to develop their problem-solving abilities. This suggests that part of the PFC role is to problem-solve; therefore, developing this ability is necessary to be able to mitigate risks to health by using PFC in remote environments. The training that this research participant developed used scenarios as a method to evoke problem-solving skills, which aligns with the practical approach to PFC training used by other research participants.

> “I feel PFC is a subject area that [needs] a practical training package, and that there is little to gain from it being purely theoretical because the issues you face are organic and it's about your ability to improvise, adapt, and optimise with the environment that you have, so it's always different. I don't think you can truly reflect that in a truly theoretical classroom-based activity. Until you're actually presented with the kit that is resource limited in an environment that is austere (that is, a conflict zone for example), you only really truly understand the pressures that you'll be under if you have to deliver that in anger. The amount of different environments that you may work in are vast and you can't deliver a package for every single eventuality; it's just impossible. The better way to do it is to create a safe (learning) environment and then allow them to deliver PFC … where they draw out why things work and why they don't. If you do that practically based, they have a better understanding of what they are trying to achieve so they can they know what the gold standard is... Then they walk away with what they must achieve within that that period, and different kind of coping strategies of how they may achieve it, regardless of the environment they're in.

- Training = preparation

This research participant explained that a practical approach to PFC training had a high efficacy in the training participants developing a PFC strategy that can be adapted for application to the different remote environments. They highlighted that the learning environment should be safe, meaning that training participants should feel comfortable to make mistakes and learn from them. By doing so, in the experience of this research participant, the training participants were better prepared to provide PFC in remote environments.

> “One of the things I always teach as part of PFC is don't make problems for yourself, don't create more work for yourself. For example, plan ahead, look … for your evacuation, look at what

your medications are, and what you've got and stagger them appropriately and make sure you're not blowing through every single bit of medication you've got in the first five minutes and then realising there is nothing for the rest of the time you are there. I talk about the importance of you (the PFC provider) being there and what difference and impact that makes to the patient, where left to their own devices they'd probably have a much worse outcome than if you weren't there. So, I think the importance of having somebody there that's trained in PFC and having that knowledge nearby is really valuable and significantly improves outcomes for patient's health.

- Training, equipment, knowledge, experience, planning = risk to health mitigation

This vignette provides evidence of the importance of sharing PFC provision experiences with others so they can develop their own strategies of PFC in remote environments. The combined experience of many deployments from the PFC provider and others who have relevant experiences, therefore, enriches the PFC training and leads to a consolidated risk mitigation capability. Another research participant advocated experiential learning about PFC.

> "I will have people laid on a cold hard floor on their back, making sure their pressure areas are in contact with the cold hard floor, and then after 15 minutes, after I've carried on waffling and then I'll come back to them and ask, "do your elbows yet? Yes, I'm not surprised. Now, think how you patient must feel." The realities of that are an important learning exercise. I remember one of the lessons that sticks in my mind as a student was, we were instructed to lay down on a bed in the classroom and be spoon fed yogurt at speed. It was a huge realisation of it's actually quite hard to feed somebody and do it in a dignified and sensitive way and safely eat without choking. So, when teaching PFC, I like to get quite hands on with things … because they learn better. So much of the subject (PFC) is about adapting things and using

> your own self-reliance and initiative to create what you need out of what you've got. … PFC is really out of their comfort zone, so I like them to be as prepared as possible with the little things so that those things come a bit more naturally. It's all the little things that I think is sort of that's how I like to try and teach and gain the interest."

- Be trained and experienced so you can train others

The aim of using experiential learning methods during this research participant's PFC training that they led was to support training participants to identify lessons learned about being a patient in a remote environment. The decision to use experiential learning was based on the research participant's own learning experience. In other words, the salient point they wanted to highlight was that PFC providers should have training and experience in PFC provision, which should be passed onto others. It was clear from other research participants that they felt training was essential to PFC and risk mitigation.

> "For me, I think it would be really handy to have done some tropical medicine training. My understanding of stuff is quite limited in terms of things like snake bites, for example. I know very little about microbiology of various different areas where I might be deployed, but I usually you go to the environmental health brief in advance and so you know not to drink the water, for example. I'd quite like to have a better appreciation of things specific to an area, training specific to an area or an environment. That would be good because a lot of the time I'm going off something I've read out of a book or bits of things I've picked up along the way. Knowing about those area specific risks to health would help me prepare to provide PFC."

- Training days to mitigate risks to health

This research participant emphasised that training specific to an environment and the associated risks is important for them to be prepared to provided PFC and, therefore, mitigate risks to health. This vignette also aligns with another research participant who advocated that knowing what they know and what they do not know is a sign of competence. Thus, it can be argued that having sufficient theoretical knowledge of PFC in remote environments is also significant. Another research participant explained that,

> "As long as [the PFC provider has] got a that underpinning theoretical knowledge and they've been able to actually use some of those principles in clinical practice, it doesn't really matter to me [what professional background they have], as long as they've got access to the same medication and the same protocols. … I think definitely the best standard of care would be delivered in a multidisciplinary team, but also increasingly we would be adding non-vocational health care providers to that. Whether that is some patrol medics in the special forces medical group and advance team medic. They get training in PFC – it's still only a couple of weeks course, but they are taught how to deliver limited PFC. … If we don't practice it, then then we'll be learning these lessons for the first time overseas where it's not the ideal learning conditions."

- Practical training and theory

It is clear from this research participant that in their experience, PFC providers should have a theoretical and practice understanding of how to provide PFC in remote environments and mitigate risks to health. They state that without this, the only learning environment is during deployment, which is not ideal because the risks are substantially higher in comparison to a learning environment that simulates the challenges experienced by PFC providers. This research participant also advocates a multidisciplinary team approach to PFC – that is, to have multiple healthcare professionals – however, with limited resources (including human resources) this would be challenging. Notwithstanding, training with other healthcare professionals can evoke the skills and knowledge needed when deployed to remote environments.

> "Some of the things that we emphasise [when training] that aren't really covered that much on the on the Clinical Guidance for Operations (CGOs – policies) protocols are things like human factors. So, how to work in a small team where everyone is tired, everyone is hungry, and everyone's trying to do the best with limited resources. The only way to get ahead of that is to train and simulate it. Also, [this includes] elements of the combat medics, through no fault of their own, aren't very experienced in."

- Simulation courses provide familiarity to PFC

This vignette provided evidence that healthcare policies cannot prepare and inform PFC providers and teams that deploy to remote environments for all challenges. The example provided about working within teams under high-stress circumstances was prepared for during training that simulated these conditions. By doing so, training participants are enabled to learn from other healthcare professionals and develop their own coping mechanisms and PFC strategies to mitigate risks to health in remote environments.

> "We have come up with a bespoke solution to PFC [in our team[7]], which we needed to do because it's not the same here [when compared with other teams] or in a field hospital. … We've had to come up with some of our own ways to address gaps [in PFC training] and make things easier to understand for people that haven't had years and years in hospitals and ambulances. We've done things like made a 24 hour care wheel – a pictorial representation of what the plan of care is for this patient over the next day, which allows medics, nurses, and doctors with a little bit of pre-training to understand how to keep this casualty in a good place over the next 24 hour period, and how to deal with complex pain issues, how to forecast the different medications and the different procedures, like dressing changes, and position changes, and even down to mouth care and passive range of

[7] Reference to military unit removed to protect confidentiality

movement. We use our own aide memoirs because we know that by the time a combat medical technician gets to the point where they're delivering PFC, they'll already be tired, they'll be hungry, they'll be cold, and they'll be wet, and they won't be in the best position to be able to recall what someone like me has taught them in a classroom. So, adapting what we've already got and expanding on it with our own aide memoirs helps us to deliver effective PFC training."

- Aide memoirs to mitigate risk of forgetting protocol

The aide memoir that was developed by this research participant and their team was an example of how to mitigate the increased risk of PFC providers forgetting their training due to the challenging conditions. Thus, this is an example of a strategy to mitigate risks to health in remote environments – linking the simulated training environments with the reality of deployment to remote environments. Another research participant explained that,

> "Simulation is everything to us. We've put a huge emphasis on simulation training with the high-fidelity manikins that we have, which are ones that are great for medical scenarios or trauma scenarios, but also because we can control things like urine output and program medical conditions to get worse. We can do long-term overnight serials where we program the amount of urine output – and we can [do this] without being stood there with a clipboard next to the patient – we can program deterioration or improvements. [This is important] because you don't learn properly how to deal with a long-term casualty by doing big artificial time jumps, by giving the medic an hour with the casualty and then saying, "right, so 18 hours has passed and these are the patients new vital signs (blood pressure, pulse rate, respiratory rate, etc.)." It's good to be able to do a proper long term scenario so that the team does actually have to break down into shifts and start looking at human factors, and start realising that people do need to go and get rest, and making sure that the

> correct physiological parameters are agreed by all so that so that junior members of the team or even non-vocational health care providers know at what point do I need to go and wake up the clinical lead – they know that when it's hard, when the heart rate hits this, or the [respiratory rate] hits this, or the temperature hits this, to get the clinical lead. Training and simulation are everything here, and that's why we've put a lot of work into developing some medium fidelity training environments, like a jungle room, and a forward operating base room[8], and we're in the process of building a lot more expensive facility to take people out of their comfort zone and become a bit of a like a multi-sensory experience to put people through. So, training and simulation are one of the big things that we are using to try and pre-empt PFC becoming a real issue in the future, so people are prepared."

- High-fidelity simulation training = preparedness

This evidence about the impact of high-fidelity simulation training suggests that this training method is essential for equipping PFC providers with the necessary knowledge, skills, and confidence to mitigate risks to health in remote environments. It was explained that high-fidelity simulation training is realistic, with the same challenges and conditions to a remote environments. The research participant emphasised that creating a highly-realistic learning environment enabled the PFC providers to develop coping mechanisms and strategies relative to the environment they were being deployed to; therefore, they felt better prepared. Other research participants explained that they suggest extra-curricular learning activities to their team members to supplement their PFC training and increase their preparedness.

> "One of the things that we add on to the training that we run here is I recommend that they go and listen to relevant podcasts[9].

[8] Forward operating base, or FOB, is a phrase used to describe a deployed and temporary military base

[9] Reference to specific podcasts are removed to protect anonymity and to respect request by research participant to highlight no individual podcasts are endorsed as an official training aid.

> [They can be …] about 40 minutes and very earnest and thought provoking. [Some are] aimed more at people in a special operations team (military special forces), where you might have a little bit more flexibility, but it deals with some of the issues that we've talked about – like how to get follow on (resupplied) PFC kit to your casualty if you're unable to get them out, and how to access and work with NGOs in various countries. [They're] really thought provoking, so we would always recommend that someone listens to [them]. Then, getting access to [various online] resources … just to stimulate your mind and realise that other people are working on this same problem, other people have done more on this than we have, and that there's a lot to be learned from that instead of just thinking about the defence medical services, because there's a lot more work being done out there than we are able to do."

- Proactive approach to PFC CPD

This research participant explained that they encouraged a proactive approach to PFC training and preparation, such as seeking additional learning resources and activities. They highlighted that by doing so, PFC provider's mind would be stimulated into critically thinking about problems and challenges in remote environments, based on their broad understanding of how PFC can mitigate risks to health. In addition, being able to assess the risks to health in remote environments was highlighted as another skillset.

> "Risk assessments are very important. Being able to write plans … [and] to be able to practice those. To look at a comms (communications) plan, and put in a comms plan together, which are not necessarily core medic skills; [although,] I think they're becoming increasingly so."

- Familiar with clinical guidance and assessment tools

This vignette suggests that having the ability to conduct risk assessments, in addition to the core skills a PFC provider is expected to have, is necessary for being able to mitigate risks to health. It was highlighted by this research participant that this capability is not currently typical of healthcare practitioners but in remote environments the PFC needs to assume additional roles to be able to mitigate risks to health. Another research participant suggested that being adaptable to changing circumstances is similarly a unique requirement of PFC providers in remote environments.

> “[I have] experience of deploying at Role 1 medic … where you pick up a lot of the non-technical skills about what your role is as a medic or as a nurse in a patrol before you receive a casualty and afterwards. For example, understanding what the tactical considerations are … informs your practice, even down to minor things like ensuring that at the point of injury that the patient is placed onto a stretcher at the very first opportunity because if the tactical situation changes and you suddenly need to move, it's not going to be acceptable that you say to the platoon Sergeant “actually, sorry no, I'm not ready to move this casualty right now,” because if you're moving the casualty well, if you're being told to move the casualty because mortars are being walked onto your position. It doesn't really matter what you're in the middle of if you're there when the mortars come in, I mean everyone is going to have a bad time.”

- Thinking ahead to how health needs change

The example provided by this research participant suggests that the circumstances in remote environments can change rapidly. This could be environmental or circumstantial risks. As a result, they advocated that PFC providers must be able to adapt their practice whenever an increase of risks to health occurs. To do this, they explained that PFC providers need to be able to think ahead, dynamically assess risks, and react at the optimum moment to protect and promote their team’s health. Thus, managing challenges to PFC in remote environments is unique, and challenges was identified as anther theme of open coding data analysis.

7.3.2.10 Challenges

The research participants explained that there were multiple challenges that they had to overcome during their experiences of providing PFC in remote environments. Many of these challenges were unique to remote environments and without effective critical thinking and problem solving, risks to health would escalate. One of the challenges highlighted was being required to provide PFC autonomously.

> "You tend to be the sole resource and [it is] very easy to become blinkered and solely concentrating on your patient, forgetting your own needs. And of course, if you pile in as the one and only medic, not only is your patient [unwell], but you've now become the next casualty and you're endangering the rest of the group …"

- Duty of care to everyone, including self

This research participant highlighted that autonomous working becomes a risk if the care of oneself is neglected. In other words, part of the PFC provider's role is to protect and promote their own health so that they can do the same for others. They explained that this can be a challenge because the duration of PFC can be multiple hours, days, or more; therefore, at some point the PFC provider needs to step away to eat, sleep, and rehydrate. It was explained they doing this is often a challenge for PFC providers; however, it was identified that a way to mitigate this risk is to train team members in basic PFC too.

> "One of the things that I've always tried to do … [is] some cross training with everybody in the team. If you're the sole [PFC] provider, what if I'm the [person] that slips over and breaks my leg, or ends up with a massive cut? I want somebody to be able to take care of me."

- Train team members in basic skills that may be needed for PFC

Training team members in how to provide basic PFC is an intervention that mitigates the risk of the PFC provider becoming injured or unwell. Due to the challenge of limited resources, it is often that there is only PFC provider deployed with a team to a remote environment. This research participant suggested that some pre-deployment training and training when in the remote environment was important to overcome this challenge and mitigate the associated risks to health. This research participant also advocated that by providing this training, they were able to consolidate a rapport with the team. Another research participant reiterated the importance of a rapport and highlighted the challenges of this.

> “You can go back to your grot (accommodation) at the end of the day, shout into your pillow and smack the sides of the tent, but you've got to have enough strength of character to maintain confidentiality [and] non-gossiping. That's mega-mega important because once you lose that, if you lose that level of trust, you are blown.”

- Professionalism

The research participant highlighted that maintaining their professionalism was integral to having a rapport with team members. It was acknowledged that this can be a challenge because being an autonomous PFC provider meant that they were never ‘off-duty’ and patients could need their help when the PFC provider needed time to themselves. Nevertheless, another research participant highlighted the important of having a coping mechanisms to manage this challenge.

> “You've got to be mentally strong. You've got to have your own support network and methods of dealing with this, because otherwise it will break you as an individual as well. No one person's an island.”

- Self-awareness

To have the coping mechanisms to manage the pressure of being a PFC provider in remote environments is, in itself, a tool to mitigate risks to health. The evidence for this is provided by this research participant, who warns that without self-awareness and resilience, a PFC provider could easily become incapable to fulfil their role in a remote environment. The impacts of this are the PFC provider could become psychologically unwell and then the team members are exposed to the risks to health without an expert providing PFC. Having a PFC provider who is confident, competent, and credible was reiterated by many research participants; however, it was also acknowledged that many healthcare practitioners do not fulfil this criteria.

> “One of the main challenges with PFC is that the clinicians learn their trade in an established medical facility, and they have no real appreciation of being in a resource limited environment. And then the ones that operate in the resource limited environment have limited exposure to the medical provision in an established facility. So, you've got two people – two groups of people – who tend to work in different environments and don't understand the middle ground between the two.”

- Awareness of environmental and circumstantial risks

This research participant explained that although many healthcare practitioners are highly trained and experienced within their fields, they lack awareness of the environmental and circumstantial risks in remote environments. As a result, many healthcare practitioners who are new to PFC in remote environments find it challenging to adjust their clinical practice, such as the sustainable use of resources. Moreover, patients in remote environment can similarly have a lack of awareness, which is also a challenge that needs careful management.

> “Patient’s perception and understanding of their illness or injury is a big challenge because they're not always necessarily the most willing and cooperative individuals, sometimes, depending on what they're doing. If you're a credible and confident PFC provider, you can inform them what they need to do to get better. Sometimes people make silly mistakes, perhaps unknowingly, so it's quite useful to have that person there that goes “this is how

> we're going to manage this, and this is how we're going to achieve this." I quite like an analogy one of the burns technicians use, which is, "the injury is the sport, and the patient is the athlete." This means that [the patient has] got something to work on, focus on."

- Team management can be a challenge

It is evident from this vignette that lack of awareness from team members about the risks associated with being in a remote environment can be a challenge to manage. This research participant gave the example of using analogies that team members can related to as a management tool. It can, therefore, be noted that PFC providers also need to have effective people management skills in addition to resource management skills. Having this skillset is similarly above and beyond what is usually expected of a healthcare practitioners, which emphasises the important of pre-deployment training. However, it was also acknowledged that despite training, PFC providers can still feel unprepared.

> "[A challenge is] … medics that we are sending into remote areas feel like they've [not] had sufficient training in PFC – I don't know of anyone who's actually ended up in a remote environment having to deliver PFC and felt like they were fully prepared for that. If we were able to provide [high-fidelity] training to our medics before they went overseas, then that would be massively beneficial to the patient, and also really useful for the medic, because then it's not just a nurse stood in a classroom showing them a PowerPoint, talking about infection, and talking about kit and all of these obscure concepts, that they're actually then learning, "oh, actually if I don't keep this this non-human model warm enough, then it doesn't matter what I do for haemostasis the casualty will continue to bleed and their overall condition will just get worse and worse." Most people in prehospital emergency care would learn that lesson a lot better, and that training would be a lot better received…"

- Despite training, PFC experience feels unprepared

Training was identified as a tool for risk mitigation; however, this research participant explains that despite training, many PFC providers still felt unprepared providing PFC in remote environments. This is due to the multifaceted and dynamic challenges that are experienced in remote environments. High-fidelity simulation training was identified as a tool to help PFC providers to feel more prepared, and this evidence also reiterates the important of coping mechanisms to fall back on when in remote environments. It follows that identifying lessons learned after returning from a remote environment was acknowledge an important step in PFC practice.

> “When I accepted the role as a medic on the expedition, I was very excited. In preparation, I focused a lot on the physical risks to health – the mountaineering, the altitude, the remoteness, the trauma from accidents. I hadn't really given it enough consideration towards … if somebody was injured for a long time. I kind of was still in the paramedic sense of, we'll get to them, will treat them, and then we'll get them to hospital, thinking that you'll have the same level of access, acknowledging that there may be some difficulties over there, but you will get them to hospital at some stage. I hadn't considered that might be a day later, or 36 hours later. That was something I learned on the expedition.”

- Self-reflection and awareness of PFC capability

This research participant explained that they had a mindset shift as a result of the challenges of providing PFC in remote environments. They adapted their approach based on the circumstances that they experienced to protect and promote the health of the patient. Identifying this cusp point was useful for this research participant, which suggests that reflecting on PFC experiences in remote environments contributes to PFC capability and overcoming similar challenges in future deployment to remote environments. A challenge for future PFC practice in general was more research is required.

> "The gaps in the research are very much similar to the gaps that we have in prehospital emergency medicine or emergency care, in which, historically the capture of documentation is poor. It's explainable why it's poor – because it's a dynamic environment where you don't necessarily know what you're walking into, and that it's really difficult to capture that documentation. It's the same with PFC – when it does happen, it's in a remote environment where you have limited resources and limited support, so capturing that clinical information but and also the lessons identified is historically difficult. That needs to improve through either case studies or people writing academically or doing their own research. If we don't have that, it can't inform the training and the training is built around, at the moment, what we perceive to be the issues with PFC and there is not that much evidence available at present to inform that that's the direction of travel. We need people to be exposed to the delivery of PFC so they can then highlight the issues with the training so the training delta can be addressed."

- Documentation and record keeping

To inform future research and policy development, documentation and record keeping of PFC in remote environments was emphasised by this research participant. It was acknowledged that documentation during deployment is a challenge; however, keeping a detailed record of events as soon as possible would ensure lessons learned were identified. Thus, increasing the body of research and evidence about PFC would inform future training and risk mitigation strategies. The emergent PFC grounded theory, therefore, has research impact in bridging the PFC grounded theory gap to inform training and health risks mitigation for deployment to remote environments. The open coding concepts formed the build blocks of the PFC grounded theory, and the subsequent stage of theory emergence was to complete axial coding.

7.3.3 Axial codes

For axial coding, the open coding concepts were assigned to the four Straussian categories – the cause, context, strategy, and consequence (Corbin and Strauss, 2015). The purpose of axial coding was to categorise the open coding concepts into a map of the conceptual influences of PFC in remote environments. Thus, by completing axial coding the conceptual understanding of the emerging PFC grounded theory is enriched. In other words, the building blocks of the PFC grounded theory are organised as per the multiple influencing factors of providing PFC in remote environments to mitigate risks to health.

It is important to note that in this chapter the presentation of axial coding findings are presented in a linear sequence after open coding; however, in reality, all three stages of grounded theory data analysis coding (open, axial, selective coding – see 6.4.3) take place simultaneously (Corbin and Strauss, 2015). The rationale for grounded theory data analysis coding being conducted simultaneously is to have theoretical sensitivity to monitor for theoretical saturation. (See Figure 4 for an illustration of the grounded theory data collection and analysis process.) The axial coding stage of grounded theory data analysis maps the categories of PFC in remote environments, beginning with the causes.

To identify the causes of PFC, the open coding concepts were critically appraised using constant comparative analysis during axial coding (see 6.4.3.4). Constant comparative analysis takes place at all stages of the grounded theory data analysis process; however, initially, open coding concepts and axial coding categories were included until selective coding took place. Constant comparative analysis was based on the researcher's theoretical sensitivity to the emerging PFC grounded theory, which was developed as a result of the literature review and concept analysis (see Chapter 3 and Chapter 4).

In this section, the axial coding categories are presented sequentially to provide transparency to the findings of this stage of the ground theory research process. The 348 open coding concepts were allocated to causes, contexts, strategies, and consequences axial categories of PFC in remote environments. Each axial category is introduced, followed by detailed critical appraisal of how the open coding concepts were allocated axial coding categories. The axial coding categories are identified by being listed as bullet points, similarly to how the open coding concepts were presented. Presenting the axial coding categories in this format demonstrates the rigorous approach that was used for this research. Firstly, the causes of PFC in remote environments to mitigate risks to health are presented.

7.3.3.1 Causes

The first axial coding category to be critically appraised is causes. The causes category of axial coding identifies the triggers of when PFC is needed in remote environments to mitigate risks to health. In other words, theoretical sensitive was used to identify what open coding concepts describe the triggers of PFC in remote environments. This stage of the grounded theory data analysis contributes to the emerging theory by identifying when PFC is required in remote environments and critically appraising the relevance to the emerging PFC grounded theory.

- Extended exposure to risk

Research participants all explained that in their experience of providing PFC in remote environments, they were there for longer than they had anticipated. The axial coding concept extended exposure to risk was identified as a cause of PFC due to the evidence from research participant’s experience of increasing risks to health relative to the time that they were in a remote environment. An increasing exposure to health risks in correlation with the time spent in remote environments included open coding concepts that explain the environmental and circumstantial risks to health. In other words, there was vulnerability to natural and anthropogenic hazards in remote environment. The relevance to PFC is when there was an unexpected extension to the time spent in the remote environment and, therefore, the associated risks.

The unexpected requirement of meeting health needs and mitigating risks to health to promote and protect health in remote environments was a common thread through open coding categories relating to axial coding category of causes. The unexpected increase in time spent in the remote environment was caused by multiple influencing factor that were relative to the environment and circumstance that the teams were experiencing. Each research participant had a unique experience; therefore, it can be noted that predicting the reason for an extended duration in a remote environment is exceptionally challenging. On the other hand, research participants advocated that planning for the unexpected mitigated the exacerbation of the risks to health. However, another cause of PFC related to how existing health needs were cared for in remote environments during the extended exposure to risks.

- Influence of existing health needs without appropriate care

Many of the research participants described that their team members in remote environments are at risk of illness and injury. However, they also explained that their pre-existing health needs may increase. In their experience, the increases of existing health needs was largely due to team members being in an unfamiliar environment that made managing their existing health needs more challenging. For example, one open coding concept allocated to the causes category was, "growing influences of health – tiredness, hunger – increases risks to health." This open coding concept was allocated to data that provided evidence that suggested daily activities, such as having sufficient sleep and nutritional intake, were less likely to be achieved. Research participants explained that the impact of this was a deterioration of minor injury or illness, such as remembering to take prescribed medications, recovery from infection, or increased feeling of homesickness. Research participants explained that the combination of existing risks to health and existing health needs without effective and efficient intervention caused the need for PFC to be provided. Research participants also explained that d to the unexpected extended duration of PFC being required, more challenges arose for them to overcome – some felt unprepared to manage these challenges.

- Unprepared to manage challenges

During the open coding process, it was identified from the evidence shared by research participants that each remote environment had unique challenges.

The unique challenges experienced by research participants were also unique for evidence shared by other research participant who had experience in similar environments. One example is at altitude. The conditions experienced by the research participants with experience of PFC at altitude were all individually unique, despite all of them being in a relatively similar environment. Thus, the evidence suggests that challenges are relative to the time, place, and people in the remote environment.

A cause of PFC being required in remote environments was occasions where research participants felt unprepared to manage the multiple challenges that they experienced. Some examples from open coding concepts included, “long distance from health services and systems,” and, “no specific PFC training.” Research participants reiterated that often challenges are unpredictable; however, they also advocated that, “planning ahead for the unexpected,” by having, “plan A, B, C,” helped they to mitigate risks to health that they experienced. In context, research participants explained that it is difficult to determine how changeable the conditions are in a remote environment; however, in preparation for PFC it can be planned that environmental climatic hazards can cause severe delays to evacuations. In this circumstance, PFC can be prepared to last for the likely duration of a worst-case delay. Without planning for this was identified as a vulnerability by research participants.

- Vulnerability to environmental climatic hazard

It was common in the vignettes provided by the research participants to explain that there were many environmental climatic hazards. Examples included, “environment – altitude,” and “weather risks.” It follows that research participants advocated that, “vulnerability to natural hazards are risks to health.” This advocation was based on their experiences of their team not being sufficiently prepared to manage environmental climatic hazard, or, in other words, the severe conditions that were experienced in remote environments. This research did not aim to define all eventualities and vulnerabilities in remote environments. Rather, through axial coding it is identified that a cause of PFC being required is vulnerability to environmental climatic hazards. Thus, PFC is more likely required if the team are vulnerable to environmental climatic hazards by not having sufficient personal protective equipment (clothing, for example) for the time spend in remote environments and a possible unexpected delay.

- Vulnerability to circumstantial hazard

Similarly to environmental climatic hazards vulnerability are vulnerability to circumstantial hazards. The activities that research participants were participating in while in remote environments varied between military deployment for conflict or humanitarian response, or civilian employment (including voluntary work). A common open coding concept was the, “activity has influence of health.” In context, experiences shared by research participants included providing health care as part of military or civilian deployment for humanitarian response. They explained that there were environmental climatic hazards in addition to the hazards associated with their activities, such as geopolitics or insurgents. The research participants explained that they were vulnerable to these risks. Furthermore, in relation to the extended exposure to risk cause, the longer they were in the remote environment, the greater risks they experienced. Thus, vulnerability to circumstantial hazards was identified as another cause of PFC in remote environments. It follows that the next axial coding category presented are the contexts that PFC was required in remote environments.

7.3.3.2 Contexts

The previous axial coding category of causes identified the triggers of PFC in remote environments, based on the evidence provided by the research participants. The contexts that PFC was provided in requires critical appraisal, which was achieved through axial coding. The contexts of PFC identify and explain the circumstances surrounding PFC provision in remote environments, and how risks to health are mitigated to protect and promote health. The first context that was identified through axial coding was atypical clinical practice.

- Atypical clinical practice

The axial coding context of atypical clinical practice explains that the context PFC is provided in – a remote environment – is distinctly different in comparison to research participant's usual environment that health care is provided in. Furthermore, linking with the causes axial code, PFC is provided in the atypical places for extended durations, which adds to the challenges of atypical clinical practice. Some features of atypical practice that were identified during axial coding align with the findings of the literature review and concept analysis of this research. Open coding concepts that were in alignment with these findings are, (1) "health service that was next available had limited resources," (2) "minimal resources," (3) "single points of failure = logistics, communication, circumstance, environment," and (4) evacuation possible but delayed." These defining characteristics of a remote environment that demands atypical clinical practice from PFC providers is important to have awareness of to have strategies to manage the associated challenges.

Research participants shared strategies that they developed and, when training others in PFC, shared with others to manage the challenges of atypical clinical practice. For example, one open coding concept included in contexts axial code was, "PFC can apply to urban environments that have limited access to health services and resources." Research participants explained that the geographical remoteness is not the defining feature of being remote, but the contextual risks and challenges. A related open coding concept was, "health needs surpassed what resources were available." An open coding concepts that is related to strategies within the context axial code include, "resupply of kit not an option so sustainable use of resources." Thus, the atypical clinical practice context axial code includes the adaptive and intuitive approach to clinical practice that research participants had while in remote environments to provide PFC and mitigate risks to health. To do so, they needed to have an awareness of the risks to health.

- Awareness of risks to health

Two causes axial codes relate to the context axial code of awareness of risks to health – vulnerability to environmental climatic hazard and circumstantial hazard. Within the context of providing PFC in remote environments, research participants identified what risks to health patients and their team members were vulnerable to. Some open coding concepts included in this context axial code were, “geopolitics can be a risk to health,” “restricted airspace,” and “transport limited.” These open coding concepts provide evidence of the multiple risks to health that PFC providers were mitigating to protect and promote health. Thus, a key point that research participants emphasised was identified by the open coding concept, “multiple risks and challenges to manage.” It follows that having awareness of these risks and attuned to how they change overtime was essential to problem-solving to mitigate an escalation of these risks. An example that relates to another axial coding context is health services that were available had limited resources.

- Health service available but limited resources

Defining features of PFC in remote environments that has been identified are no access to health services, limited resources, and delayed evacuation. In the experience of research participants, evacuation was eventually possible; however, in some circumstances, the health services that patients were evacuated too did not have sufficient resources available. In other words, even when evacuation from the remote environment is possible, the health needs of the patient may still outweigh the resources available there. An open coding concept providing evidence for this is, “no immediate access to health services that would be needed to meet the patient’s health needs.” It is, therefore, important for PFC providers to define the scope of the health service that a patient could be evacuated to and determine if the evacuation protects and promotes their health. Furthermore, evacuating to health services with limited resources applies additional pressure at the expense of local communities who similarly rely on these services. Thus, PFC providers were required to critically think about the impacts of their PFC decision-making for the patient, their team, and local communities. In many circumstances, however, evacuation was not possible and, therefore, there was no access to health services.

- No access to health service

Due to the environmental and circumstantial hazards in remote environments, research participants reported that often they has no access to health services even if they could be evacuated. Open coding concepts such as, "weather risk," provided evidence that the context PFC was provided in meant that evacuation to health services was impossible due to extreme environmental hazards. Another open coding concept that accurately represents the context is, "covert of clandestine reasons for deployment." In context, this meant that the team deployed to the remote environment could not access the health services because of sensitive geopolitical reasons. As a result, accessing the health services would have dramatically increased the risks to health with, possibly, fatal consequences. This is an example of circumstantial hazards that provides evidence of the context PFC was provided in. Awareness of the reasons there was no access to health services informs the risk mitigation strategies that research participants had to develop while in remote environments. As reiterated by research participants, preparing for these contexts, such as through training, would contribute to mitigating risks to health.

- Specific training for environment/circumstances

As critically appraised in the open coding section of this chapter, based on the research participant's experiences, PFC training took place pre-deployment or while in the remote environment (see 7.3.2.9). During axial coding, it was identified that training for PFC, before or during deployment, is included in the context of PFC in remote environments. In other words, the action of providing PFC in remote environments identifies and evokes lessons learned about PFC mitigating risks to health. Evidence from open coding contexts included in the axial category of context includes, "PFC training need," and "inappropriate equipment if not experienced/trained in PFC." These open coding concepts highlight that even when PFC providers are trained before deploying to a remote environment, they still learn how to improve their practice to protect and promote health. Rationale that explains why includes the dynamic nature of remote environments; namely, the everchanging environmental and circumstantial hazards that require critical thinking to manage challenges and problem-solving. Evidence to support this notion includes the open coding concept of, “no two PFC are the same.” Thus, training for specific environments and circumstances is necessary to contribute to risk mitigation; however, learning from practice experience still takes place. Research participant advocated a life-long approach to learning about PFC in remote environments to increase their feeling of being prepared to sufficiently meet their team member’s health needs.

- Sufficient capability of PFC for person-centred health needs

Research participants emphasised that having sufficient capability of PFC to meet the health needs of patients in remote environments determined how vulnerable they were to the environmental and circumstantial hazards. Furthermore, they highlighted that every situation is different, including the health needs experienced by patients. In other words, having a person-centred approach to PFC enabled the research participants to enhance their risk mitigation strategies. Open coding concepts included within this axial coding category were, “PFC capability = providing continuity of care,” “PFC is when you adjust your health care due to deviation from expectation of care,” and, “PFC provider needs to be able to provide interdisciplinary care.” In the context of a remote environment, evidence suggests that providing PFC includes being able to adapt and overcome challenges to provide person-centred care. To do so, PFC providers need to be able to provide care that (in their ‘usual’ place of work) may be provided by another healthcare professional. Defining the scope, or, capabilities of what PFC can be provided within the remote environment to meet the person-centred health needs of the team, therefore, determine how risks can be mitigated. However, research participant acknowledged that having awareness of the person-centred health needs required them to approach PFC from various perspectives.

- Understanding person-centred health needs

Research participant’s backgrounds included being a registered healthcare practitioner; therefore, their ‘usual’ working environment meant they approached patient care from the perspective of their professional background. (For example, doctors focus on medical care, whereas paramedics focus on prehospital care.) Research participants highlighted that in their experience they needed to think critically about their approach to PFC to ensure all health needs were met; that is, they needed to understand person-centred health needs. Open coding concepts providing evidence for this axial category include, “physical health affects mental health and vice versa,” “health needs outside of clinical expertise,” and, “holistic care, as well as enhanced care.” In addition, research participant advocated that understanding, “local cultural practice and influences of health,” was also important to inform critical thinking about strategies to mitigate risks to health. A contextual example is a local community not being set up to provide mental health care, only physical health care. By having awareness of these challenges, requests for evacuation to another health service can be action earlier within PFC. However, this requires familiarity with the environment and circumstance that team members were in.

- Unfamiliar environment/circumstances

The remote environments that research participants were deployed to were often unfamiliar. This was because they had not been there before, or the environment or circumstances were different. Research participants highlighted that some challenges can be planned for, as identified by the open coding concept, “different culture – food, language.” However, some aspects of the environment or circumstances were not prepared for; namely, unexpected delays to evacuation. Thus, “remote ≠ physical distance only,” and, “remote environment = lack of logistics and communication with supervision,” were open coding concepts that were included in this axial coding category. The salient point that research participants made was to prepare for likely unfamiliarity, and to have capability of PFC build into the deployment plan to protect and promote health while in a remote environment. This approach ties into the axial coding category of strategies that were identified during this stage of grounded theory data analysis.

7.3.3.3 Strategies

The cause and context axial coding categories have provided evidence of what constitutes PFC in remote environments, with some suggestions of how risks to health were mitigated. The axial coding category of strategies, however, provides explicit evidence of how research participants used PFC to mitigate risks to health in remote environments. The impact of these risk mitigation strategies was to protect and promote health, which is critically apprised in the last axial coding category of consequences. The components of the strategy category are constructed by the analysis of open coding concepts, similarly to the causes and context categories. It is important to reiterate that the emerging PFC grounded theory should prescribe what PFC should or should not be implemented in remote environments. Rather, the emerging PFC grounded theory explains how PFC can be used in remote environments to mitigate risks to health. The components of the strategies categories are critically appraised in this section, beginning with autonomous PFC decision-making.

- Autonomous PFC decision-making

The evidence collected during the semi-structured interviews suggests that a unique feature of PFC in remote environments is autonomous decision-making. Open coding concepts such as, “remote clinical supervision for advice,” suggested that telecommunication was an option in some circumstances. It was suggested that communication with a clinical supervisor contributed to risk mitigation; however, often the communication failed. Research participants advocated that they needed to be prepared to, “be familiar with the unfamiliar,” and have, “autonomous clinical decision-making and practice,” to provide the continuity of PFC. In other words, they explained that relying on always having access to a clinical supervisor via telecommunications was a vulnerability; therefore, their risk mitigation strategy was to prepare for making PFC decisions autonomously. This included, “resource management,” and, “sustainable kit management based on capability to meet likely health needs.” It follows that another strategy for risk mitigation was to define the scope of PFC capability.

- Define scope of PFC capability

A strategy that research participants used to mitigate risks to health was to define the scope of PFC that could be provided while in a remote environment. Research participants advocated that as part of the pre-deployment preparation and training, defining the scope of PFC enabled them to prepare for the unforeseeable challenges and risks to health they experienced. For example, itemising, “in x-environment, doing y-activity, treating z-health needs to a high standard,” was an open coding concept included in this axial coding strategy. This open coding concept was allocated to data where research participants critically thought about the risks associated with x, y, and z. It can be noted that they used their, “critical thinking about influences of health, resources, clinical decision-making,” to provide, “care until evacuation, resupply, or recovery.” By plotting the likely risks, challenges, and eventualities beforehand, the PFC research participants provided evidence of having a system in place that could be applied to the most-likely PFC scenarios. Thus, defining the scope of their PFC capability informed their dynamic risk mitigation and management interventions while in the remote environment. Furthermore, this approach defined the limits of PFC capability, which similarly enabled the research participants to foresee when they could access health services, run out of resources, and where the next opportunity for evacuation was. It follows that another strategy research participants use was to educate stakeholders about the defined scope of PFC capability.

- Educate stakeholders

In the experience of the research participants, stakeholders were identified as anyone directly or indirectly involved or impacted by someone requiring PFC in a remote environment. Educating stakeholders was identified as a strategy for risk reduction because it increased awareness of the risks and how to mitigate or manage them. Relevant open coding concepts included, “need to maintain currency,” “pre-deployment training of team for likely situations,” and, “clear, concise, and effective record keeping.” Research participants explained that ensuring their PFC knowledge and skills was current is evidently important for risk mitigations; however, so was team members. By educating them about PFC, more people were enabled to provide PFC and mitigate risks to health.

Furthermore, the need for documentation and record keeping was highlighted as an indirectly educating stakeholders who in the future could be providing PFC in remote environments. This aligns with bridging the research gap of not having enough research in this area. It was also highlighted that educating stakeholders about the defined scope of PFC capability consolidated the risk mitigation strategy so everyone knew what PFC could and could not be provided in realistic scenarios. Thus, related to the topic of educating stakeholders is to have strategies in place to mitigate risks, manage challenges, and provider person-centred care while in remote environments.

- Have strategies to mitigate risks, manage challenges, and provide person-centred care

It was evident through axial coding that strategies were an integral tool to how research participants used PFC in remote environments to mitigate risks to health. Examples of open coding concepts include, "Self – Team – Others," "rota to ensure team health needs are met," and, "pack enough equipment for 24 hours for a 4-hoiur deployment." The salient point that research participants highlighted was to extend the scope of PFC as much as needed to meet the health needs of team members in a remote environment in the event the duration was extended. Having these coping mechanisms enabled the research participants to mitigate risks, manage challenges, and provide person-centred care. It follows that they highlighted planning for exact eventualities is nearly impossible due to the dynamic nature of the environment and circumstance; however, having these strategies and being enabled to implement them proactively and reactively contributed to risk mitigation.

- Proactive and reactive PFC

A key aspect of PFC mitigating risks to health that was identified by research participants was being proactive and reactive. In context, this meant that when research participants needed to provide PFC in remote environments, they need to mitigate risks to health before they caused illness and injury, and they needed to mitigate the risk of illness and injury becoming worse. Thus, their strategy for PFC risk mitigation was identified by open coding concepts such as, “daily health clinicals to monitor health needs and mitigate risks to health,” and, “promote and protect health.” The evidence suggests that strategy category of proactive and reactive PFC is a critical thinking approach, rather than a prescription of what interventions to apply in practice in every eventually. Research participants highlights that this was an unsafe approach to PFC due to the everchanging environmental and circumstantial challenges. Rather, it was emphasised that a more effective risk mitigation strategy in addition to the proactive and reactive approach was training.

- Train for specific risks to health, challenges, activities, environments, and likely health needs

Training was reiterated by research participants as an essential tool to enable PFC to be provided and mitigate risk to health. As previously noted, training was described as taking place during pre-deployment and while in the remote environment. Open coding concepts such as, “relevant training/experiences to activities in remote environments,” and “high-fidelity simulation training = preparedness,” suggests that the more realistic training is compared with the remote environment, the more prepared research participants were to mitigate risks to health. With the addition of the opening coding concept, “self-reflection and awareness of PFC capability,” identifying evidence that suggests research participants also engaged in learning about PFC afterwards. Furthermore, the open coding concept, “be trained and experienced so you can train others,” suggests that training other PFC providers about how to mitigate risks to health in remote environments was important to the research participants. It can be noted that there is a training cycle that research participants used to identify and improve how PFC was applied in practice to mitigate risks to health. Thus, the final axial coding category to critically appraise is the consequences of PFC in remote environments.

7.3.3.4 Consequences

The axial coding category of consequences explains the impacts of PFC provision in remote environments. Critically appraising the consequences completes the categorisation of the conceptual influences of PFC in remote environments. This research was an investigation of how PFC mitigates risks to health and the axial coding analysis of the data suggested that the consequence of PFC provided by all research participants was a reduction of risk.

- Mitigates risks to health

The data collected from the research participants unanimously provided evidence that the PFC they provided mitigated the risks to health. The open coding concept, “mitigate further risks to health,” included proactive interventions that mitigated risks to health causing illness or injury, and reactive interventions that mitigated the risks to health that could have made illness and injury worse. Research participants emphasised that it was not one intervention that caused the consequence of risk mitigation but a holistic approach to PFC being utilised in remote environments. In other words, research participants advocated that a bespoke approach to the environment they were in, and the activities they were doing, within the circumstances they experienced, resulted in risk mitigation. Thus, this evidence suggests that a universal approach to mitigating risks to health in a remote environment does not exist. There was no evidence on the contrary that suggested the PFC research participants provided led to an increase or had no impact on risk mitigation. It can be noted, therefore, that effective and efficient PFC provision in remote environments, which is bespoke to the situation, mitigates risks by protecting or promoting health.

7.3.4 Selective codes

Selective coding is the final stage of grounded theory data analysis. The aim is to achieve conceptual profundity and comprehension (Corbin and Strauss, 2015). The categories from axial coding are assimilated into a conditional matrix that displays the network of fundamental variables of the developing theory on micro and macro levels (Flick, 2018). In other words, the conditional matrix holds the core components of the theory that can be traced back to individual concepts that were produced from open coding. Thus, when theoretical saturation is achieved, the emergent theory is clearly grounded in evidence (Hall and Callery, 2001). It is important to note that the memo-writings capture how selective coding and the conditional matrix leads to the PFC grounded theory emergence. In Straussian grounded theory, selective coding involves identifying the chronology of axial coding categories. The findings provides a rigorous conceptual understanding of how PFC was used by the research participant in remote environments to mitigate risks to health.

The components of the selective coding conditional matrix are similarly identified by being presented as bullet points. They are presented in chronological order, according to the research participants experience. In other words, the constitute data of the conditional matrix (axial coding categories and open coding concepts) are presented in order of how research participants used them (that is, their experiences) in remote environments to mitigate risks to health. In addition, the condition matrix is presented in Table 13 and is mapped with the axial coding categories. Overall, it is important to note that the vast majority of PFC that was used to mitigate risks to health took place before it was required in a remote environment, which began with defining the vulnerability to hazards.

- Define vulnerability to hazards

The first intervention that research participants made when using PFC to mitigate risks to health in remote environments was to define the vulnerability to hazards. Research participants advocated that gathering as much intelligence about the environment and the common hazards that exits there was an essential first step. Furthermore, in their experience, they identified the hazards as early as possible before deploying to the remote environment. The research participants explained that the hazards were environmental and circumstantial (mostly related to climatic injuries). It was emphasised that every remote environment, and every time it was visited, the hazards were different. As a result, defining the hazards and the vulnerabilities to those hazards every time was essential.

Once the hazards were identified, the vulnerability to those hazards was assessed. The severity of environmental and circumstantial hazards, and the team's vulnerability to them, could be assessed. One example was deployment to the polar regions in the summer compared with the winter has the same environmental climatic hazard but at different severity levels. However, the research participants explained that unfamiliar environments and circumstances increased vulnerability to hazards. Preparing for unknown hazards meant some hazard may cause a risk to the team without them having awareness until there arrived. Thus, unknown hazards increased the risks to health because the PFC capability may not be sufficient to manage those hazards. It follows that risks to health were next identified.

- Define environmental and circumstantial risks to health

Once the vulnerabilities to hazards were identified, the environmental and circumstantial risks to health were outlined. Research participants explained that hazards were something that could cause injury or illness, whereas risks to health were how likely the hazard would cause injury or illness and how severe this would be. Having awareness of the risks to health enabled the research participants to prepare for the risks; therefore, reducing their vulnerability to the hazards they had identified. Research participants highlighted that extended exposure to hazards also increased risks. In the experience of the research participants, longer durations were caused by unforeseeable events such as changes to the environmental and circumstantial hazards. The evidence suggests that when this occurs, vulnerability to hazards and the risks to health increase. By outlining the hazard and risk landscape, PFC preparations could be assembled, including how health needs could be met in remote environments.

- Assess and record existing health needs of the team

Once the hazards and risks were identified, the research participants turned their attention to the team that they were deploying with. Research participants conducted a thorough assessment of the existing health needs team members had. They gathered information on how they usually met their health needs and analysed if the health needs could be met in the same way while in a remote environment. By doing so, it was identified how much health equipment would need to be taken, or what would need to be sourced while they were in a remote environment. Furthermore, what would happen to the health needs of the team if they were not met. In other words, if an unexpected hazard or risk prevent them from meeting their health needs in a remote environment, what would happen to them – that is, would they become ill or injured, therefore exacerbating the situation. By having this knowledge, research participants were able to understand how they could provide person-centred health care, which informed the scope of PFC capability.

- Define scope of PFC capability

Taking into consideration the dynamic nature of remote environments, and their associated hazards and risks, research participants next defined the scope of PFC capability. In context, research participants methodically planned all aspects of PFC relative to the environment that they were deploying to for defined activities. The decisions of what resources to bring, the telecommunication availability, the access to health services, and evacuation options were informed by the information gather in the first three steps of this conditional matrix. By scoping the PFC capability, research participants were able to determine what person-centred health needs and risks could be safely managed while in the remote environment for an extended duration and what could not. Furthermore, a strategy for proactive and reactive PFC could be devised for application to mitigate risks to health and respond to illness and injury that could deteriorate. The final stage was the PFC preparation.

- PFC preparation

The preparation for PFC was the stage that research participants implemented their strategies to mitigate risks to health while in a remote environment. It was acknowledged that being unprepared for unexpected challenges increased risks to health, particularly during extended exposure to the risks. To mitigate this, research participants engaged in high-fidelity training relative to the remote environment and the activities. In other words, they trained for specific risks to health, challenges, activities, environments, and the likely health needs. The training included realistic scenarios of PFC that could take place. By doing so, research participants developed strategies to mitigate risks and manage challenges to provide person-centred care.

It is important to note that up to this point, all actions by research participants to mitigate risks to health in remote environments took place before deployment. However, the PFC preparation stage of this condition matrix includes when the teams deployed to a remote environment. Training for PFC took place during time in the remote environment before illness and injury to equip team members with basic skills needed to implement PFC to mitigate risks to health. Furthermore, if PFC was required during deployment, this was clearly documented and reflected on to identify lessons learned of how PFC mitigates risks to health in remote environments.

Table 13 provides an overview of the selective coding conditional matrix, which is mapped with axial codes and axial coding categories. The final section of this chapter presented the PFC grounded theory.

Table 13 Selective coding conditional matrix

Axial codes	Axial coding category	Chronological conditional matrix
Causes	Vulnerability to circumstantial hazard	Define vulnerability to hazards
Causes	Vulnerability to environmental climatic injury hazard	
Contexts	Unfamiliar environment/circumstances	
Causes	Awareness of risks to health	Define environmental and circumstantial risks to health
Contexts	Extended exposure to risk	
Causes	Influence of existing health needs without appropriate care	Assess and record existing health needs of the team
Contexts	Understanding person-centred health needs	
Contexts	Atypical clinical practice	Define scope of PFC capability
Contexts	Health service available but limited resources	
Contexts	No access to health service	
Contexts	Sufficient capability of PFC for person-centred health needs	
Strategies	Autonomous PFC decision-making	
Strategies	Define scope of PFC capability	
Strategies	Proactive and reactive PFC	

Causes	Unprepared to manage challenges	PFC preparation
Contexts	Specific training for environment/circumstances	
Strategies	Educate stakeholders	
Strategies	Have strategies to mitigate risks, manage challenges, and provide person-centred care	
Strategies	Train for specific risks to health, challenges, activities, environments, and likely health needs	
Consequences	Mitigate risks to health	

7.3.5 PFC grounded theory

Theoretical saturation was achieved when no new components (from the list below) were identified through grounded theory data analysis, which included constant comparative analysis and memo-writing (see Figure 4):

- Open coding concepts.
- Axial coding categories.
- Selective coding conditional matrix additions.

New interpretations of the data could be identified by continuing grounded theory data analysis; however, new interpretations did not contribute to the emerging grounded theory (Mruck and Mey, 2007). Thus, at the point of theoretical saturation, the components of the PFC grounded theory (open coding concepts, axial coding categories, and selective coding conditional matrix) had been identified and the PFC grounded theory was assembled from the memo-writings. Figure 5 provides an illustration of the emergent PFC grounded theory, which is critically appraised in this section.

It is important to reiterate that the PFC grounded theory does not instruct what to do to mitigate risks to health in remote environments. Rather, the PFC grounded theory informs people (clinicians, health service managers, and policy makers) how to think about risk mitigation. In other words, the PFC grounded theory provides an evidence-base explanation of how PFC is used in remote environments to mitigate risks to health. The PFC grounded theory has three stages, illustrated in Figure 5 by the foundation blocks.

The first stage to the PFC grounded theory is to map the hazards (including environmental and circumstantial hazards) and the risks to health landscape. The term landscape has been used to highlight that people are exposed to risks in remote environments continuously as they move through the literal landscape. Centrally to this stage is the notion that risks to health are relative. Figure 5 illustrates that risks are associated with time, place, person, and activity. These four dimensions to risk relate to the landscape term. In other words, risks are associated with the duration people spend in remote environments, with or without a team, doing specific activities.

The first stage of the PFC grounded theory does not list specific risks. This is due to the evidence collected from research participants which suggests that risks constantly change relative to time, place, person, and activity. The arrows illustrate the interconnection between these constituent risks. In context, this represents how risks to health can be exacerbated due the interrelation of risks that are associated with time, place, person, and activity. In other words, increasing the duration (time) in a hazardous remote environment (place), with a team or alone (person), and completing specific tasks (activities) increases the risks to health. It was highlighted by the research participants that risks can rarely be predicted, but these four dimensions of risk identify common sources.

The four dimensions of risk are based on evidence collected from research participants. The rationale for mapping the risk and hazard landscape can be traced back to research participant's advocation of needing to provide PFC that was bespoke to the time, place, person, activity they experienced. Thus, mapping the risks and hazards landscape enables the PFC grounded theory user to understand what risks require mitigation through PFC.

The findings of mapping the hazards and risks landscape are used for the second stage of the PFC grounded theory. The second phase requires the development of risk mitigation strategies, followed by a definition of the PFC capability. The risk mitigation strategies are bespoken to the hazard and risk mapping landscape, which reiterates the research participant's perspectives that risks are relative to time, place, person, and activity. Furthermore, the term 'strategies' is written in the plural to highlight that more than one strategy may be needed to mitigate risks due to the dynamic nature of environmental and circumstantial hazards. Once developed, the risk mitigation strategies determine the scope of PFC capability.

The primary aims of defining the scope of PFC capability is to determine how the identified risks can be mitigated within the limitations of time, place, person, and activity, and, moreover, what cannot be included. In context, the resources brought to a remote environment should be determined by (1) the hazards and risks, and (2) the reasonable worst-case scenario. Due to the unpredictability of environmental and circumstantial hazards, some scenarios cannot be foreseen, as advocated by research participants. Thus, having multiple risk reduction strategies increases the capability of PFC to mitigate risks to health.

The scope of PFC capability is determined by the hazards and risks to health mapping and the risk reduction strategies; however, research participants also advocated four other considerations. Based on the research participant's experience, the four considerations that should be included are:

- To problem-solve using critical-thinking.
- Identify proactive and reactive PFC.
- Autonomous decision-making.
- Person-centred care.

The four considerations inform the development of risk reduction strategies and the scope of PFC capability. Evidence shared by research participants suggests that these considerations, collectively, are integral for the effectiveness of the risk reduction strategies and PFC utilisation in remote environments. The considerations are interconnected to emphasise the significance of joined-up thinking. It was widely acknowledged by the research participants that there are multiple challenges in remote environments; therefore, they were required to problem-solve. In addition, they used critical thinking to problem-solving, or, in other words, make decisions based on the context they were experiencing. It was also evident that the PFC they provided was either proactive to mitigate risks to health before causing injury or illness, or reactive to mitigate the risk of illness and injury becoming worse.

The research participant's proactive PFC began before deployment to the remote environment; namely, developing the risk reduction strategies and defining the scope of PFC. Research participants proactively used PFC in the remote environment too. They protected and promoted health by intervening before illness and injury occurred. A common example was maintaining hand hygiene to mitigate the risk of infection. During situations where there was injury or illness, the reactive PFC that research participants gave was to mitigate the risks to health become more severe. In both proactive and reactive

PFC, research participants advocated that their approach was person-centred. In other words, the care they provided was specific to individual's health needs.

The third stage of the PFC grounded theory focuses on enhancing the risk mitigation strategies. The research participants achieved this through high-fidelity simulation training and documentation of lessons learnt. Similarly to stage two, the research participants experience provided evidence of four considerations:

- Training is based on the hazards and risks landscape.
- Test the risk mitigation strategies and PFC capability during realistic worst-case scenario scenarios.
- Educate stake holders about the risk mitigation strategies and scope of PFC capability.
- Accurately document lessons learned for future reference.

The research participants advocated that PFC pre-deployment training, and continued training while in remote environments, was vital to enhance the risk mitigation strategies. Basing the training on the hazards and risks landscape ensured that the PFC being provided, proactively or reactively, was bespoke to the time, place, person, and activity. Furthermore, high-fidelity simulation for pre-deployment training catalysed the development of risk mitigation strategies that research participants used to protect and promote health. Linking with high-fidelity simulation, testing the risk mitigation strategies and PFC capability during realistic worst-case scenarios also provided an opportunity for research participants to increase their preparedness for PFC provision.

Research participants explained that having risks mitigation strategies and defined PFC capability was important to protect and promote health; however, educating stakeholders was equally important. The research participants identified stakeholders are team members in remote environments, their loved ones, and locally- or home-based health service providers. Educating these stakeholders enabled everyone to understand what PFC could be provided to protect and promote health, and what could not be provided. Furthermore, education about self-care (of team members) contributed to the risk mitigation strategy. In other words, risk mitigation was not limited to one person but involved everyone. Thus, a single point of failure was removed, which could occur if the PFC provider became injured or ill.

The last consideration of stage 3 of the PFC grounded theory takes place during and after returning from a remote environment – documenting lessons learned for future consideration. Research participants highlighted that identifying lessons learned indirectly contributes to risk mitigation for future deployment. This aligns with the literature review of this research, which identified a substantial research gap in PFC to inform clinical practice and risk mitigation in remote environments. It was highlighted that documentation in remote environments can be difficult due to the demands of managing multiple challenges; however, accurately documenting lessons learned at the earliest opportunity achieves the same goal of contributing to future risk mitigation strategies and PFC capability preparation.

7.4 Summary

In this chapter the theoretical finding of this research have been presented and critically appraised. The theoretical finding of this research is the PFC grounded theory. To demonstrate that the emergent theory is grounded in empirical evidence, direct quotes have been provided in full and mapped with the open coding concepts, axial coding categories, and selective coding conditional matrix. The rationale for this presentation is to provide explicit evidence of how the PFC grounded theory has emerged from the data. Thus, this demonstrates the rigour and validity of the theoretical findings. The critical appraisal throughout this chapter defines the trustworthiness and applicability of the PFC grounded theory. The rigour and validity, trustworthiness, and applicability are measures of quality of this research that used a Straussian grounded theory approach.

The theoretical findings are critically discussed and synthesised with existing literature in Chapter 10. However, to ensure that this research is original and significant, the PFC grounded theory was tested methodologically and empirically. Testing a grounded theory goes beyond what Straussian grounded theory requires; however, pursuing these studies strengthens the trustworthiness and applicability of the findings by defining the theory scope of areas of focus for future research. The methods and findings of the methodological and empirical tests are presented in Chapter 8 and Chapter 9.

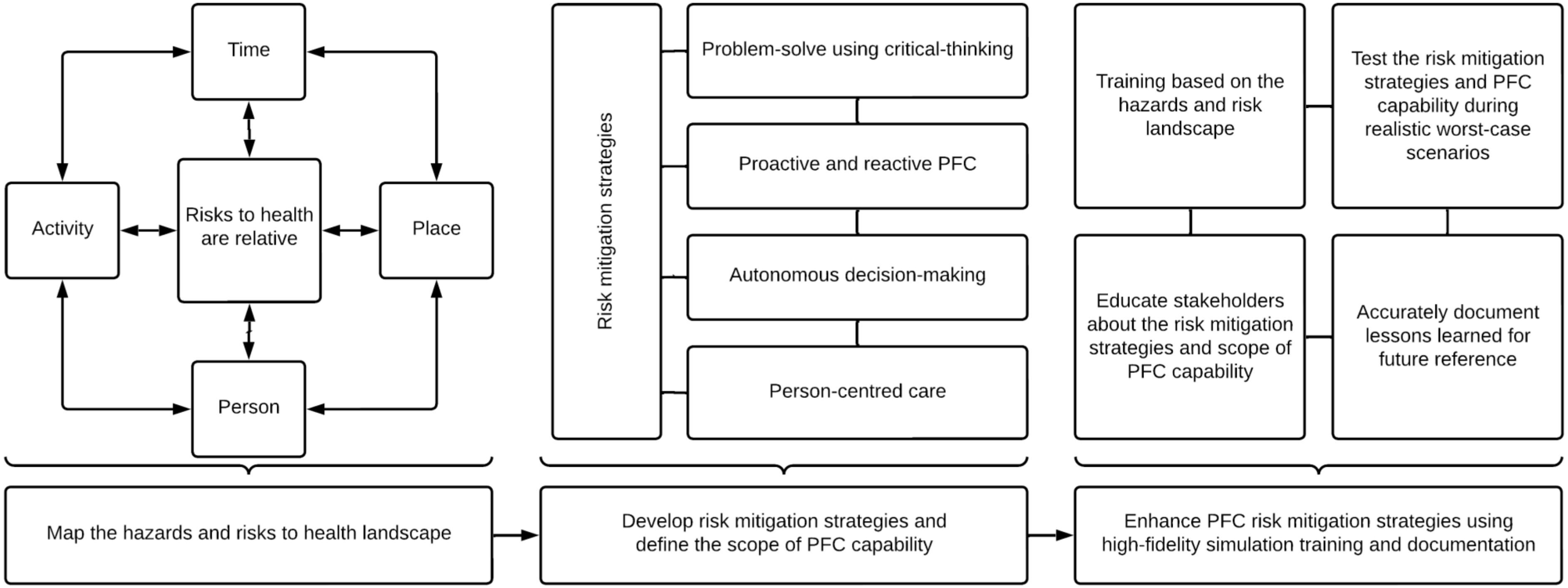

Figure 5 Prolonged field care grounded theory

Part III Methodological and empirical contributions

Chapter 8 Methodological testing

8.1 Introduction

The design of this research includes testing the PFC grounded theory methodologically and empirically. It is explained in grounded theory literature that theory testing is not required (Glaser, 1998, Glaser, 1992). The rationales for theory testing in this research are to ensure rigorously defining the scope of the PFC grounded theory, including the limitations, and develop evidenced-based considerations for future research (see 10.4). In this chapter, the methodological testing is presented and critically appraised.

To methodologically test the PFC grounded theory, a remote environment context was selected to conduct the test within. The rationale for selecting a remote environment context was to align with the methodology of this research. In other words, the philosophical landscape of this research is situated within a contextualism ontology, epistemology, and research methodology; therefore, conducting a methodological test within a defined context strengthens the validity and robustness of the test. The context that was selected to conduct the methodological test was space.

Space, as critically appraised in 3.3.2.4, is a remote environment that has similar challenges to PFC and risks to health mitigation – no access to services, limited resources, unreliable communication, and delayed evacuation. The context of space was selected to enable a methodological and empirical test of the PFC grounded theory. The methodological test consisted of designing an analogue mission that simulated the human exploration of space. The design of the analogue mission was informed by a symposium on space health and disaster risk reduction. The PFC grounded theory was tested within the analogue mission, thus enabling a methodological test of how the PFC grounded theory could be used to mitigate risks to health in a remote environment.

To conduct the methodological and empirical tests, ethical approval was applied for from UCL REC and the studies were registered with UCL Data

Protection Office. It was confirmed that the symposium was exempt from ethical review; however, registration with UCL Data Protection Office was required. The reference numbers are –

- Space health and disaster risk reduction symposium, UCL data protection office reference number: Z6364106/2021/03/36
- Analogue mission, UCL REC reference number: 17853/004, 17853/005
- Analogue mission, UCL data protection office reference number: Z6364106/2021/10/90

The findings of the methodological test and presented and critically appraised in this chapter, which leads into the empirical test that is included in Chapter 8. To begin, analogue missions are defined and critically appraised.

8.2 Critical appraisal of the analogue mission

Analogue missions[10] simulate defined aspects of space (Posselt et al., 2021). Parabolic flights are an example where an aircraft flies up into the atmosphere and down again very quickly to give those on board the experience of simulated zero gravity (Pagel and Choukèr, 2016). Alternatively, shipping containers have been used in some analogue missions to simulate the isolation and confinement experienced during long duration space flight (Häuplik-Meusburger et al., 2017). The longest isolation analogue mission was 6 analogue astronauts (participants) lived in shipping containers converted into an analogy of a spacecraft for over 500 days (Tafforin, 2015). Analogue missions, therefore, vary in what they simulate.

All analogue missions have different purposes, aims, and objectives. For example, analogue missions can take place to provide the experience of a (simulated) space mission, which can appeal to aspirant astronauts, space enthusiasts, or philanthropists who choose to financially invest in the development of human space exploration. Analogue missions are also used as training methods for career astronauts before they deploy on space

[10] Also referred to as 'analog missions' in some literature.

missions in orbit or to other planetary bodies (Groemer et al., 2014). Analogue missions can also be a field site for academic and industry research of space products, services, or technology (Zanardini et al., 2018). For this research, an analogue mission was designed to create a fieldwork site for to conduct the methodological test of the PFC grounded theory, and to evaluate if the UK could be used an analogue of space.

The next sections of this chapter outline and critically appraise the rigorous approach that was used to develop the analogue mission. The analogue mission simulated the human exploration of another planet, which had not been done in the UK previously. There were four phases of the analogue mission development – design, planning, deployment, and evaluation. The methodological test of the PFC grounded theory took place during the planning phase; however, all phases are critically appraised in this section to demonstrate transparency and originality.

Figure 6 and Figure 7 are photos from the remote island. The name of the island is protected to maintain the location a secrete for future analogue missions.

Figure 6 Aerial photo of analogue mission fieldwork site

Figure 7 Photo of analogue mission fieldwork site

8.2.1 Design phase

In the UK, there has never been an analogue mission that simulated the human exploration of another planet. There have been analogue missions to conduct research, such as in robotics development, and many UK nationals have participated in worldwide analogue missions (Groemer and Ozdemir, 2020). Thus, designing an analogue mission that simulated the human exploration of another planet for research purposes was a contribution to the originality of this research. To design the analogue mission, a symposium was organised by the researcher to theoretically explore health and risk mitigation during the human exploration of another planet.

The symposium theme was health in space and disaster risk reduction, and the aim was to establish a consensus on the provision of healthcare by an interdisciplinary healthcare practitioner during a deep space mission to another planetary body. A secondary aim was to explore how interdisciplinary healthcare practice in space can inform health risk reduction on Earth. To achieve these aims, the concept of human space exploration was examined from five perspectives:

- Space medicine
- Global and public health
- Planetary health systems
- Anthropology
- Disaster sciences.

The rationale for these perspectives is the symposium was funded by a successful grant application to UCL Global Challenge of Human Wellbeing. The five perspectives provided a holistic overview of ‘human wellbeing’ that aligns with the holistic interpretation of health that this research focuses on. Thus, the symposium was designed to be cross-disciplinary to explore how healthcare practices in space travel advance to mitigating risks to health in remote environments.

Theoretically exploring how healthcare practices in the remotest environment of space enabled the opportunity similarly explore health risk reduction in remote environments on Earth. The notions of healthcare during space exploration, however, brings into question the meaning and cultures of health, relative to remote environments. As outlined in 2.4, health, and health disparities, are relative the remote environments. Thus, exploring future healthcare practices and cultural understanding of health and risk in space from the five perspectives of health provided an opportunity to inform the design of a methodological test of the PFC grounded theory.

The symposium was structured so that the interrelation of each perspective could be explored within the context of PFC during the human exploration of another planet. Each perspective was the theme of a break-out session that was led by a representative from that specialty. The breakout room leads facilitated discussions between the symposium participants through semi-structured questions (see Appendix 10). The last activity of the symposium involved developing case studies of realistic healthcare scenarios during a space mission, which informed the design of the analogue mission.

252 people registered to attend the symposium, with people tuning in virtually from Australasia, Asia, Europe, and North America. Salient points of interest, from the perspective of the attendees, about breakout room discussions were captured via a MS Form. 74 people submitted a response to the semi-structured questions[11]. The semi-structured question relevant to this research[12] focused on what the symposium attendees thought would be realistic healthcare scenarios that could take place during the human exploration of another planet, based on the focus of the breakout rooms they attended. The symposium findings relating to the realistic health scenarios that could take place during the exploration of another planet, relevant to the breakout room specialities, are presented in Appendix 11. The direct quotes from the participants have similarly been provide in full to ensure authenticity.

The realistic health scenarios that could take place on another planet informed the decision of the case studies that would feature on the analogue mission.

[11] The statistical significance of how many people completed the questions is not relevant to this research due to the focus on qualitative data.
[12] The other questions are relevant to this research but not included because they do not contribute to the methodological test of the PFC grounded theory.

There were three case studies during which two health scenarios were enacted to enable research of healthcare practice during space exploration. The case studies and scenarios that were enacted are presented in Table 14. Each case study was designed to last for 8 hours, which is significantly longer in comparison to typical clinical simulation; therefore, prolonged care in space would be accurately simulated and the risks could be investigated (Cromwell et al., 2021).

The ‘patient’ for each scenario was acted by a volunteer. They were provided with guidance on how the patient they were simulating would be feeling and what clinical signs or symptoms they would have. During the case studies, a research assistant verbally provided physiological measurements when analogue astronauts conducted the measurement (for example, blood pressure) to ensure realistic physiology was simulated. Having a research assistant close by did limit the fidelity; however, simulating realistic physiology was more important to conduct this research.

Table 14 Analogue mission case studies

	Scenario 1	Scenario 2
Case study 1	**Patient A** Pelvic fracture – caring for an immobile patient	**Patient B** Anxiety and panic attacks – feeling homesick
Case study 2	**Patient C** Gastroenteritis (vomiting and diarrhoea) – dehydration and infection control	**Patient D** Abdominal-bleed, leading to cardiac arrest and death – end of life care
Case study 3	**Patient E** Sprained ankle – pain management (astropharmacy)	**Patient F** Pneumothorax – surgical intervention (astrosurgery)

In addition to the methodological test of the PFC grounded theory, the analogue mission enabled a programme of research to investigate a variety of space health practices. This programme of research was used to evaluate if the UK could be used as an analogy of another planet. All studies within the programme of research were included in the UCL REC approval and Data Protection Office registration (see 8.1 for the reference numbers). The studies within the programme of research included:

- Anthropology to investigate the interrelations between health and land.
- Anthropology of space enthusiasm.
- Astropharmacy, the use of medicines in space.
- Astrosurgery, clinical decision-making about surgical intervention.
- Medical anthropology to explore notions of ‘normal health’ off-world.
- Testing remote health technology that monitored heart rate variability.
- The synthesis of art and science by an artist-in-residence.

The research participants were known as analogue astronauts. The eligibility criteria of the analogue astronauts was being a registered or non-registered health care provider (first aider) with experience of PFC in remote environments. These eligibility criteria align with the eligibility criteria for the participants for the grounded theory study of this research (see 6.4.1.3).

A total of twenty-eight people applied to become an analogue astronaut. 40% identified as male verses 60% female. In comparison with the 2021 call for European Astronauts, interestingly 24% of (round one) applications identified as female verses 76% identified as male (European Space Agency, 2022). Six analogue astronauts were selected for the analogue mission, which is a standard number of astronauts for analogue missions (Klicker et al., 2023).

All analogue astronauts had health care backgrounds and experience in remote environments; however, pre-deployment training in PFC was provided for them. This enabled them to have a standardised level of training relevant to the environment they were being sent to. The PFC training focused on PFC within civilian remote environments, and it was highlighted that the analogue astronauts would be required to think critically about how to apply the PFC training to an off-world environment. The provision of training in this way mirrors the requirements of PFC providers being training in the subject of PFC but needing to adapt their practice to be appropriate for the environment they are sent to and for the activities that take place there. The pre-deployment PFC training was provided by R2Ri, and took place in Snowdonia National Park, Wales – a mountain region of the UK, with similar conditions to the location of the analogue mission.

During the design phase of the analogue mission, it was discussed how to increase the simulation fidelity (realism) of being on another planet; therefore, increasing the reliability of the research programme findings. Thus, a remote and uninhabited Scottish island was purposefully selected as an appropriate fieldwork site due to:

- There being no health services.
- Resources were limited to what could be carried.
- Communication was unreliable.
- The West Coast of Scotland provides challenging weather conditions that could delay evacuation.

The purposeful selection of this island was due to the actual risk of being in an environment that has similarities to the human exploration of another planet. Being in Scotland, the island did not have the visual appearance of another planet; however, the design of the analogue mission did not require the analogue site to look like another planet but to feel like another planet. To achieve this, the analogue astronauts were not told the location of the island, which meant that when they arrived, they saw it for the first time. This simulated astronauts opening a rocket door and seeing another planet for the first time.

The geographic remoteness of the analogue mission field site was another rationale for the purposeful selection of the Scottish island. There is no landmass between the South-West shoreline of the island and Canada; therefore, weather systems gain momentum across the Atlantic and collide with the island. Harsh conditions occur on other planets; therefore, the environmental risks of this island geography contributed to the analogue mission fidelity.

Thus, the characteristics of the Scottish island align with the remote environment context that this research focuses on; therefore, the analogue mission design was an appropriate methodological test of the PFC grounded theory. To conduct the test, the PFC grounded theory was used in the planning phase of the analogue mission.

8.2.2 Planning phase

The planning phase of the analogue mission focused on organising the design into a deployable plan. A steering group was established, with members from each of the five symposium perspectives. To facilitate the planning phase, a working document was used to develop the design (based on the symposium findings) into the analogue mission plan. The working document was also used as the source of data for the methodological test of the PFC grounded theory.

For the methodological test included in this research, the PFC grounded theory was used by the researcher to plan how to mitigate risks to health during the analogue mission deployment. The research methods used to conduct the methodological test of the PFC grounded theory are outlined and critically appraised in 8.3. The PFC grounded theory informed how the researcher planned to mitigate risks to health during the analogue mission deployment. The impact of using the PFC grounded theory in this way was tested via the risk assessment and ethics review process at UCL. The findings are presented and critically appraised in 8.4. To provide sufficient detail about the analogue mission process, the deployment and evaluation phases are included in this chapter.

8.2.3 Deployment phase

After completing the analogue mission design and planning phases, the deployment phase focused on applying the analogue mission in practice to conduct the programme of research. Included in this programmes of research was the empirical test of the PFC grounded theory, which is presented and critically appraised in Chapter 9. On completion of the analogue mission, a deep-dive evaluation workshop was conducted to establish how accurately the analogue mission simulated the human exploration of another planet.

8.2.4 Evaluation phase

The aim of the analogue mission evaluation phase was to firstly determine if the UK could be used as an analogy of another planet and, secondly, establish how accurate the simulation was. Thus, the evaluation phase was an opportunity to rigorously develop considerations for future research and UK analogue missions. The evaluation was facilitated via a post-mission workshop that explored how accurate the analogue mission felt from the perspectives of the participants, and the efficacy of the analogue mission as a fieldwork site. The evaluation proved that the analogue mission successfully felt like the human exploration of another planet and all research was completed. This research does not focus on the evaluation of the analogue mission; therefore, the detailed findings are not included within this thesis. The research that is included within this thesis is the methodological test of the PFC grounded theory. The methods are outlined in the next section of this chapter.

8.3 Methods

The research methods used for the methodological test of the PFC grounded theory were selected to be aligned with the Straussian grounded theory approach. Having aligned research methods contributes to the robustness of this research; therefore, increasing the trustworthiness of the findings. For the methodological test of the PFC grounded theory, an autoethnographic approach was used to explore how the PFC grounded theory was utilised during the planning of the analogue mission. An autoethnographic approach was an appropriate method because the researcher that developed the PFC grounded theory conducted the autoethnographic approach study. In other words, a subject matter expert conducted the autoethnographic approach study to methodologically test the PFC grounded theory.

Autoethnographic approach is a qualitative research method that has three interrelating components – ‘auto’ meaning self, ‘ethno’ meaning culture, and ‘graphic’ meaning writing (Pace, 2016). Autoethnography approach must include all three components, or the resultant product consists of an autobiography or anthropology narrative. Autobiographies and anthropological narratives can make important contributions to literature and research, including cultural- and thought-development; however, the purpose of this study is to methodologically test the PFC grounded theory. Autoethnography approach is an appropriate research method for this study because it enables the connection of personal experiences with sociological practices to establish understanding of the research topic. Within the context of this study, the topic of research is the methodological test of the PFC grounded theory.

An autoethnographic approach was used for this study, which requires definition to clarify how pure autoethnographic was not used. Traditional autoethnography is a method used to explore the experience of wider sociological practices and culture to establish new understanding, knowledge, and insights (Charmaz and Mitchell, 2001). However, for this study, the focus of the autoethnography was to research the PFC grounded theory to test it methodologically. In other words, this study did not focus on wider sociological practices and culture but concentrated on how the PFC grounded theory informed the planning of the analogue mission to mitigate risks to health. Autoethnography enabled the use of reflexivity to explore the researcher’s experience of utilising the newly developed PFC grounded theory.

Autoethnography (and ethnography) is a method that is aligned with grounded theory, as it provides a systematic continuation of this research to methodologically test the PFC grounded theory (Timmermans and Tavory, 2007). The alignment is made due to the methodology and methods that were used for this autoethnographic study. Firstly, autoethnography is in juxtaposition to research with a realism ontology (see 5.2.1) and positive epistemology (see 5.2.2). When using autoethnography, the notions of pursing a singular, objectifiable truth of knowledge are rejected. The rejection is based on the embracement of relativist ontology (see 5.2.1) and subjective epistemology (see 5.2.2). In other words, autoethnography amplifies the significance of the researcher's experience as a source of data that, once analysed, makes original contributions to knowledge.

An obvious critique of autoethnography from a realism and positivist perspective is the influence of bias (namely researcher subjectivity) that leads to invalid results with 100% probability that the results occurred by chance (that is, a high p-value). This critique is correct; however, autoethnography, which is underpinned by relativism and subjectivity, means purposefully researching the experience of an individual researcher to produce findings that explain and lead to understanding of sociological applications of the research subject. It follows that attempting to quantify the experience of sociological phenomena produces results that do not thoroughly explain meaning or experience sociologically. An autoethnographic approach is a method used for this study to investigate and explore evocations of experience using the PFC grounded theory to plan the analogue mission. The systematic continuity of research methods used during the grounded theory study result in valid and substantial contributions to knowledge.

Conducting the methodological test using autoethnographic approach increases the potential for confirmation bias to be introduced to this study, particularly because the researcher developed the PFC grounded theory. The reason for this potential is the study is conducted by the researcher who developed the PFC grounded theory; therefore, there is a risk that preferential biases may influence the methodological test of the PFC grounded theory. To mitigate the potential introduction of confirmation bias, this study could have been conducted by an independent researcher. While this approach controls the influence of confirmation bias, this research is limited to the timeline of a PhD (3 years). For an independent researcher to test the PFC grounded theory methodologically, they would (1) need time to become familiar with the content, (2) select an appropriate context for the methodological test (for example, military deployment or a civilian expedition to Antarctic), (3) conduct the methodological research, and (4) complete the analyses and write the findings. By the researcher completing this study, step (1) was already completed and, furthermore, the researcher had detailed knowledge of the PFC grounded theory. Detailed knowledge of the PFC grounded theory enabled a rigorous methodological assessment and ensured this study could be completed within the timeframe of a PhD.

8.3.1 Data collection

The continuity of research from grounded theory to autoethnography is achieved by the use of memo-writing as the autoethnographic data collections method. In autoethnography, data collection methods are collectively written fieldnotes; however, as this a methodological study, the 'field site' was the planning phase of the analogue mission. Similarly to fieldnotes, the memo-writings recorded the researcher experiences of using the PFC grounded theory to inform the planning of the analogue mission. In pure autoethnography literature, researcher experiences about the research topic can include thoughts, feelings, or emotions (Ellingson and Ellis, 2008). This study uses an autoethnographic approach; thus, the memo-writings focused on how the PFC grounded theory informed the planning of the analogue mission to mitigate risks to health. Memo-writing was conducted whenever new experiences or thoughts were identified as relevant to the methodological test of the PFC grounded theory.

In pure autoethnography, visual-audio materials are used to record experiences, which can be used as a reference of the researcher's experiences. Writing a narrative or diary can provide a rich data source; however, these materials are not limited to writings. Rather, autoethnographic can include visual and audio data materials in the form of photos, video recordings, or artwork that are used to accurately record the researcher's experience (White, 2003). In pure autoethnography, collating a diverse set of materials is necessary to explore, investigate, and build connections between the researcher's experience of sociological phenomena (Klenke, 2016). This study uses an autoethnographic approach, because the focus is on the methodological test of the PFC grounded theory; therefore, the materials that were the working group document. This document was a live document, meaning it was updated as the plan for the analogue mission were developed.

8.3.2 Data analysis

The working group document provided a source of material to evoke experiences of utilising the PFC grounded theory to mitigate risks to health in the planning of the analogue mission, which were recorded in memo writing. To analyse the memo-writings (the data), an autoethnographic approach was utilised by a similar data analysis method but not the same that was used during the grounded theory (see 6.4.3). In pure autoethnography, thematic analysis is most commonly used to analyse fieldnotes (the data) (White, 2003). This autoethnographic study was designed to have continuity with the grounded theory study used to develop the PFC grounded theory. The rationale to have continuity with the grounded theory study is to strengthen the robustness of the research. It is important to note, however, that using the same data analysis methods that were used (grounded theory data analysis – open, axial, and selective coding) would be an inappropriate data analysis method to use. Grounded theory data analysis is only utilised when the overall research method is grounded theory; that is, the end product being a grounded theory (Corbin and Strauss, 2015). The utilisation of grounded theory data analysis for this study, which uses an autoethnographic approach, would be inappropriate. However, to ensure the research continuity, a similar but appropriate data analysis method was decided.

For the methodological test of the PFC grounded theory, the data analysis method used was a reflexive thematic analysis approach. Thematic analysis is utilised for pure autoethnographic studies, which echoes grounded theory data analysis methods (Pace, 2016). Both data analysis methods utilise coding; however, in grounded theory data analysis, open, axial, and selective coding, steered by theoretical sensitivity, are used to rigorously create a theory grounded in empirical evidence (Glaser, 1992). Reflexive thematic analysis, however, uses a coding process to identify themes within the data set, then associate common themes to distil the research findings (Braun and Clarke, 2021).

For thematic analysis, there is one stage of coding, whereas in grounded theory data analysis (Straussian) there are three stages – open, axial, and selective coding (Corbin and Strauss, 2015). It could be argued that grounded theory data analysis is more rigorous in comparison to thematic analysis; however, this is not a fair critique. The end products (findings) of each research and data analysis method are different – to investigate themes or establish an evidence-based grounded theory; therefore, one is not better than the other. One is more suitable in comparison to the other depending on the research question. For this study, a reflexive thematic analysis approach was deemed as the most appropriate data analysis method to test the PFC grounded theory methodologically.

Using a reflexive thematic analysis approach enabled the identification and analysis of recursive themes within the data from the perspective of the researcher (Braun and Clarke, 2006). A reflexive thematic analysis approach was similarly used in the literature review and concept analysis of this research; therefore, adopting a reflexive thematic analysis approach provides continuity and strengthens the overall robustness. In comparison with thematic analysis, the salient difference is the emphasis on the researcher's perspective (Braun and Clarke, 2019). Emphasis on the researcher's perspective makes using a reflexive thematic analysis approach the most appropriate data analysis method for this study because it uses an autoethnographic approach. In other words, the autoethnographic approach embraces the experience of the research as a subjective matter expert in the research topic (the PFC grounded theory) and using a reflexive thematic analysis approach acknowledges the emphasis on the researcher's experience. Thus, the reflexive thematic analysis approach aligns with the ontological, epistemological, and methodological paradigms that this study has with an autoethnographic approach has.

Using a reflexive thematic analysis approach can be critiqued similarly to autoethnography. The emphasis on identifying the themes within a data set based on the researcher's experience can expose research findings to confirmation bias. Research findings that are based on the researcher's experience can be described as not generalisable because of the emphasis on the individual experience. What is relevant for the researcher conducting the study is likely to be relevant for one or more other people. Furthermore, the experience of the researcher may not be relevant to the research topic; therefore, their expertise may be immaterial to the themes within the data set. Within the context of this research, the reliance on the researcher's experience is paramount to the validity of this study – a methodological test of the PFC grounded theory using an autoethnographic approach.

Reflexive thematic analysis has many interpretations and approaches, which reflects how diverse this data analysis method is (Braun and Clarke, 2021). The adaptability of reflexive thematic analysis enables the method to be shaped to have a perfect alignment with the study design. The reflexive thematic analysis approach used for the empirical test of the PFC grounded theory study is similarly based on the original and updated reflexive thematic analysis method (see 3.2.2). The process of reflexive thematic analysis approach for this study, using an autoethnographic approach, is outlined in Table 15.

Table 15 Methodological test: reflexive thematic analysis approach

Stage		Action
1	Familiarisation	Immersion into the data about the methodological test of the PFC grounded theory.
2	Identification	Systematically document the themes identified within the data.
3	Reviewing	Assess the accuracy of identification and cross-check all themes for duplication.
4	Mapping	Map the themes to identify correlations or contradictions.
5	Refining	Continue reflexive thematic analysis to combine or separate themes for clarification.
6	Report	Critically appraise the themes and findings of the thematic analysis.

In the original reflexive thematic analysis method, it is advocated themes are the combination of codes that are allocated in step 2 (Braun and Clarke, 2006).

However, for this study, themes are recognised as individual concepts within the data – the memo writings, written on the working group document. The rationales for this deviation are, firstly, this approach begins thematic analysis at an earlier stage. The impact of this is the emergent findings are based on analysis of individual components of the data, rather than the combination of data before analysis, which risks the exclusion of data that may contribute to the methodological test of the PFC grounded theory. As a result, the findings of produced from this reflexive thematic analysis are grounded in the data, which provides continuity with the grounded theory method used to develop the PFC grounded theory. Thus, ensuring that all research study designs are as aligned as possible strengthens the overall robustness of this research. In addition, a final rationale for utilising reflexive thematic analysis is this method unlocks the tools required to engage with the data and rigorously analyse it to produce enriched, evidence-based findings on the methodological test of the PFC grounded theory.

As reflexive thematic analysis is conducted based on the experience, or within the context of this study, it is important to clarify the focus of the reflexive thematic analysis. The focus was on how the PFC grounded theory informed the planning of the analogue mission to mitigate risks to health. Using the working group document provided the materials to identify experiences of using the PFC grounded theory during the planning of the analogue mission to mitigate risks to health. The next sections include a critical appraisal of how the salient themes that were identified using the reflexive thematic analysis approach mitigated risks to health during the planning of the analogue mission.

8.4 Findings

In this section, the findings of the methodological test of the PFC grounded theory are presented and critically appraised. To present the findings clearly and effectively, this section is structured as per the salient themes that emerged from the data analysis. The raw data is not included in this chapter because the data collection and analysis methods have been explicitly outlined; however, the findings themes are mapped with the PFC grounded theory. Mapping the themes of findings with the PFC grounded theory is presented in a robust, critical narrative, which enables thorough appraisal of the findings. The three themes that emerged from the methodological test of the PFC grounded theory are risk assessment, ethics and data management, and emergency action plan. To reiterate, these themes are findings of how the PFC grounded theory informed the planning phase of the analogue mission, which focused on how risks to health could be mitigated on the island.

8.4.1 Risk assessment

The first theme that was identified was the need to conduct a risk assessment. Assessing risks was identified in the planning of the analogue mission. The design of the analogue mission was to simulate the human exploration of another planet. The island served as the analogy of another planetary body due to the geographical remoteness of the location that mean evacuation to a health service (such as a hospital) could be delayed due to the weather. Access to the island was only possible by a twelve-person powerboat, which limited the amount of resources that could be brought. Communication could be unreliable depending on phone signal, which compounded the risk of delayed evacuation if there was an injury or illness that required treatment outside the PFC capability. Thus, there were real risks to health of the analogue mission participants. The real exposure to risks increased the fidelity of the simulation because similar risks to health are experienced in space (Cromwell et al., 2021, Schlotman et al., 2019). All of these risks to health were identified during the design of the analogue mission, which required risk assessing and mitigation.

The PFC grounded theory informed the identification of risks to health during the planning process of the analogue mission. In addition to this, the identification of risks to health during the design strongly suggested that the island would enable the simulation of humankind exploring another planet – never before conducted in the UK. Thus, the PFC grounded theory contributed to the development of analogue research as a methodology, as well as informing the risk assessment process. The PFC grounded theory was paramount to identifying the risks to health and informing the decision-making of how the risks to health could be mitigated. The risks to health for the analogue mission were relative to:

- Time – the analogue mission took place in May (UK spring); therefore, there was a risk of spring storms from the Atlantic brought to the West Coast of Scotland by the jet stream.
- Place – the island was remote and uninhabited, with a diverse typography that has similarities with the surface of the Moon and Mars, which meant moving around on foot on the island was demanding.
- Person – the majority of people (researchers and analogue astronauts) were unfamiliar to the environment, meaning they were out of the comfort zones and at a high risk of injury due to the terrain.
- Activity – the activity that took place during the analogue mission was a programme of research in the established fieldwork site that involved surveying the simulated planet.

The PFC grounded theory informed the thought process of assessing the hazards and risks that analogue mission participants would be exposed to. A limitation of this process was the unpredictability of weather conditions on the West Coast of Scotland. However, the PFC grounded theory enabled the recognition that the weather conditions risk assessment required flexibility to accommodate poor weather. The impact of this informed the risk mitigation strategies.

The risk assessment informed the risk mitigation strategies for the analogue mission, which was underpinned by the PFC grounded theory. Firstly, the unpredictable weather conditions was mitigated by using critical-thinking to establish a plan A, B, and C for the deployment phase. For example, the powerboat had two options for landing, and the final option was to reattempt a landing after poor weather improved. This mitigated the risk of injury during the arrival to the island. The PFC capability was defined into proactive and reactive health care. Proactive interventions included a health and safety briefing, whereas reactive was having a designated first aider on standby at all times during the mission. The mountain leader and medical team had autonomy to pause or stop the simulation to manage an incident and provide person-centred care where required. These examples demonstrate how the PFC grounded theory informed the development of the risk mitigation strategies. An important distinguishment is the PFC grounded theory did not prescribe the strategies but evoked them based on the hazards and risk mapping.

The final contribution that the PFC grounded theory had to the risk assessment of the analogue mission was to enhance the risk mitigation strategy. The participants of the analogue mission were trained in PFC in a similar environment to the island. The environment was similar due to the overnight exercise in hillside terrain, during which the risk mitigation strategies were tested. A deviation from the PFC grounded theory, however, was the analogue astronauts developed their own risk mitigation strategies, in addition to the strategies already planned. This was due to them operating autonomously during the analogue mission. This deviation was a contribution to the health risks mitigation, which suggests that high-fidelity training is a tool that provided additional PFC capability by encouraging participants of the activity to have informed autonomy of PFC.

Educating stakeholders about the risk mitigation strategy and scope of PFC capability was tested by the risk assessment being submitted for review by UCL. The risk assessment, including the risk mitigation strategies, were approved after the first submission, which suggests that the risks were accurately assessed and mitigated. By extension, this suggests that the PFC grounded theory made valuable contributions to the process of risk assessment; however, this impact requires further systematic investigation to determine if this was an anomaly or not.

The lessons learned about how PFC was utilised during the analogue mission was completed; however, this features in the empirical test of the PFC grounded theory (see 9.3). The next theme that emerged from the methodological test was about ethics and data management, which is presented and critically appraised in the next section of this chapter.

8.4.2 Ethics and data management

During the planning phase of the analogue mission, it was identified that there are risks to health from the research being conducted. The risks to health from the research were ethical and data management. Any research has ethical considerations and as one of the activities to take place during the analogue mission was research, ethics was identified as a risk to health. The ethical considerations were relative to the individual studies that took place during the analogue mission. It follows that research has different severity of ethical risks, relative to the programme of research that is hosted.

The PFC grounded theory informed the decision-making of how ethical and data management risks could be mitigated. Both ethnical and data management risks could result in injury or illness; therefore, they can be described as risks to health. Relating to the PFC grounded theory, the activity conducted in the remote environment brings to the surface ethical and data management risks; that is, the activity is research. In comparison to exploratory expeditions or military deployment to a humanitarian crisis, research may also be conducted; however, research is unlikely to be the primary aim of the activity. Exploratory expeditions usually have geographical aims, whereas military deployment as part of a humanitarian response is focused on logistics and aid. That said, ethics and data management are still important considerations for these activities.

Exploratory, geographical expeditions may involve sample collection or speaking with local communities and humanitarian response may include documentation of the disaster impact. Both of these activities require ethical and data management consideration and, therefore, there are still risks to health despite the activity not being research. Thus, these examples exemplify how the PFC grounded theory can be applied to and inform decision-making for a variety of activities in remote environments. They also highlight that there are risks to health during activities in remote environments, therefore, an emergency action plan is required to manage incidents if they occur. The analogue mission also had an emergency action plan, which was informed by the PFC grounded theory.

As a result of conducting the research, new data (quantitative and qualitative) was collected. To use this data, informed consent was required from the research participants. To make an informed decision about whether to give their consent, the analogue astronauts (research participants) needed to be explained how their data would be managed and protected. The relevance of data and risks to health is the type of data that was being collected. Collectively, the studies that took place during the analogue mission focused on health during the human exploration of another planet. For example, data was collected about (1) physiological vital signs (for example, blood pressure, pulse rate, and respiratory rate) were collected to test newly developed remote health monitoring technology, and (2) observations of analogue astronaut's experiences of health in an unfamiliar environment. These examples of quantitative and qualitative data demonstrate that the data was linked to the analogue astronaut's health, and without rigorous management their data could negatively affect their health.

The analogue mission took place on a remote an uninhabited island in Scotland and, as aforementioned, the risks to health were real (despite the analogue mission simulating space exploration). Duty of care to the participants is an ethical issue that has was rigorously planned for through developing risk mitigation strategies. Thus, to mitigate risks to health, all research participants and researchers going to the island were required to complete pre-deployment training –

- PFC course by R2Ri, 2-days in-person at Plas-Y-Brenin, Eryri (Snowdonia) National Park, Wales.
- 'Baby It's Cold Outside' (BICO) Free Online Course to ensure the group is able to assess and protect themselves a remote mountainous environment.
- Health and safety briefing before the analogue mission and on arrival.

In addition to the pre-deployment training, the analogue mission plan clearly distinguished between what is simulated and what is in reality. A duty of care is required for all research participants and researchers in reality; thus, the analogue mission crew includes –

- 2 mountain leaders: qualified mountain leaders with first aid certification.
- 1 medical officer: qualified medical doctor with clinical experience in remote environments.

Mountain leaders are qualified to guide people in UK mountainous terrain and challenging conditions, who are registered with Mountain Training UK. The mountain leaders and medical officer had complete autonomy in health and safety decisions. This means they could pause or stop the analogue mission if there were any risks to health. Evacuation from the island, if required, would be via the same powerboat that brought all personnel to the island. An emergency vehicle was on standby at all times during the analogue mission to transport people to a hospital or public transport station, if required. Aeromedical evacuation would have been provided by the UK Coastguard, if required.

During the analogue mission, participants may have been reminded of previously challenging situations when they provided PFC in remote environments, which could have evoked anxiety or stress. It is important to note that participating in this research may have provided an opportunity to reflect of the provision of PFC in remote environments, which participants may not have had an opportunity to do so before; thus, participating in this research may be beneficial. Nevertheless, evoking distressful memories was not the intension of the analogue mission; however, in this circumstance:

- Participants would be reminded that they can withdraw from analogue mission at any time of their choosing, thus empowering the participants to be in-control. Should a participant have wished to stop their participation of the analogue mission, they would be accommodated with the researchers.
- After the analogue mission, if participants experience any emotional distress, they will be signposted to occupational health support networks which they can access via their GP and, or the mental health charity Mind, who can provide professional mental health counselling if required

An ethical issue to be mindful of was maintaining confidentiality of research participants. To mitigate the risk of exposure, all data was collected anonymously and securely stored on UCL N drive (primary storage), UCL Data Safe Haven and external portable hard drive (backup stores). (See 8.1 for details of UCL Data Protection Office registration.)

8.4.3 Emergency action plan

In the planning phase of the analogue mission, the PFC grounded theory informed the identification of risks, which led to the need to write risk assessments. It was highlighted that an emergency action plan was needed to enable an efficient response to any incident during the analogue mission and to mitigate the risks that were present. The emergency action plan was developed during the planning phase, based on literary evidence, and informed by the analogue mission.

Emergency action plans outline of how to respond to an incident. Within the context of this research, the emergency action plan focused on how to respond to incidents during the analogue mission and the activities taking place. The activities are defined as the research taking place on the island. The analogue mission aim for the analogue astronauts, and the programme of research, required all participants to move around the island. Due to the island being uninhabited, no paths are available to use; therefore, moving around the island was challenging. The risk of musculoskeletal injury (especially to lower limbs) was high. Thick heather (where ticks[13] are present), steep slopes, and boggy areas meant that vulnerability to these natural hazards required risk mitigation and the emergency action plan to be in place so an incident could be responded to efficiently and effectively. The emergency action plan for the analogue mission is outlined in Table 16.

Table 16 Emergency action plan

	Emergency action plan
1	Check and remove danger, if safe to do so.

[13] Ticks are small, spider-like insects that feed on drinking the blood of other animals, including humans. Tick bites are pain-free; however, a small percentage of ticks carry a bacteria that can cause Lyme Disease. Lyme Disease presents itself as a ring-shaped rash expanding from the bite site, and sometimes includes flu-like symptoms. Unsafely removing Ticks can cause them to vomit, increasing the volume of saliva entering the bloodstream.

2	Provide first aid to injured person(s) – Mountain leader, medical officer, or other qualified first aider.
3	Injured person(s) to be escorted to basecamp for assessment from the mission doctor.
4	If step 3 is not possible, the mission doctor will be brought to the location of the injured person(s). In the meantime, an emergency shelter will be placed over injured person(s) and other personnel to prevent hyperthermia. The project doctor will decide if the injured person(s) should be brought back to the basecamp (which is a brick-built building).

The PFC grounded theory informed the decision-making for the emergency action plan during the planning phase. This was achieved by the emergency action plan needing to accommodate all risks that were identified as relative to time, place, person, and activity, in the event that injury or illness took place. For example, in the event a participant got a tick bite, they were informed how to remove it safely and to monitor for signs of Lyme disease (a circular rash) (Millins et al., 2021). If a rash appeared, the participant would need to be evacuated for antibiotics. This is an example of a minor illness that could not be managed with the capability of PFC; therefore, it is not included in the emergency action plan relating to PFC. However, a twisted ankle is an example of a minor injury that could be managed in the field site; therefore, the emergency action plan applied. Thus, the PFC grounded theory informed the development of the emergency action plan; however, fortunately, there were no injuries or illness that required the emergency action plan to be used. Further research would be beneficial to explore how the PFC grounded theory was used during the planning stages of a case study when minor injury or illness took place in a remote environment.

8.5 Summary

In this chapter the methods used to methodologically test the PFC grounded theory have been outlined and critically appraised. Using an autoethnographic approach with a reflexive thematic analysis method to analyse the data provides continuity with the methods used in this research, which strengthens the validity and robustness of the findings. Deviations from autoethnography and reflexive thematic analysis have been evidenced and rationalised to provide transparent and explicit reasons why the deviations were necessary. The impact of these deviations enabled the PFC grounded theory to be test methodologically during the planning phase of the analogue mission.

The key findings of the methodological test provide evidence that the PFC grounded theory informed the risk mitigation processes, specifically on risk assessment, ethics and data management, and the emergency action plan. Moreover, it was clear that evidence of the PFC grounded theory was identifiable, which suggests that the PFC grounded theory has validity and is applicable to practice. Validity and applicability are quality indicators of the grounded theory study (see 6.5). There are limitations to this methodological test, namely the potential influence of confirmation bias because it was conducted by the same researcher. However, the interventions to mitigate the influence of confirmation bias have been outlined and critically appraised. Considerations for future research have also been suggested to reaffirm or refute the methodological test findings. The findings are critically discussed and synthesised with existing literature in Chapter 10. The PFC grounded theory was also tested empirically, which is presented in Chapter 9.

Chapter 9 Empirical testing

9.1 Introduction

Empirically testing a grounded theory is not required to validate the findings (Glaser, 1998, Glaser, 1992). Rather, carrying out the grounded theory research diligently and rigorously determines the validity of the emergent grounded theory. Similarly to the methodological test, the rationales for empirically testing the PFC grounded theory are to define the scope of the PFC grounded theory (namely, how it can be used in practice) and to identify evidenced-based considerations for future research (see 10.4). In this chapter, the empirical test of the PFC grounded theory and the findings are presented and critically appraised.

The empirical test of the PFC grounded theory was designed to align with the methodology and methods used at other stages of this research. The rationale for designing the empirical test in this way was to strengthen the robustness of this research and, therefore, the trustworthiness of the findings. There are, however, limitations to the empirical test findings, which are outlined in this chapter. Firstly, the methods used for the empirical test are critically appraised.

9.2 Methods

To align the methodology and methods of the empirical test with this research, two case studies were selected to test the PFC grounded theory within. The methodology underpinning the empirical test is similarly contextualism and inductive qualitative research (see 5.4); therefore, case studies were selected within clearly defined remote environments contexts. Furthermore, using case studies aligns with the final stage of the concept analysis (see 4.3.6). Alignment of the methodology and research methods across this research strengthens the robustness, which consolidates the trustworthiness and validity of the findings.

For this research, there were two case studies that were purposefully selected for the empirical test of the PFC grounded theory. The first was the experience of the medical officer providing PFC during the analogue mission that simulated the human exploration of another planet (see 8.2). This case study provided continuity with the methodological test; therefore, providing evidence of how the PFC grounded theory mitigates risks to health in practice. A limitation of this case study is the researcher led the development of the analogue mission, which potentially exposes the findings to confirmation bias from the researcher. To mitigate any influence of confirmation bias, a second case study was purposefully selected.

The second case study was a cross-country skiing expedition across the Norwegian Hardangervidda Plateau. The researcher was not involved in the expedition design, planning, or deployment; therefore, findings about how the PFC grounded theory mitigates risks to health in practice were less exposed to confirmation bias. (See 10.4 for research limitations.) Thus, purposefully selecting these two case studies provided rigorous academic investigation and mitigated the influence of confirmation bias, within the defined research methodology. The next sections of this chapter outline and critically appraise the data collection and analysis methods used for the empirical test of the PFC grounded theory.

9.2.1 Data collection

To promote continuity and robustness of this research, the data collection methods used for the empirical test were aligned with the methods used for the grounded theory (see 6.4.2). Firstly, the research participants from each case study (one participant from each case study) met the same eligibility criteria as the research participants for the grounded theory study (see 6.4.1.3). Secondly, data was collected about their experience of using PFC, however, the semi-structured interviews were concentrated on the case studies – the analogue mission and cross-country skiing expedition. Each research participant of the empirical test was asked the same questions as the grounded theory research participants during a semi-structured interview;

although, the questions were focused on their case study experience (see Appendix 8).

It is important to note that the research participants of the empirical test were not shown or taught about the PFC grounded theory. They were informed that data they shared would be analysed to test how the PFC ground theory relates to their clinical practice, focusing on what elements of the PFC grounded theory they used resulted in mitigating risks to health. The rationale for conducting the empirical test in this way was to provide continuity with the wider research methodology and methods. In other words, data was collected about the research participant's experience of PFC mitigating risks to health, which would be analysed to see how their experience relates to the PFC grounded theory or how it does not. Thus, if the open coding concepts, axial coding categories, and selective coding conditional matrix are relative to the PFC grounded theory, the findings suggest how the PFC grounded theory can be used in practice to mitigate risks to health.

An alternative empirical test could be to teach clinical practitioners about the PFC grounded theory and collect data about their experience; however, it was decided not to do this within this research. The rationale for this decision was the increased potential of confirmation bias if the researcher explained the PFC grounded theory to the case study research participants. Collecting data about the research participant's experience and analysing it without their knowledge of the PFC grounded theory mitigated the potential influence. Future research could conduct a study using this approach to provide further insights into how the PFC grounded theory can be used to mitigate risks to health in remote environments. To complete the empirical test of the PFC grounded theory, the data collected from the case study research participants needed to be analysed. The data analysis methods are critically appraised in the next section.

9.2.2 Data analysis

To provide a consistent rigorous approach to this research, the data analysis methods used in the empirical test of the PFC grounded theory were similarly aligned with the data analysis methods used throughout this research. For the grounded theory study, is important to note that the grounded theory data analysis methods was not used to analyse the data for the PFC grounded theory empirical test. While using grounded theory data analysis methods would precisely align the data analysis methods, the empirical test does not use grounded theory. Thus, using grounded theory data analysis methods would be inappropriate. Rather, the data analysis methods for the empirical test was a reflexive thematic analysis approach.

A reflexive thematic analysis approach was identified as the most appropriate data analysis method for the empirical test of the PFC grounded theory for robustness and continuity. The rationales for this were that it enabled the researcher (a subject matter expert in the PFC grounded theory) to rigorously analyse the data shared by the research participants for evidence of utilisation of the theory in practice. Furthermore, a reflexive thematic analysis approach to data analysis was utilised for the literature review of this research (see 3.2.2) and methodological test of the PFC grounded theory (see 8.3.2). Consistency in the data analysis methods strengthened the robustness of this research and, therefore, the trustworthiness of the findings.

Similarly to the methodological test of the PFC grounded theory, there are critiques of using a reflexive thematic analysis approach. Having the same researcher conduct the empirical test exposes the study to the potential influence of selection bias, which may decrease the trustworthiness of the findings. To mitigate the influence of selection bias, an independent research could have conducted the empirical test. Independence mitigates the potential influence of selection bias; however, an independent research may require instruction on the PFC grounded theory and how to use it. Thus, teaching an independent researcher about the PFC grounded theory for them to empirically test it increases the risk of confirmation bias. As a result, the data analysis methods would deviate from the rigorous approach this research used. A reflexive thematic analysis approach conducted by the research was, therefore, deemed most appropriate for continuity and robustness.

The reflexive thematic analysis approach used for the empirical test of the PFC grounded theory study is similarly based on the original and updated reflexive thematic analysis method (see 3.2.2) (Braun and Clarke, 2006, Braun and Clarke, 2019). The process of reflexive thematic analysis approach for this study, using an autoethnographic approach, is outlined in Table 17. Similarly to the methodological study, how the reflexive thematic analysis approach is used in this research deviates from the original method.

In traditional thematic analysis, themes are identified by the allocation of codes of data. Data from the semi-structured interviews of the case study participants were initially analysed using grounded theory data analysis. Grounded theory data analysis enabled the identification of open coding concepts, axial coding categories, and a selective coding matrix. By analysing the data in this way, concepts, categories, and a selective coding matrix that were relative to the PFC grounded theory could be identified. However, as aforementioned, using grounded theory methods to empirically test the PFC grounded theory is not appropriate. Thus, the memo-writings that were documented during the case study semi-structured interviews and grounded theory data analysis was the data used to conduct the reflexive thematic analysis approach of the empirical test. In practice, the reflexive thematic analysis approach used for data analysis in the empirical test is outlined in Table 17.

Thus, the themes that were identified as a result of the reflexive thematic analysis approach for the empirical test emerged from the data shared by the case study participants. The data they shared was based on their experience during the case study and not clouded by teachings about the PFC grounded theory. The impact of the empirical test design is the findings were routed in data, and the potential influence of confirmation bias was mitigated. Furthermore, using memo-writings as the data for the reflexive thematic analysis approach ensured grounded theory data analysis methods were not used inappropriately. The next section of this chapter presents and critically appraises the findings of the PFC grounded theory empirical test.

Table 17 Empirical test: reflexive thematic analysis approach

Stage		Action
1	Familiarisation	Immersion into the data (the memo-writings, focusing on relative open coding concepts, axial coding categories, and a selective coding matrix).
2	Identification	Systematically document the themes identified within the data.
3	Reviewing	Assess the accuracy of identification and cross-check all themes for duplication.
4	Mapping	Map the themes to identify correlations or contradictions.
5	Refining	Continue reflexive thematic analysis to combine or separate themes for clarification from the case studies.
6	Report	Critically appraise the themes and findings of the thematic analysis.

9.3 Findings

The empirical test of the PFC grounded theory is based on evidence of how PFC was utilised to mitigate risks to health in remote environments. The two PFC providers from each case study were both medical doctors with experience of providing health care in remote environments. The pre-interview survey included the same questions as the grounded theory pre-interview survey (see 7.2), which confirmed both participants were eligible for this study (the eligibility criteria was the same as the grounded theory study; see 6.4.1.3). As previously highlighted, however, the experience that the participants focused on related to how they used PFC within their case study, which enabled the empirical test of the PFC grounded theory.

The case study of the analogue mission focused on collecting data about the experience of providing PFC during the mission on the island. It is important to note that this case study focused on the experience of proving PFC within reality – that is, not within the simulated human exploration of another planet. Conducting an empirical test of the PFC grounded theory within the simulation of an analogue mission is a consideration for future research, which could lead to a study of PFC during human spaceflight. However, for the purposes of this research, the analogue mission case study empirical test focused on the reality of providing PFC on a remote an uninhabited island. The design of this case study provides continuity with the methodological test and enabled a reflexive thematic analysis approach for the data analysis. The findings of the reflexive thematic analysis approach were refined (see step 5 in Table 17) by analysing data from the Norway Hardangervidda Plateau case study.

The Norway Hardangervidda Plateau case study was a cross-country skiing expedition. The expedition lasted for 12 days in total and replicated the World War II Heroes of Telemark mission. The Heroes of Telemark mission was a covert attack on a hydroelectric plant in Hardangervidda, which at the time was occupied by the Nazis and key infrastructure for the building of an atomic bomb. Norwegian agents of Churchill's 'Special Operations Executive' launch a series of covert assaults on the hydroelectric dam, eventually sabotaging all of Hitler's capacity to build an atomic bomb in Norway. The cross-country skiing expedition retraced the route of the original mission in celebration of their achievements. This expedition was the world's first all-female expedition to complete the route unsupported. The case study similarly focused on the experience of the PFC provider's experience during the expedition.

The design of the expedition has many parallels with the analogue mission design (see 8.2); namely, the challenges of providing PFC and mitigating risks to health in a remote environment. Norway's Hardangervidda Plateau is on the boarder of the Arctic Circle and is a large national park. There is very limited infrastructure (hospitals) and the logistics of an evacuation, including an aeromedical evacuation, mean long delays are highly likely. As the mode of transport for this expedition was cross-country skiing, the resources available were limited to what could be carried on skis. All of these environmental and circumstantial hazards meant that the need for PFC to mitigate the risk of illness and injury was significant, similar to the analogue mission case study.

9.3.1 Analogue mission case study

In this section, findings from the analogue mission case study that was used to empirically test the PFC grounded theory are presented and critically appraised. The planning phase of the analogue mission was used for the methodological test of the PFC grounded theory (see 8.2.2), whereas the deployment phase was the focus of the empirical test. The findings of the analogue mission case study empirical test are presented similarly to the methodological test, in the salient themes that emerged as a result of the reflexive thematic analysis.

Similar to the findings of the grounded theory study, anonymous direct quotes have been presented to ensure that the research participant's voice is authentic, and to mitigate the risk of confirmation bias. The quotations have been edited to provide clarity (as per data editing example provided in Table 12) but otherwise provided in full. The impact of presenting the findings in this way is research participant's experiences are shared transparently and their authentic voice is maintained. Furthermore, open coding concepts have been mapped with the direct quotes (listed below the direct quotes) to provide an explicit demonstration of how the empirical data relates to the PFC grounded theory. The interrelations are critically appraised through detailed narrative to demonstrate transparency and robustness of the reflexive thematic analysis.

Although the analogue mission case study focused on the deployment phase of the analogue mission, evidence that the case study participant thought through PFC and risk mitigation before deployment was clear. They stated that,

> "There were some steep-sided cliffs and multiple areas of rough terrain where a person might sustain a serious fracture … [and]

> there was a small potential for things like hypothermia or cold immersion."

- Climatic injury = risk from environment and activity

Identifying hazards and risks, such as steep-sided cliffs and fractures, suggests that the case study participant mapped the hazard and risk landscape before deployment. By extension, and based on findings from the methodological test, the risks to health on the island were relative to time, place, person(s), and activity. The case study participant did not refer to a hazards and risk map; however, the language used, and the evidence provided, suggests that this process did take place, despite not being called a hazards and risk map. Thus, this evidence of the PFC grounded theory being used in practice before deployment to the remote environment.

After mapping the hazards and risk landscape, the next phase of the PFC grounded theory is to develop risk mitigation strategies and define the scope of PFC capability. The case study participant stated that,

> "We had an extremely well-resourced medical kit… [and] I think the risk assessment and planning went a long way towards protecting [people] (sic) from injuries."

- Critical thinking about influences of health, resources, clinical decision-making

This quotation suggests that the case study participant critically thought about having enough resources to be self-sufficient for the duration of the analogue mission. This is evidence of a risk mitigation strategy that, based on the evidence provided, was informed by the risk assessment. It can be noted that the methodological findings about the analogue mission risk assessments (see 8.4.1) contributed to risk mitigation during the deployment; therefore, contributing to the evidence of how the PFC grounded theory mitigates risk to health. The emphasis on protection of injuries, rather than responding to injuries, consolidates a risk reduction approach. Furthermore, the case study participant emphasised that,

> "Having mountain leaders walking to and from sites with researchers who were maybe less familiar in that environment was extremely protective against a lot of the potential injuries and accidents that could have occurred."

- Promote and protect health

It is suggested by the case study participants that the risk mitigations in place during the analogue mission were thorough and, most importantly, protected the health of people in the remote environment. Linking with the PFC grounded theory, this evidence suggests that the case study participant had defined proactive and reactive PFC. Fortunately, no reactive PFC was required for injury or illness; however, the case study participant experience included health protection and promotion, which contributes to the evidence of the PFC grounded theory reducing risks to health in practice.

The final phase of the PFC grounded theory focuses on enhancing the risk mitigation strategies. The analogue mission case study focuses on investigating how the PFC grounded theory was utilised in practice to mitigate risks to health; therefore, evidence of high-fidelity simulation training was not identifiable, which is a limitation of the empirical test. However, training about the hazards and risk landscape could be identified in the experience of the case study participant. They stated that,

> "Promotional care provided was tick removal and advice the risks of Lyme disease and looking out for signs and symptoms [enabled people to be] able to take care of [themselves] in that environment."

- Specific training relevant to activities and environment

The case study participant explained that training people how to look after themselves and their health contributed to mitigating risks to health. Lyme disease is an example of a risk to health and the case study participant identified that training analogue mission participants mitigated this risk. This is evidence that, based on the case study participant's experience, training stakeholders about risk mitigation based on the hazards and risk landscape, as featured in the PFC grounded theory, contributed to risk mitigation. The case study participant also stated that,

> “Planning for the absolute worst-case scenario reduced the risk to the participants. It also increased the confidence of the medical providers in that should anything have happened, I felt adequately resourced to be able to deal with that situation and that I thought about it in advanced and mentally rehearsed it. … You can't plan for every eventuality, but I thought about some of the major things that could potentially happen and knew that we were adequately resourced for that, and I knew that there was a plan in place for what we would do if something was to happen. So that's one of the most important things for me.”

- Confident, competent, and credible

Based on the experience of the case study participant, using realistic worst-case scenarios to enhance the risk mitigation strategies contributed to protecting health and it increased their confidence. A limitation of this finding is high-fidelity scenarios were not used to test the risk mitigation strategies; however, this evidence suggests the PFC grounded theory contributed to risk mitigation through the case study participant using realistic worst-case scenarios. Having their confidence increased links to evidence shared by the grounded theory participants (see 7.3.2.10). They acknowledged PFC in remote environment is unpredictable; therefore, having a strategy in place equips the PFC provider with tools to help manage challenges of PFC in remote environments. Thus, this evidence suggests that the PFC grounded theory is of benefit to risk mitigation for patients and PFC providers.

As the empirical test of the PFC grounded theory focused on the deployment of the analogue mission, no evidence was collected about the documentation of lessons learned (although, this did take place in practice). This is a limitation of the empirical test; however, future research could investigate how documentation and lessons learned contributes to risk mitigation. To strengthen the trustworthiness of these findings, the cross-country skiing case study provided data about a case study that the researcher was not involved with.

9.3.2 Cross-country skiing expedition case study

In this section, findings from the empirical test of the PFC grounded theory within the Norwegian Hardangervidda Plateau cross-country skiing case study are presented and critically appraised. This case study is an ideal source of data for an empirical test because of the impartiality the researcher had to the expedition design, and the well-defined remote context that the expedition took place in. The case study participant stated that,

> "It is really an inhospitable environment, and you need to know what you're doing. So we went with guides that were leading us, and I had a discussion with them so that I could clarify exactly what my roles and responsibilities were."

- Team roles depend on the environment and activities

This vignette suggests that the case study participant assessed the hazard and risk to health landscape because they acknowledged the environment was, "inhospitable." Without conducting research about risks that are relative to time, place, person, and activity, it would not be possible to know the environment was so challenging. As a result, this is evidence that the first phase of the PFC grounded theory took place in practice. This is also evidence that the case study participant conducted a dynamic assessment of the hazards and risks to health landscape at the beginning of the expedition to define the scope of their PFC practice. Psychological care was an area that they focused on.

> "The psychological anxiety was a big one, particularly the unknown. A lot of the girls hadn't skied before, so it was learning a new skill and not really knowing what to expect. We knew we were doing a few punchy [difficult and challenging] days of skiing, pulling pulks, and it took 24 hours for anxiety levels to ease. But

> when we got out there after dropped off. I think everybody had a collective sigh of relief."

- Physical health affects mental health and vice versa

It is clear from this vignette that the remoteness of the environment and the challenging activity taking place influenced the psychological health of the participants. This was recognised by the case study participant, which is further evidence that they mapped the hazards and risks to health landscape. Furthermore, this evidence links with the second phase of the PFC grounded theory; namely, to develop risk mitigation strategies by defining proactive and reactive PFC. The case study participant explained,

> "I was the only doctor there, so I ended up taking medical responsibility for the team. It was a much more stressful situation because I didn't have a full medical kit with me, so it literally was trying to provide first aid cover and bits and bobs without actually being fully prepared, which was the challenge."

- Resources available are what can be transported to the environment

The case study participant recognises that the situation they are in was stressful, which was exacerbated by a limited supply of resources (due to the logistically constraints) and being the only PFC provider. Being the only PFC provider on the expedition is evidence of autonomous decision-making from the second stage of the PFC grounded theory. Furthermore, identifying stress within the hazard and risks landscape links with the development of risk mitigation strategies because the case study participant can define proactive and reactive PFC interventions. This vignette also suggests that the case study participant overcame the limitation of resources by critically thinking about the problem, which is additional evidence that the PFC grounded theory was used in practice. A difference in this case study when compared with the analogue mission, however, was an injury.

> "One of the girls during our training session fell and fractured her elbow. We were able to get her to hospital. She got a plaster on,

> and she still managed to do the full expedition, including pulling the pulks. So my role in this was mainly providing support for the team, patching up blisters, giving some ibuprofen for aches and pains. And then psychologically making sure that the girl that had fractured her elbow was supported and she felt like she was able to do it."

- Holistic care, as well as enhanced care

In this case study, the injury took place while training in-country shortly before deploying on the expedition. The patient was taken to hospital and treated relatively quick; therefore, the injury is not within the scope of PFC. In this case study, it was deemed safe for the patient with the fractured elbow to continue on the expedition because it was in a cast. Thus, the care of an existing injury during the expedition is within the scope of PFC due to the remoteness of the expedition. The case study participant explains the majority of the care they provided was to treat minor injuries (blisters, muscular aches), stress, and the patient with a broken elbow. In other words, the PFC the case study participant provided was holistic and person-centred, with the aim to protect and promote health. This is contributing evidence to the use of the PFC grounded theory to mitigate risks to health in remote environments.

An additional risk mitigation intervention that can be identified in this vignette is the use of high-fidgety simulation training to upskill the expedition participants to promote their self-sufficiency. This is evidence of the final phase of the PFC grounded theory. It could be argued that the training was not specifically about PFC risk mitigation strategies; however, the purpose of the high-fidelity simulation training was a proactive intervention to promote and promote their health. Thus, this is contributing evidence of the PFC grounded theory being used in practice to mitigate risks to health. The case study participant reiterated their risk mitigation strategy by explaining,

> "I made sure I integrated myself well within the team, the girls were really comfortable with me. They came [to me] early so, if there were any problems, it wasn't that they were festering or that

they were worried about them. We were very open and honest with each other, so any problems that they had, they came early. And actually I think that meant that I didn't have to deal with anything major."

- Rapport and trust

Based on the perspective of the case study participant, and the absence of major injury or illness during the expedition (excluding beforehand), their PFC mitigated risks to health. Establishing a rapport and trust with expedition participants evidently encouraged them to communicate risks to their health (minor injury, such as blisters and muscular aches) before they became serious. Creating this open forum was a proactive intervention from the case study participant that educated expedition participants about risks to their health and how to mitigate them. Thus, this is an example of the risk mitigation strategy that was developed by the case study participant being enhanced – the final phase of the PFC grounded theory.

This case study focused on evidence of the practical use of PFC grounded theory to mitigate risks to health. As a result, no evidence of the risk mitigation strategy being tested during realistic worst-case scenarios was identified; however, this may have taken place before the expedition. This was not identified during the semi-structured interview because it focused on the deployment of the expedition. Similarly, the documentation of lessons learned for future reference may have taken place after the expedition. Future research that empirically tests the PFC grounded theory could focus on the chronology of the PFC grounded theory being used to mitigate risks to health from the pre-deployment training through to post-deployment evaluation. Nevertheless, this case study provided evidence that the PFC grounded theory was used in practice to mitigate risks to health, which affirms the findings of the analogue mission case study.

9.4 Summary

In this chapter the methods used to test the PFC grounded theory empirically have been presented and critically appraised. The same methods used in the grounded theory study were utilised in the empirical test of the PFC grounded theory; however, there were two key differences. Firstly, two case studies were used as the source of data – the analogue mission and Norway's Hardangervidda Plateau cross-country skiing expedition. The analogue mission provided continuity with the methodological test, whereas the Hardangervidda Plateau cross-country skiing expedition mitigated the influence of confirmation bias.

In both case studies, empirical evidence of the PFC grounded theory was identified. Presence of empirical evidence suggests that the PFC grounded theory is valid and applicable to practice, which are quality indicators (see 6.5). It is important to reiterate that the PFC grounded theory was not taught to the case study participants, because the empirical test was designed to test for evidence of the PFC grounded theory in practice. In other words, evidence of the in practice suggests that the PFC grounded theory is an evidence-based, explanatory theory. Thus, findings from the empirical test, combined with findings from the methodological test, provide evidence that the research aim and objectives have been achieved and the research question answered.

The findings of the empirical test have limitations, which are identified and critically appraised in this chapter. Future empirical tests could be completed by repeating this study with more case studies in a variety of contexts by a variety of researchers. This research would provide new insights into how the PFC grounded theory can be used to mitigate risks to health. All findings of this research are critically discussed and synthesised in Chapter 10, which also summarises future research considerations.

Part IV Research synthesis

Chapter 10 Discussion

10.1 Introduction

In this chapter the findings of this research will be critically discussed, synthesised, and transparently presented to explore original contributions to knowledge. The critical discussion is mapped with the theoretical, methodological, and empirical contributions to demonstrate the systematic approach that the findings are synthesised. In other words, the findings of this research are brought together for critical appraisal and are situated in the wider literatures. Thus, the key findings are identified, contextualised, and synthesised with other research to critically appraise the significance of the findings relative to existing knowledge. The limitations of this research are also critically appraised to demonstrate robustness and to inform future research considerations. Lastly, recommendations for future research are presented. To begin, the research design is critically appraised.

10.2 Critical appraisal of the research design

The aim of this research was to make an original and significant contribution to knowledge of how PFC mitigates risks to health in remote environments. There were three objectives identified to achieve the aim. The outputs of the objectives are presented in Table 18, which provides evidence of the research aim being achieved.

The research aim was achieved by rigorously investigating a PFC grounded theory which resulted in establishing an explanatory, evidence-based theory of the identified phenomena. It follows that the literature review and concept analysis (see Chapter 3 and Chapter 4) provided evidence of PFC being used to mitigate risks to health in remote environments; however, no literature about an explanatory, evidence-based theory was identified. In other words, a PFC grounded theory was the identified phenomena and research gap for this research.

Table 18 Research objective outputs

	Research objective	Output achieved
1	To rigorously investigate an explanatory, evidence-based theory of how PFC mitigates risks to health in remote environments.	PFC grounded theory has been established using a Straussian grounded theory approach.
2	To methodologically investigate how a PFC grounded theory could be used to plan for the mitigation of health risks in remote environments.	A methodological test of how the PFC grounded theory was used to plan for the mitigation of risks to health in a remote environment has been completed.
3	To empirically investigate how a PFC grounded theory can mitigate risks to health in a remote environment.	An empirical test for evidence of the PFC grounded theory being used in practice to mitigate risks to health in a remote environment has been completed.

The achievement of the research objectives has resulted in original and substantial contributions to theory, methodology, and empirics. In other words, the research aim of making an original and significant contribution to knowledge has been achieved. The originality of this research is evidenced by the absence of literature about an explanatory, evidence-based theory of PFC mitigating risks to health in remote environments. Evidence of a significant contribution to knowledge as a result of this research has been evidence by the establishment of a PFC grounded theory and, furthermore, the methodological and empirical testing of the theory. While testing grounded theory findings does not influence the validity or trustworthiness (see 6.5), completing these studies has demonstrated significant contributions to knowledge and the achievement of the research aim.

In addition to the research aim, a research question was identified to guide the direction of the research – “What is an explanatory, evidence-based theory of how PFC mitigates risks to health in remote environments?” The research question has been answered by the rigorous investigation of an evidence-based PFC grounded theory of mitigating risks to health in remote environments. Thus, the completion of the research aim, objectives, and question has resulted in a PFC grounded theory, which is critically appraised and synthesised in 10.3. However, the implementation of the research design has made original contributions to grounded theory methods that are critically appraised in this section.

The primary method used for this research was a Straussian grounded theory approach (see 6.4). The nuances of the approach used for this research are:

- Having a contextualism research paradigm (ontology and epistemology), rather than pragmatism, in a Straussian grounded theory approach.
- Explicit presentation of data mapped with open coding concepts, axial coding categories, and selective coding conditional matrix to emphasise the delineation between data and PFC grounded theory.

Having a contextualism research paradigm is an innovative approach to Straussian grounded theory. The research philosophy that traditionally underpins Straussian grounded theory is pragmatism (see 6.3.3), which emphasises that knowledge is created through action. While the research paradigm for this research (see 5.4) does not dispute a pragmatist approach, a contextualism approach to Straussian is more appropriate due to the dynamics of remote environments. Findings of the PFC grounded theory reiterated a contextual approach to Straussian grounded theory was appropriate due to risks to health being relative to time, place, person, and activity. Thus, use of a contextualism research paradigm within this research has contributed to grounded theory enhancement by providing evidence that grounded theory can be utilised with different philosophical underpinnings.

In the presentation of the research findings, direct quotations are provided at full length to ensure the research participant's perspectives and experiences are authentically presented. The direct quotations are mapped with the open coding concepts, axial coding categories, and selective coding conditional matrix. Traditionally, findings from grounded theory research are evidence only through memo-writing (Glaser and Strauss, 1967). The rationale to map the open coding concepts, axial coding categories, and selective coding conditional matrix with the data (rather than memo-writing) is to provide explicitly evidence of the delineation between data and the emergent grounded theory. The impact of this decision is greater transparency and, therefore, trustworthiness of the research findings.

The trustworthiness of the findings is an important consideration for remote health system policy makers, educators, and practitioners who operate within a Western, evidence-based model of health (see 2.3.2). A limitation of the findings, however, is remote health systems who operate with a traditional model of health may not consider trustworthiness and the evidence-base as significant. Nevertheless, the findings could be relevant for indigenous communities to complement their practice, should it be deemed significant from their perspective as local experts. The limitations of this research are critically appraised in more detail later in this chapter (see 10.4). In the next section, the theoretical, methodological, and empirical research findings are critically synthesised.

10.3 Critical appraisal of research findings

In this section, the theoretical, methodological, and empirical findings are critically discussed and synthesised within the existing body of knowledge that was identified in the literature review (see Chapter 3). Furthermore, original contributions to research and practice are critically appraised to inform future studies and practical application of the findings. This section is systematically structured to clearly present the theoretical, methodological, and empirical synthesis to demonstrate the academic robustness of this research. In other words, the delineation of the research methods have resulted in robust findings that have meaningful impact to the fields within the context of this research, as identified in Chapter 2. Firstly, the contributions to theory are presented.

10.3.1 Contributions to theory

The philosophical landscape of this research was identified as having a contextualism ontology and epistemology, with an inductive qualitative methodology (see 5.2). The philosophical landscape was critically appraised in Chapter 5. It was explained that having a contextualism ontology and epistemology was necessary and appropriate for this research due to the research context (see 5.2). In summary, the research context includes (1) the dynamic nature of remote environments, and (2) the various influences and determinants of health and risks within the remote environments. Investigating the research topic within this philosophical landscape was proven to be appropriate due to the recognition of risk relativity to time, place, person, and activity within the emergent PFC grounded theory.

In the literature review of this research (see Chapter 3) it was identified that people in remote environments can experience increased risks to their health (Wyler et al., 2022). These risk are due to having limited access to health services that have minimal resources (Travers et al., 2019). Furthermore, the health services are located in remote environments that have unreliable communication networks and frequent delayed evacuation due to the challenging conditions (Smith et al., 2021, Stewart et al., 2017). No PFC theory was discovered during the literature review that informed practice, policy, or pre-deployment training about risks to health. Thus, a PFC theory of how to mitigate risks to heath was identified as the focus of this research. It follows that the emergent PFC grounded theory is an original and significant contribution to knowledge.

The PFC grounded theory is an original and significant contribution to knowledge due to it bridging the identified research gap and providing a platform (theory) for research and practice. The PFC grounded theory is also the first theoretical contribution to knowledge of the fields included within the conceptual framework of health (see 5.3). Thus, if additional theories are produced, critical synthesis with the PFC grounded theory is a consideration for future research. For now, the PFC grounded theory can be critically synthesised within the existing literature about PFC, health, and risks in remote environments. This critical synthesis demonstrates the positionality of this research within the fields identified in the conceptual framework of health (see 5.3).

A traditional literature review method was used for this research to enable a comprehensive review of the literature (see 3.2). Adopting a traditional literature review method mitigated the risk of missing literature about risks, health, and PFC in remote environments that could have informed the research design. Thus, the impact of using a traditional literature review was a critical appraisal of the evidence-base about risks to health and PFC in remote environments. These findings were used to identify any previous research of this topic and the research gaps. Furthermore, these findings informed the design of this research, which ensured the research was original and significant. An overview of the included literature was provided in Table 2.

It was evident from the literature findings that a PFC theory of risk mitigation in remote environments would be original research that would be a significant contribution to knowledge. The articles included in the literature review for this research are valid contributions to knowledge about risks, health, and PFC in remote environments that provides new insights into clinical practice, policy, and pre-deployment training. The positionality and relation of the PFC grounded theory to this knowledge (evidence-base) within practice is it provides a theoretical foundation about risks, health, and PFC in remote environments. The existing body of literature informs clinicians, policy makers, and educators about –

- Who is affected by vulnerability to health risks in remote environments (DeSoucy et al., 2017)
- What happens to health in remote environments (Smith and Withnall, 2018)
- Where and when illness and injury take place in remote environments (Travers et al., 2019)
- Why illness and injury occurs in remote environments (Wyler et al., 2022)

The impact of the PFC grounded theory is it informs clinicians, policy makers, and educators *how* to think about health risk reduction in remote environments. Due to the duration and words limitation of this research[14], the extent of how impactful the PFC grounded theory is to clinicians, policy makers, and educators is not investigated. Thus, impact measure of the PFC grounded theory is outside the scope of this research; however, systematically investigating the impact is a consideration for future research. A method that could be used is a Delphi study, which would bring together a group of subject matter experts and rigorously investigate a consensus about the impact of the PFC grounded theory (Hong et al., 2019). Researching the impact of the PFC grounded theory in mitigating the risks to health in remote environments from patient perspectives is another consideration for future research.

To research the impact of the PFC grounded theory on mitigating risks to health from patient's perspectives would require robust ethical scrutiny due to people being exposed to risk in remote environments. In other words, exposing people to risk in remote environments that is likely to result in injury and, or illness for the sole purpose of testing the PFC grounded theory is unethical (Beauchamp and Childress, 2001). However, in the circumstance of (1) unexpected increased risk to health, or (2) minor injury or illness in a remote environment, research of the PFC grounded theory impact could take place. This is providing appropriate ethical scrutiny has been conducted and approved by an ethics committee[15]. A study of this nature is akin to research during a disaster; therefore, researchers could draw upon the ethics of disaster research to inform their research design (Kelman, 2014, Kendra and Gregory, 2019).

Findings of the literature included in this research focused on definitions, clinical guidance, and anecdotal case studies about risks, health, and PFC in remote environments (DeSoucy et al., 2017, Smith et al., 2021). (See 3.3.1 for the literature review finding themes.) Similarly to practice-based knowledge of risks, health, and PFC in remote environments, the positionality of the PFC

[14] Three years full-time research and maximum 100,000 words thesis.
[15] A research ethics committee can also be known as an institutional review board.

grounded theory to this literature is it provides a theoretical foundation. For example, it was recognised in the literature review that there is no standardised definition of PFC (Keenan, 2015). The contexts that PFC takes place in are identified, such as the provision of care beyond doctrinal planning timelines; however, there is no consensus of a PFC definition (Ball and Keenan, 2015). The PFC grounded theory does not define PFC, as rationalised in 1.3. Rather, the PFC grounded theory is an explanatory, evidence-based theory of how PFC is used within practice to mitigate risks to health in remote environments.

As the PFC grounded theory is evidence-based and explanatory, it provides a theoretical foundation to the existing and future research of defining PFC. The impact of this theoretical contribution is the PFC grounded theory provides an evidence-based foundation to this research. The PFC grounded theory, therefore, may strengthen the reliability of research investigating a PFC definition because it has brought together contextual evidence of PFC mitigating risks to health in a variety of remote environments. Thus, the findings of this research about the PFC grounded theory contribute to understanding the definition of PFC.

In addition to the PFC grounded theory, the findings of the concept analysis included in this research (see 4.3.3.3) make original and significant contributions to knowledge of defining PFC. It is acknowledged in the concept analysis that the findings do not include a definition of PFC. Rather, the findings provide a conceptual understanding of PFC in remote environments. The impact of these findings was the development of theoretical sensitivity to PFC mitigating risks to health in remote environments, which was necessary for the Straussian grounded theory approach. However, similar to the PFC grounded theory, the conceptual understanding of PFC is another original and significant contribution to knowledge of defining PFC. Thus, enhanced understanding of PFC inform clinicians, policy makers, and educators, equipping them with a more substantial evidence-base about PFC.

Another area of research identified in the literature focuses on clinical guidance. The majority of this literature focused on developing algorithmic guidance to clinical scenarios; for example, sepsis (Smith et al., 2021, Smith and Withnall, 2018). As critically analysed in 2.3.2, this approach to health in remote environments aligns with Western medicine, which focused on evidence-based health care (opposed to traditional medicine that has a greater significance on historical efficacy of treatments). It follows that the PFC grounded theory makes an original and significant contribution to the development of this guidance by informing clinicians and policy makers how to think about PFC mitigating risks to health. Algorithmic guidance, however, informs clinicians and policy makers what to do in a specific scenario.

The impact of providing a theoretical foundation to algorithmic clinical guidance is the PFC grounded theory is applicable to time, place, person, and activity. Algorithmic clinical guidance, on the other hand, is focused to defined scenarios. While focused, evidence-based clinical guidance is necessary in Western medicine, the hyperdynamic nature of remote environments may make the guidance irrelevant due to is being very focused on a set of circumstances. Thus, the PFC grounded theory provides an evidence-based explanation of how risks to health in remote environments can be mitigated in a broad range of contexts. The scope of this impact is similarly not included within the scope of this research due to the limitations; therefore, it is a consideration for future research.

Clinical guidance forms the basis of pre-deployment training to provide PFC in remote environments (Charnell and Rainey, 2019). The PFC grounded theory, therefore, contributes to educational practice by providing an explanatory, evidence-based theory. The impact of this is pre-deployment training is equipped with evidence-based clinical guidance and a theoretical foundation. To investigate the scope of this impact, future research could investigate the translation of theory (namely clinical guidance and the PFC grounded theory) into practice. A focus on practitioner experiences, similar to this research, could evoke valuable insights and new data about how clinical guidance and the PFC grounded theory informs their practice. Research of the impact for patients is possible, providing the aforementioned ethical considerations are robustly reviewed and managed.

A potential contribution to theory that this research may have in the future is being used in the analysis of anecdotal case studies of PFC in remote environments. Future research could investigate evidence of the PFC grounded theory within literature about anecdotal case studies, which may provide additional contributions to theory about reducing risks to health in remote environments. Conducting this research could not be included within this thesis due to the duration and words limitations; however, case study research is a method that could be considered for future systematic enquiry. Rather, this research was designed to research a PFC grounded theory, followed by a methodological and empirical test. The findings of the methodological and empirical tests are discussed and critically synthesised in the next two sections of this chapter.

10.3.2 Contributions to methodology

In this research, an original and significant contribution to knowledge is the PFC grounded theory. To enrich these findings and achieve greater depth, a methodological and empirical test of the PFC grounded theory was designed. The methodological test used an autoethnographic approach to investigate how the PFC grounded theory was used to plan for mitigating risks to health during the analogue mission on a remote Scottish island. Memo-writing was used as the data collection method for the autoethnographic approach, which aligned the methodological test with the grounded theory research. The analogue mission was a simulation of the human exploration of another planet, which was achieved because the island is remote. Thus, the island is a remote environment that has analogies with space; namely –

1. There was no access to health services.
2. The resources were limited to what could be carried.
3. Communication was unreliable due to the geographical remoteness.
4. Delayed evacuation was likely due to frequently poor weather conditions.

In the analogue mission design (see 8.2), it was clearly distinguished what was simulated and what activities were taking place within reality. This decision was based on literature about safety and healthcare during analogue missions

(Posselt et al., 2021). The impact of this decision is it informed a four-phase approach to the analogue mission (see 8.2.1 to 8.2.4). The first phase (the design phase) provided an opportunity to test the PFC grounded theory being used to plan for the mitigation of health in a remote environment. Thus, the methodological test of the PFC grounded theory aligned with the second objective of this research – to methodologically investigate how a PFC grounded theory could be used to plan for the mitigation of health risks in remote environments.

A contribution to research methodology that this study made is the correlation between the concept analysis, grounded theory, and the methodological and empirical tests – collectively, the studies of this research. The concept analysis method used for this research was based on a combination of Rodgers (1989) and Foley and Davis (2017) approaches, which is outlined in Table 5 (see 4.2). The final stage was to identify a model case study of the concept. Due to the analogue mission taking place in a remote environment, it provided an ideal model case study of PFC. Thus, the studies of this research were correlated due to PFC featuring in all four studies. The impact of this is the studies of this research had continuity. The continuity of research methodology increased the academic robustness of the overall research. It follows that this methodological contribution demonstrates how concept analyses can be linked with grounded theory and methodological and empirical testing to produce valid and trustworthy findings.

While the methodological study provided correlation with the concept analysis, the methodological study also made a methodological contribution to grounded theory. A Straussian grounded theory approach was used for this research (see 6.4). Theoretical sensitivity was used to guide theoretical sampling until the point of theoretical saturation was achieved (see 6.4.1). To develop theoretical sensitivity, constant comparative analysis of the open coding concepts, axial coding categories, and selective coding condition matrix took place (see 6.4.3.4). In Straussian grounded theory, engagement in the literature before the research begins is encouraged to initiate theoretical sensitivity (which is strongly opposed in Glaserian grounded theory; see 6.3);

however, the integration of a concept analysis within this research enhanced the theoretical sensitivity.

Integrating a concept analysis into this research provided a methodological contribution to Straussian grounded theory. In other words, the concept analysis was also used as a tool to further develop theoretical sensitivity of PFC in remote environments following the literature review before grounded theory data collection took place. Thus, the concept analysis was necessary to understand PFC in greater depth and, consequently, it enhanced the researcher’s theoretical sensitivity. It could be argued that the impact of this methodological contribution strengthened the trustworthiness of the research findings because the researcher used an evidence-based advancement to theoretical sensitivity. While Glaserian grounded theorist would dispute this claim due to the engagement with literature before the grounded theory research, this research used a Straussian grounded theory approach (Glaser, 1998). In Straussian grounded theory, engagement in the literature is encouraged (Corbin and Strauss, 2015, Dunne, 2011). It follows that use of a literature review and concept analysis is an original and significant contribution to Straussian grounded theory methods that results in enhanced theoretical sensitivity.

The findings of methodologically testing the PFC grounded theory produced evidence of how the PFC grounded theory could be used to inform the planning of mitigating risks to health in remote environments. The analogue mission that provided the methodological test, however, was also a contribution to methodology. As critically appraised in 8.2, the analogue mission included in this research was the first of its kind to take place in the UK. In other words, designing an analogue mission to simulate the human exploration of another planet by using a remote environment as the analogy was an original and significant contribution to methodology. Evidence for this is the analogue mission enabled a methodological test of the PFC grounded theory, and it hosted a programme of other research. As outlined in 8.2.1, the studies included in the analogue mission programme of research were:

- Anthropology to investigate the interrelations between health and land.

- Anthropology of space enthusiasm.
- Astropharmacy, the use of medicines in space.
- Astrosurgery, clinical decision-making about surgical intervention.
- Medical anthropology to explore notions of ‘normal health’ off-world.
- Testing remote health technology that monitored heart rate variability.
- The synthesis of art and science by an artist-in-residence.

The inclusion of these studies within the analogue mission programme of research demonstrates that the analogue mission design which was deployed to the Scottish island is an original and significant contribution to research methodology. The studies include social science, technology testing, and artistic practice. Thus, the breadth of research that was conducted demonstrates that analogue missions which simulate the exploration of space by taking place in remote environment can facilitate a variety of field-based research. The findings and results from these studies are not included in this thesis because they were led by other researchers. What was included is the empirical testing of the PFC grounded theory within the analogue mission, which is critically synthesised in the next section.

10.3.3 Contributions to empirics

The methodological test of the PFC grounded theory provided addition depth and richness to the research findings. An empirical test for evidence of the PFC grounded theory in practice was also conducted to increase the depth of this research even further. In this section, the original and significant findings from the empirical test are critically synthesised to demonstrate the positionality of the PFC grounded theory within practice and relevant literature.

The findings of the empirical test provided evidence that suggests the PFC grounded theory is an explanatory theory of how PFC in used in practice to mitigate risks to health in remote environments. It is important to reiterate that the empirical test was not an investigation of the efficacy of using the PFC grounded theory. Rather, the empirical test was an investigation of evidence that the PFC grounded theory is an accurate explanatory theory of how PFC can be used to mitigate risks to health in remote environments. The empirical test also provided evidence that the research aim had been achieved and the research question was answered.

The empirical test used two case studies to investigate evidence of the PFC grounded theory being used to mitigate risks to health in remote environments. The analogue mission case study provided continuity with the studies of this research by correlating the concept analysis, grounded theory, and methodological and empirical test. In other words, the PFC model case study was the analogue mission, which enabled the methodological and empirical test. Findings from the analogue mission empirical test identified evidence of constituent data from the PFC grounded theory in practice; therefore, proving the PFC grounded theory is an accurate explanatory theory.

In the empirical testing findings section (see 9.3.1), open coding concepts were mapped with direct quotes from the semi-structured interview. The rationale for this presentation was to demonstrate empirical evidence of the PFC grounded theory within the analogue mission case study. As advocated in the literature, a grounded theory should be traceable back to the data that was collected, which proves that the grounded theory is evidence-based (Corbin and Strauss, 2015). Mapping the open coding concepts with data from the analogue mission case study demonstrated that the PFC grounded theory (1) is evidence-based and (2) it is an accurate explanatory theory of how PFC is used to mitigate risks to health in remote environments. Thus, this is evidence that the research aim and objective three (to empirically investigate how a PFC grounded theory can mitigate risks to health in a remote environment) were achieved (see 1.3). Lastly, this evidence also demonstrates that the research question – what is an explanatory, evidence-based theory of how PFC mitigates risks to health in remote environments?” – was accurately answered.

The empirical evidence that was collected and critically analysed suggested that the PFC grounded theory was used before and during the analogue mission. Data such as the recognition of risks relative to time, place, person, and activity was identified. This data is evidence that suggests the first stage of the PFC grounded theory accurately identifies that health risks mitigation begins before deployment to a remote environment by mapping the hazards and risks landscape. This finding contributes to the current knowledge base about planning to provide health care in remote environments, which advocates conducting a risk assessment before deployment (Mellor et al., 2020). The contribution of the hazard and risk landscape mapping is it provides a more detailed framework to inform the risk assessment process. It follows that the hazard and risk landscape does not inform a PFC provider how to do a risk assessment, but how to think about risk assessments. In other words, how to use critical thinking to assess hazards and risks from the perspectives of time, place, person, and activity. Evidence identified in the included literature of this research simply advocates conducting a risk assessment (Mellor et al., 2015). This demonstrates how the PFC grounded theory is an original and significant contribution to knowledge.

The empirical test also provided evidence that suggests developing risk mitigation strategies and defining the scope of PFC similarly takes place in practice as part of the overall approach to mitigate risks to health. The case study participant explained that they had put together a well-resourced medical kit. Doing so demonstrates that they had critically thought about (1) how to mitigate and manage the hazards and risks relative to the analogue mission, and (2) defined what PFC could and could not be provided while there. As a result, the case study participant and stakeholders of the analogue mission knew the scope of PFC. This finding is an important consideration for PFC pre-deployment training. Currently, pre-deployment training predominantly focuses on emergency response to major illness and injury (Charnell and Rainey, 2019). Including PFC of minor illness and injury is arguably more likely to be common in practice (between 50% to 75% of all travellers) (Wyler et al., 2022). However, defining the scope of PFC for a specific time, place, person(s), and activity would make the pre-deployment training more relevant. This could lead to enhanced health risk mitigation, which is a consideration for future research to investigate. This also links with the final stage of the PFC grounded theory.

The final stage of the PFC grounded theory is to enhance the risk mitigation strategy through high-fidelity simulation training and documentation. The analogue mission case study participant explained that they identified realistic worst-case scenarios to test their risk mitigation strategies. In the findings section (see 9.3.1), it was explained that although realistic worst-case scenarios were used to test the risk mitigation strategies, no evidence of the final stage of the PFC grounded theory was identified – high-fidelity simulation. Nevertheless, there are parallels between identifying realistic worst-case scenarios and high-fidelity simulation training.

As identified in the literature, high-fidelity simulation training is used to prepare and upskill PFC providers before deployment to a remote environment (Charnell and Rainey, 2019). As noted, predominantly this training focuses on emergency response to major illness and injury (DeSoucy et al., 2017). Findings of the PFC grounded theory suggest that high-fidelity simulation training is required to enhance the PFC scope and mitigate risks to health in remote environments. It follows that bespoke training based on the hazard and risk landscape may increase preparedness for PFC provision and risk mitigation. A consideration for future research, therefore, is to investigate the impact of the PFC grounded theory on (1) pre-deployment training and (2) the efficacy of risk mitigation in a remote environment. Nevertheless, the analogue mission case study participant said that their confidence was increased as a result of their approach to pre-deployment preparation. This suggests that the PFC grounded theory may have similar effects when informing pre-deployment training.

The analogue mission case study provided continuity with the other studies of this research; however, as an empirical test, there was a risk of confirmation bias due to the researcher's involvement in the analogue mission design. Similarly to the grounded theory study, the influence of confirmation bias is mitigated by the explicit and transparent explanation of the research methods. Furthermore, direct quotations are mapped with open coding concepts, axial coding categories, and selective coding conditional matrix to demonstrate the research methods. To mitigate the influence of bias in the empirical test, the Norwegian Hardangervidda Plateau cross-country skiing expedition was used as a second case study.

The Norwegian Hardangervidda Plateau cross-country skiing expedition provided an independent case study due to the researcher not being involved in the design, planning, deployment, or evaluation. Findings from the Norwegian Hardangervidda Plateau cross-country skiing case study providing original and significant findings that correlated with the findings from the analogue mission case study. An example of parallel findings include the limited availability of resources.

In relation to the PFC grounded theory, this provides evidence of the hazard and risks landscape; namely, the place and activity limits the supply of resources. The case study participant described being the sole PFC provider with a limited amount of resources was stressful. This data provided evidence of the second stage of the PFC grounded theory; namely, the requirements to (1) use critical thinking skills to problem solve and (2) make autonomous decisions. A consideration for future research is to investigate the impact of the PFC grounded theory on stress management for PFC providers in remote environments, which could link with future research about clinical impacts.

Similar to the analogue mission, no data was collected following the Norwegian Hardangervidda Plateau cross-country skiing expedition. The rationale for this was the study concentrated on investigating empirical evidence in the remote environment, rather than impacts afterwards. A study that investigates the impact of the PFC grounded theory on the design, planning, deployment, and evaluation phases of any deployment to remote environments has been identified as an important consideration for future research. However, a key difference with the analogue mission case study is the presence of an injury during the Norwegian Hardangervidda Plateau cross-country skiing expedition.

The case study participant explained that the injury (a fractured elbow) took place shortly before the cross-country skiing expedition. As a result, PFC was not required to meet the health needs of the patient – a hospital was easily accessible – however, the prolonged care of a patient with a fractured elbow is included within the scope of PFC during the expedition.

The case study participant explained that the PFC that was required was pain management and psychological care. Recognition of the different types of care that the patient required is evidence of the second stage, which advocates a person-centred approach to proactive and reactive PFC. This approach to care in the field is advocated in the literature, which demonstrates this PFC grounded theory is situated alongside current practice (Royal and Smith, 2020). Future research could use a traditional literature review to explore how the PFC grounded theory aligns with all current practices, and how it does not. Furthermore, considering much of the literature focuses on anecdotal case studies, a traditional literature review could investigate how the PFC grounded theory aligns with these case studies also. The impact of these literature reviews would inform future research about the development of the PFC grounded theory, namely as a methodological or empirical tool for mitigating risks to health in remote environments. The literature reviews could also be used to evaluate the PFC grounded theory, which is advocated by grounded theorists (Corbin and Strauss, 2015, Creswell and Miller, 2000).

It was identified that the training before the Norwegian Hardangervidda Plateau cross-country skiing expedition began contributed to mitigating risks to health by upskilling the participants in the activity they were undertaking. This intervention aligned with the final stage of the PFC grounded theory. The training was a high-fidelity simulation of the activities they would be doing during the expedition. However, the final stage of the PFC grounded theory advocated high-fidelity training based on the hazard and risk landscape, and the risk mitigation strategies. Nevertheless, this demonstrates that the PFC grounded theory may be utilised flexibly in practice; however, this requires further systematic enquiry to determine. If so, the impact of this is an increase in the applicability of the PFC grounded theory, because it can be applied to multiple situations and environments.

Generalisability is a quality indicator of grounded theories (Corbin and Strauss, 2015). Despite this, every research has limitations. Limitations for this research have been identified throughout this thesis; however, they are explained in-depth and critically appraised in the next section.

10.4 Critical appraisal of the research limitations

This research has made original and significant contributions to theory, methodology, and empirics; however, this research also has limitations. Defining the limitations demonstrates transparency and informs future research considerations. In this section, the limitations are outlined and critically appraised. The aim is to strengthen the credibility of this research by:

- Critically appraising the research methods and synthesising them within the evidence-base of grounded theory.
- Defining the boundary lines between (1) the analysis and critical synthesis of the findings, and (2) potential speculations that have no evidence-base.

The primary study for this research used grounded theory. It was acknowledged in the research methods chapter that there are many nuanced approaches to grounded theory (see 6.3). From the perspective of a traditional, Glaserian grounded theory approach, this research has severe limitations. It is demanded in Glaserian grounded theory literature that no engagement in the literature before data collection is permitted (Glaser and Strauss, 1967). Thus, Glaserian grounded theory is a journey of theoretical discovery in uncharted territory with no compass bearing. A rationale for this approach is, according to Glaserian grounded theorists, it can produce a grounded theory that is not influenced by any predetermined biases that are informed by historical research (Glaser, 1998). Within the research paradigm and conceptual framework of health related to this research, this would be a limitation.

This research uses a Straussian grounded theory approach. It is advocated in Straussian grounded theory literature that engagement in the literature is necessary to inform the research design, but not the data collection methods (namely theoretical sampling) (Corbin and Strauss, 2015). By doing so, a research gap can be accurately defined (Chun Tie et al., 2019). Thus, a Straussian grounded theory approach was necessary and appropriate for this research to (1) fulfil the criteria of a PhD, and (2) achieve the research aim. This position aligns with literature that advocates literature engagement in grounded theory research for PhD theses (Dunne, 2011).

The literature that informed design of this research was identified and critically appraised within the literature review and concept analysis (see Chapter 3 and Chapter 4). The research design was underpinned by a research paradigm that was situated within a defined philosophical landscape and conceptual framework of health (see 5.4). Thus, the research design was evidence-based, and the positionality of the research was explicitly identified. This research, however, was conducted through the lens of Western medicine, rather than traditional medicine that is often practiced by communities living in remote environments (Bodeker and Kariippanon, 2020). The salient difference of the Western perspective is the focus on evidence-based practice. Thus, the Western medicine perspective is a limitation that requires careful consideration.

The paradox between Western and traditional medicine is defined and critically appraised in 2.3.2. The focused examination of PFC from a Western medicine perspective causes assumptions about the practice of health care and risk mitigation in remote environments. In other words, people who practice Western medicine often reside in industrial, urban locations. It follows that they can travel to and through permanent remote environments (see 2.2.1), in which case the PFC grounded theory is relevant to mitigate risks to health. Furthermore, the PFC grounded theory is also relevant if they are caught in a temporary remote environment (see 2.2.2). However, due to the focus on Western medicine, the PFC grounded theory may not be relevant for communities practicing traditional medicine. Nevertheless, some literature suggests that indigenous communities do adopt evidence-based approaches to health (Marques et al., 2023). Thus, the PFC grounded theory may be of use to some remote communities. Future research could investigate how effective it is within traditional health systems; however, this may have neo-colonial connotations. Rather, conducting a grounded theory study from the perspective of traditional medicine could be more appropriate and beneficial to the local community.

As the findings of this research are produced from a Western medicine perspective, the sample size of the research participants may be considered a limitation by quantitative researchers and biomedical scientists or clinicians. The reason for this apparent limitation is the importance of probability values and statistical significance in biomedical Western medicine (see 5.3.1) (Aguinis et al., 2021). It is a fair argument that the findings of this research are representative of the research participants only, rather than all people who experience health risks in remote environments. However, this research has a contextualism research paradigm and qualitative research methodology, which is critically appraised in Chapter 5. These research philosophies were necessary to achieve the research aim and answer research question (Cutcliffe, 2000). Thus, the richness and validity of the data are considered substantially more important because statistical data would not answer the research question[16]. In other words, the research question demanded an explanatory theory, not a representative theory of the defined phenomena, which was achieved by the robust use of the research methods.

The grounded theory research methods were critically appraised in 6.4. A limitation that was identified is the potential influence of confirmation bias, namely during data analysis. To mitigate the risk of confirmation bias, an explicit and transparent description of how the methods were used is provided. An example of how the data was editing for analysis and of memo-writing is also provided in Table 12. Furthermore, the mapping of open coding concepts, axial coding categories, and selective coding conditional matrix with data is an explicit presentation of the data analysis methods. Thus, the potential influence of confirmation bias is mitigated by academic rigour and transparency; therefore, the methods and findings of this research can be (and should be) critically appraised by other researchers.

10.5 Summary

In this chapter the findings of the grounded theory study, and the methodological and empirical tests are synthesised with the existing body of literature and knowledge about health, risks, and remote environments. The

[16] What is an explanatory, evidence-based theory of how PFC mitigates risks to health in remote environments?

findings suggest that the research aim and objectives have been achieved, and the research question answers. In other words, the PFC grounded theory has met the quality indicators outlined in 6.5, which provide evidence that an original and significant contribution to knowledge of how PFC mitigates risks to health in remote environments has been achieved. Furthermore, findings from the methodological and empirical tests have provided evidence that the PFC grounded theory is an explanatory, evidence-based theory of how PFC mitigates risks to health in remote environments; this answers the research question.

The synthesis of the research findings has limitations, which have been outlined and critically appraised in this chapter. Further research of the PFC grounded theory will provide additional insights into the applicability, and contribute to the efficacy of informing practitioners, policy-makers, and educators on how to mitigate risks to health in remote environments. Despite the limitations of this research, the findings are still valid for the purposes of achieving the research aim and objectives and answering the research question.

The contributions to theory, methodology, and empirics have been outlined and critically appraised in this chapter. The critical appraised has focused on the body of literature, and the context of this research outlined in Chapter 2. This situates this thesis in the fields of study within the research context and informs future research of health and risk in remote environments. The conclusions of this research are presented in Chapter 11.

Chapter 11 Conclusions

11.1 Introduction

In this chapter the conclusions of this research are brought together and critically appraised. The key findings are summarised explicitly and concisely to highlight the contributions to theory, methodology, and empirics that this research has made. In addition to the impact statement, key impacts that have occurred are outlined and suggestions are identified within this chapter. The key findings and research impact inform the considerations for future research, which are presented in this chapter.

11.2 Key findings

The key findings of this research have made original and significant contributions to knowledge at depth, rather than breadth. The contributions are theoretical, methodological, and empirical, which have been outlined and critically appraised in this thesis. In summary, the PFC grounded theory is the primary contribution to theory.

The PFC grounded theory is an explanatory, evidence-based theory of how PFC can be used in remote environments to mitigate risks to health. This is based on the experience of the research participants, which have shared data about how their clinical practice and training has contributed to mitigating risks to health. Their experiences were varied, thus the data that was collected was rich and comprehensive, as guided by theoretical sensitivity. Once theoretical saturation had been achieved, data collection and analysis ceased, and the PFC grounded theory had emerged. While the PFC grounded theory had emerged as a result of robust and valid research, greater depth of original and significant contributions to knowledge was achieved by the methodological an empirical tests.

The methodological test of the PFC grounded theory provided evidence that suggested it was an explanatory, evidence-based grounded theory of how

PFC could be used to plan for mitigating risk to health in remote environments. Evidence that the methodological test was successful was the identification of elements from the PFC grounded theory in the process of planning for mitigating risks to health during the analogue mission. The analogue mission was the vehicle that drove the methodological test; however, use of the analogue mission as a model case study made an original and significant contribution to methodology.

The analogue mission was identified as a model case study to achieve the simulation of a human exploration of another planet, the mission needed to take place in a remote environment with similarities to space. This was achieved by the analogue mission taking place on a remote and uninhabited island in Scotland. The methodological contribution was to align the concept analysis and grounded theory studies of this research. The impact of this alignment is it provides an example of how to evoke greater theoretical sensitivity for research using a Straussian grounded theory approach. For this research, the impact is strengthened rigour due to the continuity of research methods. Strengthened rigour improves the trustworthiness of the PFC grounded theory findings, as does findings of the empirical test.

Analogue mission design and plan was deployed as a case study to empirically test the PFC grounded theory. Evidence of the PFC grounded theory in practice and how it mitigated risks to health was identified. Thus, this is evidence of the research aim and objectives being achieved, and the research question answered. To mitigate the influence of bias, the Hardangervidda Plateau cross-country skiing expedition provided a case study that the researcher was not involved in the design, planning, or deployment. The identification of evidence of the PFC grounded theory in this case study contributed to the validity of the research findings. As critically appraised, further research will provide new insights and contributions to the PFC grounded theory. However, in addition to providing an empirical test, the analogue mission deployment was also a contribution to empirics.

The analogue mission simulated the human exploration of another planet by taking place on a remote and uninhabited island in Scotland. This type of analogue mission has never been conducted in the UK before. The analogue mission provides a field site for a programme of space research that was successfully completed. As a result, the analogue mission deployed provided a proof of concept that the UK can be used as an analogy to space exploration; therefore, future research could take place using analogue missions. In the next sections, considerations for future research are summarised.

11.3 Considerations for future research

The positionality of the researcher was explicitly outlined in 1.2, and the methodology that underpinned this research was critically appraised in Chapter 5. The rationale for including these was to provide transparency to the background, assumptions, and approaches that this research was conducted from. Future researchers should similarly consider their own perspectives when conducting research within the context of this research, which will identify how their perspectives align and differ with this research. The rationale for this is the emphasis of contextualism paradigm of this research. In other words, each experience of risks to health and PFC in remote environments is unique, which should be considered carefully in practice, policy making, and pre-deployment training, not least research. The intend impact of this is to ensure that risk mitigation is relative to the time, place, person(s), and activity in remote environments; thus, increasing the effectiveness and efficiency of PFC risk mitigation interventions.

It is clear from the literature review and the concept analysis (see Chapter 3 and Chapter 4) that PFC is a developing area of practice. Continued publications of case studies and algorithmic guidance will make valuable contributions to the body of literature due to the identification of lessons learned, not least how to mitigate risks to health. In addition to scholarly publications could be a database of anonymous case studies that has data about the injuries and illness relative to the time, place, person(s), and activity in a remote environment. Having access to this data could make valuable contributions to PFC policy and pre-deployment training. Furthermore, this data could be used in conjunction with the PFC grounded theory to design and plan risk mitigation interventions specific to the time, place, person(s), and activity in a remote environment. The potential impact of this would be lower incidents of injury and illness, which may provide additional data to further investigate the efficacy of the PFC grounded theory.

To further investigate the efficacy and scope of the PFC grounded theory, it has been suggested that future research could include a Delphi study and, or additional case study research. Findings from this research would provide new insights to the PFC grounded theory, in addition to findings from the methodological and empirical tests included in this research. It is important to highlight that future research of the PFC grounded theory and, by extension, risks to health in remote environments, will always provide new insights and findings. This is due to the dynamic nature of remote environments that was explored in the context of this research (see Chapter 2), and the ever-changing risks and hazards in remote environments. Thus, the PFC grounded theory is relative to time, place, person(s), and activity; therefore, as these dimensions to risks to health evolve, the PFC grounded theory will also develop overtime.

11.4 Final words

In this chapter, the conclusions of this research have been presented, including evidence that the research aim and objectives have been achieved, and the research question answered. The contributions to theory, methodology, and empirics have the potential to impact the practice, policy, and pre-deployment training related to health and risk in remote environments. The potential benefits that these impacts bring are mitigating risks to health in remote environments, which has been a key motivator for this research. Future research can build on these contributions and impacts, providing new insights to how the PFC grounded can be used in remote environments to mitigate risks to health.

References

ABHILASH, K. P. P. & SIVANANDAN, A. 2020. Early management of trauma: The golden hour. *Current Medical Issues,* 18**,** 36-39.

ADGER, W. N., DE CAMPOS, R. S. & MORTREUX, C. 2018. Mobility, displacement and migration, and their interactions with vulnerability and adaptation to environmental risks. *Routledge handbook of environmental displacement and migration.* Routledge.

AGUINIS, H., VASSAR, M. & WAYANT, C. 2021. On reporting and interpreting statistical significance and p values in medical research. *BMJ Evidence-Based Medicine,* 26**,** 39-42.

AHMED, S., CHASE, L. E., WAGNILD, J., AKHTER, N., STURRIDGE, S., CLARKE, A., CHOWDHARY, P., MUKAMI, D., KASIM, A. & HAMPSHIRE, K. 2022. Community health workers and health equity in low-and middle-income countries: systematic review and recommendations for policy and practice. *International Journal for Equity in Health,* 21**,** 49.

AL HARTHI, M., AL THOBAITY, A., AL AHMARI, W. & ALMALKI, M. 2020. Challenges for nurses in disaster management: a scoping review. *Risk management and healthcare policy***,** 2627-2634.

AL HILFI, T. K., LAFTA, R. & BURNHAM, G. 2013. Health services in Iraq. *The Lancet,* 381**,** 939-948.

ALHOJAILAN, M. I. 2012. Thematic analysis: A critical review of its process and evaluation. *West east journal of social sciences,* 1**,** 39-47.

ALI, A., AHMED, M. & HASSAN, N. 2021. Socioeconomic impact of COVID-19 pandemic: Evidence from rural mountain community in Pakistan. *Journal of Public Affairs,* 21**,** e2355.

ALTY, J., LAWLER, K., SALMON, K., MCDONALD, S., STUART, K., CLEARY, A., MA, J., RUDD, K., WANG, X. & CHIRANAKORN-COSTA, S. 2023. A new one-stop interdisciplinary cognitive clinic model tackles rural health inequality and halves the time to diagnosis: Benchmarked against a national dementia registry. *International Journal of Geriatric Psychiatry,* 38**,** e5988.

ALVAREZ, A. S., PAGANI, M. & MEUCCI, P. 2012. The clinical application of the biopsychosocial model in mental health: a research critique. *American journal of physical medicine & rehabilitation,* 91**,** S173-S180.

ANDERSEN, D., POPESCU, V., CABRERA, M. E., SHANGHAVI, A., MULLIS, B., MARLEY, S., GOMEZ, G. & WACHS, J. P. 2017. An augmented reality-based approach for surgical telementoring in austere environments. *Military medicine,* 182**,** 310-315.

ANDERSEN, M. H., OTTESEN, L. & THING, L. F. 2019. The social and psychological health outcomes of team sport participation in adults: An integrative review of research. *Scandinavian journal of public health,* 47**,** 832-850.

ANDREWS, G. J., HALL, E., EVANS, B. & COLLS, R. 2012. Moving beyond walkability: On the potential of health geography. *Social science & medicine,* 75**,** 1925-1932.

ANDREWS, L., BILES, B. & TAYLOR, I. 2009. Effective and transferable teaching methods from wilderness medicine: the students perspective. *The clinical teacher,* 6**,** 147-151.

ANTONSEN, E. L., CONNELL, E., ANTON, W., REYNOLDS, R. J., BUCKLAND, D. M. & VAN BAALEN, M. 2023. Updates to the NASA human system risk management process for space exploration. *npj Microgravity,* 9**,** 72.

ARBOUR, L., PARKINSON, A. & KULIG, J. C. 2010. Human health at the ends of the earth. James Cook University Townsville QLD.

BADZRI, S. B., BAKAR, A. K. & CLARE, V. Challenges and Effective Strategy for Managing Occupational Health and Industrial Hygiene at Onshore Remote Environments of Garraf, Iraq Operation. SPE International Conference and Exhibition on Health, Safety, Environment, and Sustainability?, 2018. SPE, D021S015R001.

BAKATHER, A. M., BINSAEEDU, A. S., ABBAD, A. A. B., BAJABER, A. O., BAWAZIR, A. A., ALAWADI, M. M., KAWEILH, O. R., ALJAAIDI, W. K., BAWAHAB, Y. O. & FADHL, Z. A. B. 2019. Healthcare of yemen: advancements and challenges. *Current Politics and Economics of the Middle East,* 10**,** 27-80.

BALL, J. A. & KEENAN, S. 2015. Prolonged Field Care Working Group Position Paper: Prolonged Field Care Capabilities. *Journal of special operations medicine,* 15**,** 76-77.

BARRETT, E. A. M. 2002. What is nursing science? *Nursing Science Quarterly,* 15**,** 51-60.

BEAUCHAMP, T. L. & CHILDRESS, J. F. 2001. *Principles of biomedical ethics*, Oxford University Press, USA.

BEDARD, A. F., MATA, L. V., DYMOND, C., MOREIRA, F., DIXON, J., SCHAUER, S. G., GINDE, A. A., VIKHYAT, B., MOORE, E. E. & MOULD-MILLMAN, N.-K. 2020. A scoping review of worldwide studies evaluating the effects of prehospital time on trauma outcomes. *International Journal of Emergency Medicine (Online),* 13.

BEECROFT, C., BOOTH, A. & REES, A. 2015. Finding the evidence. *In:* GERRISH, K. & LACEY, A. (eds.) *The research process in nursing.* 7 ed. Chichester: John Wiley & Sons.

BIALAS, C., MOSER, C. & SIMS, C. A. 2019. Artificial oxygen carriers and red blood cell substitutes: A historic overview and recent developments toward military and clinical relevance. *Journal of Trauma and Acute Care Surgery,* 87**,** S48-S58.

BIESTERVELD, B. E., SIDDIQUI, A. Z., O'CONNELL, R. L., REMMER, H., WILLIAMS, A. M., SHAMSHAD, A., SMITH, W. M., KEMP, M. T., WAKAM, G. K. & ALAM, H. B. 2021. Valproic Acid Protects Against Acute Kidney Injury in Hemorrhage and Trauma. *Journal of Surgical Research,* 266**,** 222-229.

BILAU, A. A., WITT, E. & LILL, I. 2018. Research methodology for the development of a framework for managing post-disaster housing reconstruction. *Procedia engineering,* 212**,** 598-605.

BINNS, C., HOKAMA, T. & LOW, W. Y. 2010. Island health: hope and challenges for public health. *Asia Pacific Journal of Public Health,* 22**,** 19-24.

BLUMER, H. 1970. What's wrong with social theory? *In:* FILSTEAD, W. J. (ed.) *Qualitative methodology: firsthand involvement with the social world.* Chicago: Markham Publishing Company.

BLUMER, H. 1986. *Symbolic interactionism: perspective and method,* California, University of California Press.

BODEKER, G. & KARIIPPANON, K. 2020. Traditional medicine and indigenous health in indigenous hands. *Oxford Research Encyclopedia of Global Public Health*.

BOLTON, D. & GILLETT, G. 2019. *The biopsychosocial model of health and disease: New philosophical and scientific developments*, Springer Nature.

BONANNO, A. M., GRAHAM, T. L., WILSON, L. N., MADTSON, B. M. & JAMES, D. R. 2018. Efficacy of the perfluorocarbon dodecafluoropentane as an adjunct to pre-hospital resuscitation. *PLoS One,* 13.

BOROWY, I. 2014. Shifting between biomedical and social medicine: international health organizations in the 20th Century. *History Compass,* 12**,** 517-530.

BOUTONNET, M., RAYNAUD, L., PASQUIER, P., VITIELLO, L., COSTE, S. & AUSSET, S. 2018. Critical Care Skill Triad for Tactical Evacuations. *Air Medical Journal,* 37**,** 362-366.

BOYATZIS, R. E. 1998. *Transforming qualitative information: Thematic analysis and code development*, sage.

BOYD, A. T., COOKSON, S. T., ANDERSON, M., BILUKHA, O. O., BRENNAN, M., HANDZEL, T., HARDY, C., HUSAIN, F., CARDOZO, B. L. & COLORADO, C. N. 2017. Centers for disease control and prevention public health response to humanitarian emergencies, 2007–2016. *Emerging infectious diseases,* 23**,** S196.

BRAUN, V. & CLARKE, V. 2006. Using thematic analysis in psychology. *Qualitative research in psychology,* 3**,** 77-101.

BRAUN, V. & CLARKE, V. 2019. Reflecting on reflexive thematic analysis. *Qualitative research in sport, exercise and health,* 11**,** 589-597.

BRAUN, V. & CLARKE, V. 2021. One size fits all? What counts as quality practice in (reflexive) thematic analysis? *Qualitative research in psychology,* 18**,** 328-352.

BRENDEL, E. 2014. Contextualism, relativism, and the semantics of knowledge ascriptions. *Philosophical Studies,* 168**,** 101-117.

BRICKNELL, M. C. M. & NADIN, M. 2017. Lessons from the organisation of the UK medical services deployed in support of Operation TELIC (Iraq) and Operation HERRICK (Afghanistan). *Journal of the Royal Army Medical Corps,* 163**,** 273.

BRIDGES, E. 2018. Regulated En Route Care-A Scoping Review. *In:* U.S. AIR FORCE SCHOOL OF AEROSPACE MEDICINE, A. R. D. (ed.). Wright-Patterson AFB, OH: Air Force Research Laboratory.

BRYANT, A. & CHARMAZ, K. 2007. Grounded theory in historical perspective: An epistemological account. *The SAGE handbook of grounded theory***,** 31-57.

BRYANT, A. & CHARMAZ, K. 2019. *The SAGE handbook of current developments in grounded theory*, Sage.

BUDIMSKI, M. 2018. Application of ultrasound in emergency medicine and resuscitation. *Journal Resuscitatio Balcanica,* 4**,** 131-136.

BUI, D. T., BARNETT, T., HOANG, H. T. & CHINTHAMMIT, W. 2021. Tele-mentoring using augmented reality technology in healthcare: A systematic review. *Australasian Journal of Educational Technology***,** 81-101.

CALLAWAY, D. W. M. D. F. 2017. Translating Tactical Combat Casualty Care Lessons Learned to the High-Threat Civilian Setting: Tactical Emergency Casualty Care and the Hartford Consensus. *Wilderness & environmental medicine,* 28**,** S140-S145.

CAMPBELL, K. A., ORR, E., DUREPOS, P., NGUYEN, L., LI, L., WHITMORE, C., GEHRKE, P., GRAHAM, L. & JACK, S. M. 2021. Reflexive thematic analysis for applied qualitative health research. *The Qualitative Report,* 26**,** 2011-2028.

CAMPBELL, M. R. & CHARLES, J. B. 2015. Historical review of lower body negative pressure research in space medicine. *Aerospace medicine and human performance,* 86**,** 633-640.

CAROLAN, M., ANDREWS, G. J. & HODNETT, E. 2006. Writing place: a comparison of nursing research and health geography. *Nursing Inquiry,* 13**,** 203-219.

CARRIE, H., MACKEY, T. K. & LAIRD, S. N. 2015. Integrating traditional indigenous medicine and western biomedicine into health systems: a review of Nicaraguan health policies and miskitu health services. *International journal for equity in health,* 14**,** 1-7.

CARVER, L. J. 2015. *Prolonged field care.* AIR UNIVERSITY.

CASTELLANOS, J., CORONEL-RUIZ, C., PARRA-ALVAREZ, S., CASTILLA, M., CALVO, E., ARÉVALO-HERRERA, M. & VELANDIA-ROMERO, M. 2016. Description of high rates of unapparent and simultaneous multiple dengue virus infection in a Colombian jungle settlement. *Tropical Biomedicine,* 33**,** 375-382.

CEVIK, C. & SELCUK, K. T. 2019. Prevalence and correlates of the use of complementary and alternative medicine in adults living in a rural area. *Holistic nursing practice,* 33**,** 36-44.

CHALELA, J. A. & BRITELL, P. E. 2019. Tactical neurocritical care. *Neurocritical care,* 30**,** 253-260.

CHAMBERLAIN, K. 2015. Epistemology and qualitative research. *Qualitative research in clinical and health psychology***,** 9-28.

CHANCELLOR, J. C., BLUE, R. S., CENGEL, K. A., AUÑÓN-CHANCELLOR, S. M., RUBINS, K. H., KATZGRABER, H. G. & KENNEDY, A. R. 2018. Limitations in predicting the space radiation health risk for exploration astronauts. *npj Microgravity,* 4**,** 8.

CHANG, C. D. 2019. Social determinants of health and health disparities among immigrants and their children. *Current problems in pediatric and adolescent health care,* 49**,** 23-30.

CHARLTON, S. & BRABAZON, T. 2020. Who is excluded from ‘Universal’health care?: Rurality, the marginalization of health services, and moving beyond social capital. *International Journal of Social Sciences & Educational Studies,* 7**,** 88-102.

CHARMAZ, K. 2008. Grounded theory as an emergent method. *Handbook of emergent methods,* 155**,** 172.

CHARMAZ, K. 2014. *Constructing grounded theory*, sage.
CHARMAZ, K. & MITCHELL, R. G. 2001. Grounded theory in ethnography. *In:* ATKINSON, P., COFFEY, A., DELAMONT, S., LOFLAND, J. & LOFLAND, L. (eds.) *Handbook of ethnography.*
CHARNELL, A. M. & RAINEY, O. H. 2019. Opportunistic medical simulation during high-fidelity military training. *Medical education,* 53**,** 515-516.
CHEN, S. C.-I., HU, R. & MCADAM, R. 2020. Smart, remote, and targeted health care facilitation through connected health: Qualitative study. *Journal of medical Internet research,* 22**,** e14201.
CHILDS, E. M., BOYAS, J. F. & BLACKBURN, J. R. 2022. Off the beaten path: A scoping review of how 'rural'is defined by the US government for rural health promotion. *Health Promotion Perspectives,* 12**,** 10.
CHINN, P. L. & KRAMER, M. K. 1983. Theory and nursing a systematic approach.
CHRISTENSEN, J. B. 2018. How the International Special Training Centre Is Training World-Class Medics: An Outline of the NATO Special Operations Combat Medic Course. *J Spec Oper Med,* 18**,** 103-108.
CHUN TIE, Y., BIRKS, M. & FRANCIS, K. 2019. Grounded theory research: A design framework for novice researchers. *SAGE open medicine,* 7**,** 2050312118822927.
CLARKE, A. E. 2005. *Situational analysis: grounded theory after the postmodern turn,* Thousand Oaks, CA, SAGE.
CLEMENS, M. S., STULL, M. C., RALL, J. M., STEWART, I. J., SOSNOV, J. A., CHUNG, K. K. & ROSS, J. D. 2018. Extracorporeal Filtration of Potassium in a Swine Model of Bilateral Hindlimb Ischemia–Reperfusion Injury With Severe Acute Hyperkalemia. *Military medicine,* 183**,** e335-e340.
CLÉMENT, G. 2011. *Fundamentals of space medicine*, Springer Science & Business Media.
CMICH, D. E. 1984. Theoretical perspectives of holistic health. *Journal of School Health,* 54**,** 30-32.
CONVERTINO, V. A., PARQUETTE, B. A., WAMPLER, D. A., MANIFOLD, C. A., LINDSTROM, D. A., BOLAND, L. L., BURKHART, N. T., LURIE, K. G. & LICK, C. J. 2017. Use of intrathoracic pressure regulation therapy in breathing patients for the treatment of hypotension secondary to trauma. *SCAND J TRAUMA RESUS,* 25**,** 105-105.
COOKE, A., SMITH, D. & BOOTH, A. 2012. Beyond PICO: the SPIDER tool for qualitative evidence synthesis. *Qualitative health research,* 22**,** 1435-1443.
CORBIN, J. M. & STRAUSS, A. L. 2015. *Basics of qualitative research: techniques and procedures for developing grounded theory,* London, SAGE.
CORCOSTEGUI, S.-P., DULAURENT, E. & LUFT, A. 2018. Management of a cardiac shock in an austere military environment (Northern Niger). *Anaesthesia Critical Care & Pain Medicine,* 37**,** 75-77.
CRESWELL, J. & MILLER, D. 2000. Determining validity in qualitative research: Theory into practice. McGraw Hill.
CRITICAL APPRAISAL SKILLS PROGRAMME. 2022. *CASP Qualitative Studies Checklist* [Online]. Available: https://casp-uk.net/casp-tools-checklists/ [Accessed 11 January 2022].

CROMWELL, R. L., HUFF, J. L., SIMONSEN, L. C. & PATEL, Z. S. 2021. Earth-based research analogs to investigate space-based health risks. *New Space,* 9**,** 204-216.

CROOKS, V., ANDREWS, G., PEARCE, J. & SNYDER, M. 2018. Introducing the Routledge handbook of health geography. *In:* CROOKS, V., ANDREWS, G. & PEARCE, J. (eds.) *Routledge handbook of health geography.* Oxford: Routledge.

CUELLAR, N. G., CAHILL, B., FORD, J. & AYCOCK, T. 2003. The development of an educational workshop on complementary and alternative medicine: what every nurse should know. *The Journal of Continuing Education in Nursing,* 34**,** 128-135.

CUNNINGHAM, S. D., SUTHERLAND, R. A., YEE, C. W., THOMAS, J. L., MONIN, J. K., ICKOVICS, J. R. & LEWIS, J. B. 2021. Group medical care: a systematic review of health service performance. *International Journal of Environmental Research and Public Health,* 18**,** 12726.

CUTCLIFFE, J. R. 2000. Methodological issues in grounded theory. *Journal of advanced nursing,* 31**,** 1476-1484.

D'ANGELO, M., WELDER, M., CHAUHAN, R. & KEARNS, M. J. 2019. Future Trends in Trauma Care: Through the Lens of the Wounded How Lessons from the Battlefield May Be Used at Home. *Anesthesiology Clinics,* 37**,** 183-193.

DADI, R., KALOLO, A., KAPOLOGWE, N. A., KIBUSI, S. M., TANNER, M. & DE SAVIGNY, D. 2023. Beyond Health-System Building Blocks: Context and Determinants of Health. *Primary Health Care in Tanzania through a Health Systems Lens: A History of the Struggle for Universal Health Coverage.* CABI GB.

DAHLGREN, G. & WHITEHEAD, M. 2021. The Dahlgren-Whitehead model of health determinants: 30 years on and still chasing rainbows. *Public health,* 199**,** 20-24.

DALEY, K., CASTLEDEN, H., JAMIESON, R., FURGAL, C. & ELL, L. 2015. Water systems, sanitation, and public health risks in remote communities: Inuit resident perspectives from the Canadian Arctic. *Social Science & Medicine,* 135**,** 124-132.

DALLIMORE, J., ANDERSON, S. R., IMRAY, C., JOHNSON, C., MOORE, J. & WINSER, S. 2023. *Oxford handbook of expedition and wilderness medicine*, Oxford University Press.

DANIEL, Y., HABAS, S., MALAN, L., ESCARMENT, J., DAVID, J. S. & PEYREFITTE, S. 2016. Tactical damage control resuscitation in austere military environments. *Journal of the Royal Army Medical Corps,* 162**,** 419.

DAVIES, A. 2021. COVID-19 and ICT-supported remote working: Opportunities for rural economies. *World,* 2**,** 139-152.

DAVIS, D. E. 2019. Too Big: Rebuild by Design: A Transformative Approach to Climate Change: Henk Ovink and Jelte Boeijenga Nai010 Publishers, 2018 288 pages $40.00 USD. *Technology***|** *Architecture+ Design,* 3**,** 117-119.

DEEPAK, G., LADAS, A., SAMBO, Y. A., PERVAIZ, H., POLITIS, C. & IMRAN, M. A. 2019. An overview of post-disaster emergency communication systems in the future networks. *IEEE Wireless Communications,* 26**,** 132-139.

DEROSE, K. 2011. *The case for contextualism: Knowledge, skepticism, and context, vol. 1*, Oup Oxford.
DESOUCY, E., SHACKELFORD, S., DUBOSE, J. J., ZWEBEN, S., RUSH, S. C., KOTWAL, R. S., MONTGOMERY, H. R. & KEENAN, S. 2017. Review of 54 Cases of Prolonged Field Care. *J Spec Oper Med,* 17**,** 121-129.
DHILLON, A., AHMAD MOHAMMAD SALMAN, Z., BREEZE, J. & BLANCH, R. J. 2020. Prolonged deployed hospital care in the management of military eye injuries. *Eye,* 34**,** 2106-2111.
DICKINSON, A., DALAL, S. & BEALES, L. 2016. Returning to contingency: the forward trauma team. *Journal of the Royal Army Medical Corps,* 162**,** 400.
DOBSON, G. P. & LETSON, H. L. 2020. Far Forward Gaps in Hemorrhagic Shock and Prolonged Field Care: An Update of ALM Fluid Therapy for Field Use. *J Spec Oper Med,* 20**,** 128-134.
DONABEDIAN, A. 2002. *An introduction to quality assurance in health care,* Oxford, Oxford University Press.
DUGGLEBY, W. & WILLIAMS, A. 2016. Methodological and epistemological considerations in utilizing qualitative inquiry to develop interventions. *Qualitative health research,* 26**,** 147-153.
DUNNE, C. 2011. The place of the literature review in grounded theory research. *International Journal of Social Research Methodology,* 14**,** 111-124.
EGHAREVBA, H. O., IBRAHIM, J. A., KASSAM, C. D. & KUNLE, O. F. 2015. Integrating traditional medicine practice into the formal health care delivery system in the new millennium–the Nigerian approach: a review. *Int J Life Sci,* 4**,** 120-128.
ELLINGSON, L. L. & ELLIS, C. 2008. Autoethnography as constructionist project. *Handbook of constructionist research,* 445.
EUROPEAN SPACE AGENCY. 2022. *Final figures show astronaut applicants from all ESA member states* [Online]. Paris: European Space Agency. Available: https://www.esa.int/About_Us/Careers_at_ESA/ESA_Astronaut_Selection/Final_figures_show_astronaut_applicants_from_all_ESA_Member_States [Accessed 27 April 2022].
FAIRMAN, J. C., LECH, P. L., MCCORMICK, M. R. & BUXTON, M. P. 2022. Strategies for Supporting Teachers' Instructional and Mental Health Needs during the COVID Pandemic in Maine and Other States.
FARMER, J., MUNOZ, S. A. & THRELKELD, G. 2012. Theory in rural health. *Australian Journal of Rural Health,* 20**,** 185-189.
FATONI, F., PANDURAGAN, S. L., SANSUWITO, T. & PUSPORINI, L. S. 2022. Community first aid training for disaster preparedness: a review of education content. *KnE Life Sciences***,** 549–558-549–558.
FEIRING, B. 2013. Indigenous peoples' rights to lands, territories and resources. *International Land Coalition, Rome,* 94**,** 12-21.
FISHER, A. D., MILES, E. A., CAP, A. P., STRANDENES, G. & KANE, S. F. 2015. Tactical damage control resuscitation. *Military medicine,* 180**,** 869-875.
FLICK, U. 1992. Triangulation revisited: strategy of validation or alternative? *Journal for the theory of social behaviour*.

FLICK, U. 2017. Mantras and myths: The disenchantment of mixed-methods research and revisiting triangulation as a perspective. *Qualitative Inquiry,* 23**,** 46-57.

FLICK, U. 2018. *Doing grounded theory*, Sage.

FOLEY, A. S. & DAVIS, A. H. 2017. A guide to concept analysis. *Clinical nurse specialist,* 31**,** 70-73.

FORRESTER, J. D., AUGUST, A., CAI, L. Z., KUSHNER, A. L. & WREN, S. M. 2019. The golden hour after injury among civilians caught in conflict zones. *Disaster medicine and public health preparedness,* 13**,** 1074-1082.

FRAIMAN, Y. S. & WOJCIK, M. H. 2021. The influence of social determinants of health on the genetic diagnostic odyssey: who remains undiagnosed, why, and to what effect? *Pediatric research,* 89**,** 295-300.

FUKADA, M. 2018. Nursing competency: Definition, structure and development. *Yonago acta medica,* 61**,** 001-007.

GAFFLEY, M. & WILLIAMS, T. 2022. 12 - Endovascular Variable Aortic Control. *In:* RASMUSSEN, T. E. & TAI, N. R. M. (eds.) *Rich's Vascular Trauma (Fourth Edition).* Philadelphia: Elsevier.

GARRY, S. & CHECCHI, F. 2020. Armed conflict and public health: into the 21st century. *Journal of Public Health,* 42**,** e287-e298.

GÉCZY, I., SAEWYC, E. M., POON, C. S. & HOMMA, Y. 2020. Health-risk behaviors and protective factors among adolescents in rural British Columbia. *The Journal of Rural Health,* 36**,** 65-76.

GEILING, J., BURKLE JR, F. M., AMUNDSON, D., DOMINGUEZ-CHERIT, G., GOMERSALL, C. D., LIM, M. L., LUYCKX, V., SARANI, B., UYEKI, T. M. & WEST, T. E. 2014. Resource-poor settings: infrastructure and capacity building. *Chest,* 146**,** e156S-e167S.

GENCER, E. A. 2013. Natural disasters, urban vulnerability, and risk management: a theoretical overview. *The interplay between urban development, vulnerability, and risk management: A case study of the Istanbul metropolitan area***,** 7-43.

GLASER, B. 1992. *Basics of grounded theory analysis: emergence vs forcing,* Mill Valley, CA, Sociology Press.

GLASER, B. G. 1978. *Theoretical sensitivity*, University of California.

GLASER, B. G. 1998. *Doing grounded theory: issues and discussions,* Mill Valley, CA, Sociology Press

GLASER, B. G. 2001. *The grounded theory perspective: Conceptualization contrasted with description,* Mill Valley, CA, Sociology Press.

GLASER, B. G. & STRAUSS, A. L. 1967. *Discovery of grounded theory: strategies for qualitative research*, Routledge.

GLASER, J. M. C. U. S. N., ZEMAN, J. M. C. U. S. N., NOBLE, S. M. C. U. S. N. & FERNANDEZ, N. M. C. U. S. N. 2018. CAVH in the Combat Environment: A Case Report and Lessons Learned in Southern Afghanistan. *Military Medicine,* 183**,** E167-E171.

GOLEMBIEWSKI, E. H., GRAVHOLT, D. L., ROLDAN, V. D. T., NARANJO, E. P. L., VALLEJO, S., BAUTISTA, A. G., LAVECCHIA, C. M., PATTEN, C. A., ALLEN, S. V. & JALADI, S. 2022. Rural patient experiences of accessing care for chronic conditions: A systematic review and thematic synthesis of qualitative studies. *The Annals of Family Medicine,* 20**,** 266-272.

GÓMEZ, B. I., MCINTYRE, M. K., GURNEY, J. M., CHUNG, K. K., CANCIO, L. C., DUBICK, M. A. & BURMEISTER, D. M. 2018. Enteral resuscitation with oral rehydration solution to reduce acute kidney injury in burn victims: Evidence from a porcine model. *PLoS One,* 13.

GRANT, M. J. & BOOTH, A. 2009. A typology of reviews: an analysis of 14 review types and associated methodologies. *Health information & libraries journal,* 26**,** 91-108.

GROEMER, G. & OZDEMIR, S. 2020. Planetary analog field operations as a learning tool. *Frontiers in Astronomy and Space Sciences,* 7**,** 32.

GROEMER, G., SOUCEK, A., FRISCHAUF, N., STUMPTNER, W., RAGONIG, C., SAMS, S., BARTENSTEIN, T., HÄUPLIK-MEUSBURGER, S., PETROVA, P. & EVETTS, S. 2014. The MARS2013 Mars analog mission. *Astrobiology,* 14**,** 360-376.

GUERRERO, H., GUERRERO & RAUSCHER 2019. *Excel data analysis*, Springer.

GUMBLEY, A. E., CLAYDON, M. A., BLANKENSTEIN, T. N. & FELL, T. H. 2013. Medical provision in forward locations in Afghanistan: the experiences of General Duties Medical Officers on Op HERRICK 15. *Journal of the Royal Army Medical Corps,* 159**,** 68.

HALL, W. A. & CALLERY, P. 2001. Enhancing the rigor of grounded theory: Incorporating reflexivity and relationality. *Qualitative health research,* 11**,** 257-272.

HAN, S. Y., KIM, H. Y., LIM, J. H., CHEON, J., KWON, Y. K., KIM, H., YANG, G. Y. & CHAE, H. 2016. The past, present, and future of traditional medicine education in Korea. *Integrative medicine research,* 5**,** 73-82.

HARDING, S. & LIBAL, K. 2019. War and the public health disaster in Iraq. *In:* LUTZ, C. & MAZZARINO, A. (eds.) *War and health: The medical consequences of the wars in Iraq and Afghanistan.* New York: New York University Press.

HARDY, W., ROBERTS, R. & HARDY, L. 2019. Developing excellence in outdoor provision, enhancing training pathways for outdoor qualifications: the Mountain Leader qualification. Bangor: University of Bangor.

HÄUPLIK-MEUSBURGER, S., BINSTED, K. & BASSINGTHWAIGHTE, T. Habitability studies and full scale simulation research: preliminary themes following HISEAS mission IV. 2017. 47th International Conference on Environmental Systems.

HAWKINS, S. C., MILLIN, M. G. & SMITH, W. R. 2021. Wilderness EMS. *Emergency Medical Services: Clinical Practice and Systems Oversight,* 2**,** 392-405.

HAWKINS, S. C. & SIMON, R. B. 2021. Ten Myths about Medical Emergencies and Medical Kits. *Advances in Archaeological Practice,* 9**,** 23-33.

HEATH, H. & COWLEY, S. 2004. Developing a grounded theory approach: a comparison of Glaser and Strauss. *International journal of nursing studies,* 41**,** 141-150.

HENNESSY, T. W. & BRESSLER, J. M. 2016. Improving health in the Arctic region through safe and affordable access to household running water and sewer services: an Arctic Council initiative. *International journal of circumpolar health,* 75**,** 31149.

HENNING-SMITH, C. 2021. The unique impact of COVID-19 on older adults in rural areas. *Older Adults and COVID-19.* Routledge.

HERRON, R. & SKINNER, M. 2018. Conceptualizing rural. *Routledge Handbook of Health Geography*.

HOAREAU, G. L. 2017. *Renal Effects of Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) Therapy Following Traumatic Hemorrhagic Shock.* Ph.D., University of California, Davis.

HODKINSON, P., ANDERTON, R., POSSELT, B. & FONG, K. 2017. An overview of space medicine. *BJA: British Journal of Anaesthesia,* 119**,** i143-i153.

HONG, Q. N., PLUYE, P., FÀBREGUES, S., BARTLETT, G., BOARDMAN, F., CARGO, M., DAGENAIS, P., GAGNON, M.-P., GRIFFITHS, F. & NICOLAU, B. 2019. Improving the content validity of the mixed methods appraisal tool: a modified e-Delphi study. *Journal of clinical epidemiology,* 111**,** 49-59. e1.

HOOD, J. C. 2007. Orthodoxy vs. power: the defining traits of grounded theory. *In:* BRYANT, A. & CHARMAZ, K. (eds.) *The SAGE handbook of grounded theory.* London: SAGE.

HOOPER, T. J., DE PASQUALE, M., STRANDENES, G., SUNDE, G. & WARD, K. R. 2014. Challenges and possibilities in forward resuscitation. *Shock,* 41**,** 13-20.

HOSPENTHAL, D. R., GREEN, A. D., CROUCH, H. K., ENGLISH, J. F., POOL, J., YUN, H. C., MURRAY, C. K. & PANEL, P. O. C.-R. I. G. 2011. Infection prevention and control in deployed military medical treatment facilities. *Journal of Trauma and Acute Care Surgery,* 71**,** S290-S298.

HOWARD-PAYNE, L. 2016. Glaser or Strauss? Considerations for selecting a grounded theory study. *South African Journal of Psychology,* 46**,** 50-62.

HOWIE, W., SCOTT-HERRING, M., POLLAK, A. N. & GALVAGNO, S. M. 2020. Advanced Prehospital Trauma Resuscitation With a Physician and Certified Registered Nurse Anesthetist: The Shock Trauma “Go-Team”. *Air Medical Journal,* 39**,** 51-55.

HUDSON, I. L., BLACKBURN, M. B., STAUDT, A. M., RYAN, K. L. & MANN-SALINAS, E. A. 2020. Analysis of Casualties That Underwent Airway Management Before Reaching Role 2 Facilities in the Afghanistan Conflict 2008-2014. *Military Medicine,* 185**,** 10-18.

HUMPHREYS, J. S., WAKERMAN, J. & WELLS, R. 2006. What do we mean by sustainable rural health services? Implications for rural health research. *Australian Journal of Rural Health,* 14**,** 33-35.

HUNT, M., SCHWARTZ, L., PRINGLE, J., BOULANGER, R., NOUVET, E. & O'MATHÚNA, D. 2014. A research agenda for humanitarian health ethics. *PLoS currents,* 6.

HUTTER, P. J., ROSKI, J., WOODSON, J., MIDDLETON, A., KNEELAND, R., WORTHY, A., ZITELMAN, D., TRINH, T., CRUZ, S. D. & COOPER, E. 2019. Readiness of medical providers in the military health system: overview of operational and policy considerations. *Health Affairs,* 38**,** 1274-1280.

IERONIMAKIS, K. M., COLOMBO LTC, C. J., VALOVICH, J., MARK GRIFFITH, C., DAVIS CAPT, K. L. & PAMPLIN COL, J. C. 2021. The Trifecta of Tele-Critical Care: Intrahospital, Operational, and Mass Casualty Applications. *Military Medicine,* 186**,** 253-260.

JAHRE, M., PAZIRANDEH, A. & VAN WASSENHOVE, L. 2016. Defining logistics preparedness: a framework and research agenda. *Journal of Humanitarian Logistics and Supply Chain Management,* 6**,** 372-398.

JAMIE, R., DOUG, P. & PAUL, L. 2017. The loss of the golden hour. *Special warfare,* 30**,** 49.

JAVADI, M. & ZAREA, K. 2016. Understanding thematic analysis and its pitfall. *Demo,* 1**,** 33-39.

JESCHKE, E. A. 2018. Adapting to Death: Clarifying the Roles of Special Operations Combat Medics in Prolonged Field Care. *J Spec Oper Med,* 18**,** 153-156.

JOHNSON, S. A., LAUBY, R. S., FISHER, A. D., NAYLOR, J. F., APRIL, M. D., LONG, B. & SCHAUER, S. G. 2022. An analysis of conflicts across role 1 guidelines. *Military medicine,* 187**,** e263-e274.

JORDAN, K., LEWIS, T. P. & ROBERTS, B. 2021. Quality in crisis: a systematic review of the quality of health systems in humanitarian settings. *Conflict and health,* 15**,** 1-13.

KAROS, K., MCPARLAND, J. L., BUNZLI, S., DEVAN, H., HIRSH, A., KAPOS, F. P., KEOGH, E., MOORE, D., TRACY, L. M. & ASHTON-JAMES, C. E. 2020. The social threats of COVID-19 for people with chronic pain. *Pain,* 161**,** 2229.

KEENAN, S. 2015. Deconstructing the definition of prolonged field care. *J Spec Oper Med,* 15**,** 125.

KEENAN, S. & RIESBERG, J. C. 2017. Prolonged Field Care: Beyond the "Golden Hour". *Wilderness & Environmental Medicine,* 28**,** S135-S139.

KELLY, Y., O'ROURKE, N., FLYNN, R., HEGARTY, J. & O'CONNOR, L. 2023. Definitions of health and social care standards used internationally: A narrative review. *The International Journal of Health Planning and Management,* 38**,** 40-52.

KELMAN, I. 2014. Ethics of disaster research. *Geoethics: Ethical challenges and case studies in earth sciences,* 37.

KENDRA, J. & GREGORY, S. 2019. Ethics in disaster research: A new declaration. *Disaster research and the second environmental crisis: Assessing the challenges ahead***,** 319-341.

KENNY, A., FARMER, J., DICKSON-SWIFT, V. & HYETT, N. 2015. Community participation for rural health: a review of challenges. *Health Expectations,* 18**,** 1906-1917.

KHOO, M., KRIS, S. K., TJIANG, W., OOI, S. & KHAW, M. 2020. Space Medicine Propelling Earth-Based Medicine for the Advantage of Human on Earth–A Vision Beyond 2020. *J Regen Biol Med,* 2**,** 1-3.

KHORRAM-MANESH, A. & BURKLE, F. M. 2023. Civilian population victimization: a systematic review comparing humanitarian and health outcomes in conventional and hybrid warfare. *Disaster medicine and public health preparedness,* 17**,** e192.

KIM, J. K., KIM, K. H., SHIN, Y. C., JANG, B.-H. & KO, S.-G. 2020. Utilization of traditional medicine in primary health care in low-and middle-income countries: a systematic review. *Health Policy and Planning,* 35**,** 1070-1083.

KING, S., GARRETT, R., WRENCH, A. & LEWIS, N. The loneliness of relocating: Does the transition to university pose a significant health risk for rural and isolated students. First Year in Higher Education Conference, 2011 Brisbane, Australia.

KINGSTON, C., NISHA, B., KIRUBA, S. & JEEVA, S. 2007. Ethnomedicinal plants used by indigenous community in a traditional healthcare system. *Ethnobotanical Leaflets,* 2007**,** 7.

KIRKPATRICK, A. W., MCKEE, J. L., TIEN, C. H., LAPORTA, A. J., LAVELL, K., LESLIE, T., MCBETH, P. B., ROBERTS, D. J. & BALL, C. G. 2017. Abbreviated closure for remote damage control laparotomy in extreme environments: A randomized trial of sutures versus wound clamps comparing terrestrial and weightless conditions. *The American Journal of Surgery,* 213**,** 862-869.

KLENKE, K. 2016. Grounded Theory and Ethnography. *Qualitative Research in the Study of Leadership.* Emerald Group Publishing Limited.

KLICKER, M., ZOLLER, A. & REHNBERG, L. 2023. Safe Mars analog missions. *Acta Astronautica,* 203**,** 429-435.

KOHRT, B. A., MISTRY, A. S., ANAND, N., BEECROFT, B. & NUWAYHID, I. 2019. Health research in humanitarian crises: an urgent global imperative. *BMJ Global Health,* 4**,** e001870.

KOTWAL, R. S., HOWARD, J. T., ORMAN, J. A., TARPEY, B. W., BAILEY, J. A., CHAMPION, H. R., MABRY, R. L., HOLCOMB, J. B. & GROSS, K. R. 2016. The effect of a golden hour policy on the morbidity and mortality of combat casualties. *JAMA surgery,* 151**,** 15-24.

KRETOWICZ, P. 2010. The influence of socio-economic factors upon public health on the example of Podkarpackie voivodship. *Bulletin of Geography. Socio-economic series***,** 63-78.

KRITTANAWONG, C., SINGH, N. K., SCHEURING, R. A., URQUIETA, E., BERSHAD, E. M., MACAULAY, T. R., KAPLIN, S., DUNN, C., KRY, S. F. & RUSSOMANO, T. 2022. Human health during space travel: state-of-the-art review. *Cells,* 12**,** 40.

LECHNER, R., KÜPPER, T. & TANNHEIMER, M. 2018. Challenges of military health service support in mountain warfare. *Wilderness & environmental medicine,* 29**,** 266-274.

LEHMAN, B. J., DAVID, D. M. & GRUBER, J. A. 2017. Rethinking the biopsychosocial model of health: Understanding health as a dynamic system. *Social and personality psychology compass,* 11**,** e12328.

LEHMANN, U., DIELEMAN, M. & MARTINEAU, T. 2008. Staffing remote rural areas in middle-and low-income countries: a literature review of attraction and retention. *BMC health services research,* 8**,** 1-10.

LEIGHT, S. B. 2003. The application of a vulnerable populations conceptual model to rural health. *Public Health Nursing,* 20**,** 440-448.

LEMPERT, L. 2007. Asking questions of the data: memo writing int he grounded thoery tradition. *In:* BRYANT, A. & CHARMAZ, K. (eds.) *The SAGE handbook of grounded theory.* SAGE.

LEVERS, M.-J. D. 2013. Philosophical paradigms, grounded theory, and perspectives on emergence. *Sage Open,* 3**,** 2158244013517243.

LEWIS-BECK, M., BRYMAN, A. E. & LIAO, T. F. 2003. *The SAGE encyclopedia of social science research methods*, Sage Publications.

LINCOLN, Y. S. & GUBA, E. G. 1985. *Naturalistic inquiry*, sage.

LINN, Y. C. 2011. Evidence-based medicine for traditional Chinese medicine: exploring the evidence from a western medicine perspective. *Proceedings of Singapore Healthcare,* 20**,** 12-19.

LIU, N. T. & SALINAS, J. 2016. Machine learning and new vital signs monitoring in civilian en route care: A systematic review of the literature and future implications for the military. *Journal of Trauma and Acute Care Surgery,* 81**,** S111-S115.

LOPOUR, J. 2016. Spotlight on Yemen's Forgotten War and Humanitarian Disaster. Preventing the Next Syrian Refugee Crisis. *Preventing the Next Syrian Refugee Crisis (March 23, 2016). CIGI Paper Series*.

LORENTZOU, C., KOUVARAKIS, G., KOZYRAKIS, G. V., KAMPANIS, N. A., TRAHANATZI, I., FRAIDAKIS, O., TZANAKIS, N., KANAKIDOU, M., AGOURIDAKIS, P. & NOTAS, G. 2019. Extreme desert dust storms and COPD morbidity on the island of Crete. *International journal of chronic obstructive pulmonary disease***,** 1763-1768.

LUFT, A., CORCOSTEGUI, S.-P., MILLET, M., GILLARD, J., BOISSIER, J., RONDY, P., BANCAREL, J. & CARFANTAN, C. 2020. Aeromedical evacuations within the French armed forces: analysis of 2,129 patients. *Military Medicine,* 185**,** 468-476.

LYNG, S. 1990. *Holistic health and biomedical medicine: A countersystem analysis*, SUNY Press.

MADILL, A., JORDAN, A. & SHIRLEY, C. 2000. Objectivity and reliability in qualitative analysis: Realist, contextualist and radical constructionist epistemologies. *British journal of psychology,* 91**,** 1-20.

MAGUIRE, M. & DELAHUNT, B. 2017. Doing a thematic analysis: A practical, step-by-step guide for learning and teaching scholars. *All Ireland Journal of Higher Education,* 9.

MALLINSON, T. E. 2017. A review of ketorolac as a prehospital analgesic. *Journal of Paramedic Practice,* 9**,** 522-526.

MARQUES, B., MCINTOSH, J. & HALL, C. 2023. Cross-cultural Rongoā healing: a landscape response to urban health. *Landscape Research***,** 1-17.

MARTIN, S. M., FISHER, A. D., MELEDEO, M. A., WAMPLER, D., NICHOLSON, S. E., RACZEK, K., APRIL, M. D., WEYMOUTH, W. L., BYNUM, J. & SCHAUER, S. G. 2021. More sophisticated than a drink cooler or an old sphygmomanometer but still not adequate for prehospital blood: A market review of commercially available equipment for prehospital blood transport and administration. *Transfusion,* 61**,** S286-S293.

MASSEY, S. 2018. Work–leave rotation pattern and incidence of offshore workplace injury. *Occupational Medicine,* 68**,** 184-186.

MAZARELLA, J. A., PEKARI, T. B. & ANTOSH, I. J. 2022. An Updated Review of Improvised Ground Evacuation Platforms for Austere Special Operations Casualty Transport. *Med J (Ft Sam Houst Tex)***,** 56-61.

MCCARTNEY, G., POPHAM, F., MCMASTER, R. & CUMBERS, A. 2019. Defining health and health inequalities. *Public health,* 172**,** 22-30.

MCLEOD, M., BOYES, M., NORRIS, L., MAHER, A. & WELSH, H. 2012. Holistic health care in rural India. *Australian Journal of Rural Health,* 20**,** 167-167.

MCNAIR, C. & ROBINSON, S. E. Challenges in Rural Emergency Management. *Local Government Administration in Small Town America*, 266-279.

MCPHERSON, J., KENNEDY, C., SLOBOGEAN, G., HILSDEN, R. & TALBOT, M. 2022. Augmented-reality telementoring for leg fasciotomy: a proof-of-concept study. *BMJ MILITARY HEALTH*.

MELLOR, A., DODDS, N., JOSHI, R., HALL, J., DHILLON, S., HOLLIS, S., DAVIS, P., HILLEBRANDT, D., HOWARD, E., WILKES, M., LANGDANA, B., LEE, D., HINSON, N., WILLIAMS, T. H., ROWLES, J. & PYNN, H. 2015. Faculty of Prehospital Care, Royal College of Surgeons Edinburgh guidance for medical provision for wilderness medicine. *Extreme physiology & medicine,* 4**,** 22-22.

MELLOR, A., OBOLENSKY, L., SEREBRIAKOFF, P., HINSON, N., HILLEBRANDT, D., WINSER, S., WHITMORE, W., GAULT, L., GROGAN, C., HALL, J. & IMRAY, C. 2020. *Updated guidance on medical provision for wilderness medicine* [Online]. Edinburgh: Faculty of Pre-Hospital Care, Royal College of Surgeons of Edinburgh. Available: https://fphc.rcsed.ac.uk/media/2781/updated-guidance-on-medical-provision-for-wilderness-medicine.pdf [Accessed 02 October 2020].

MESAR, T., LESSIG, A. & KING, D. R. 2018. Use of Drone Technology for Delivery of Medical Supplies During Prolonged Field Care. *J Spec Oper Med,* 18**,** 34-35.

MEYER, D. Z. & AVERY, L. M. 2009. Excel as a qualitative data analysis tool. *Field methods,* 21**,** 91-112.

MEYER, E. G. & WYNN, G. H. 2018. The importance of US military cultural competence. *Military and veteran mental health***,** 15-33.

MICROSOFT CORPORATION 2021. Microsoft Excel for Mac. 16.54 ed. London: Microsoft Coporation.

MILLINS, C., LEO, W., MACINNES, I., FERGUSON, J., CHARLESWORTH, G., NAYAR, D., DAVISON, R., YARDLEY, J., KILBRIDE, E. & HUNTLEY, S. 2021. Emergence of Lyme disease on treeless islands, Scotland, United Kingdom. *Emerging Infectious Diseases,* 27**,** 538.

MILLS, G. H. & MILLS, C. N. 2008. Challenges of air medical evacuation from Antarctica. *Air Medical Journal,* 27**,** 281-285.

MILLS, I. J. 2017. A person-centred approach to holistic assessment. *Primary dental journal,* 6**,** 18-23.

MILLS, J., BONNER, A. & FRANCIS, K. 2006. The development of constructivist grounded theory. *International journal of qualitative methods,* 5**,** 25-35.

MINISTRY OF DEFENCE 2014. The Operational Patient Care Pathway: Joint Services Publication 950. *In:* DEFENCE, M. O. (ed.). London: Ministry of Defence.

MINISTRY OF DEFENCE 2019. Allied Joint Publication-4.10 (B). Allied Joint Doctrine for Medical Support.

MJØSET, L. 2009. The contextualist approach to social science methodology. *In:* BYRNE, D. & RAGIN, C. (eds.) *The SAGE handbook of case-based methods.*

MOORE, J. 2009. An exploration of the origin of classic grounded theory. *Nurse researcher,* 17.

MORA, P. V. 2020. *Application of lean philosophy to the delivery of blood components through drones.* MSc Business Administration Universidade Federal Do Rio De Janeiro.

MORGAN, C. G., NEIDERT, L. E., HATHAWAY, E. N., RODRIGUEZ, G. J., SCHAUB, L. J., CARDIN, S. & GLASER, J. J. 2019. Evaluation of prolonged 'Permissive Hypotension': results from a 6-hour hemorrhage protocol in swine. *Trauma Surgery & Acute Care Open,* 4.

MORSE, J. M. 2010. Sampling in grounded theory. *The SAGE handbook of grounded theory***,** 229-244.

MORTON, M. J. & BURNHAM, G. M. 2010. Dilemmas and controversies within civilian and military organizations in the execution of humanitarian aid in Iraq: a review. *American journal of disaster medicine,* 5**,** 385-391.

MOULD-MILLMAN, N.-K., KEENAN, S., DIXON, J., STEYN, E., LATEGAN, H. J., VRIES, S. D., MATA, L. V., PATEL, C., SCHAUER, S. G., FISHER, A. D., APRIL, M. D., GINDE, A. A. & BEBARTA, V. S. 2022. An Innovative Civilian Research Model to Inform Combat-Relevant Prolonged Casualty Care. *U.S. Army Medical Department journal***,** 62.

MRUCK, K. & MEY, G. N. 2007. Grounded theory and reflexivity. *In:* BRYANT, A. & CHARMAZ, K. (eds.) *The SAGE handbook of grounded theory.* London: SAGE.

MUKHOPADHYAY, A. K., TAKEDA, Y. & BALAKRISH NAIR, G. 2014. Cholera outbreaks in the El Tor biotype era and the impact of the new El Tor variants. *Cholera Outbreaks***,** 17-47.

MULLINS-OWENS, H. 2016. *Integrative health services: Ethics, law, and policy for the new public health workforce*, Springer.

MUNOZ, S. A. 2014. Rural health geography. *The Wiley Blackwell Encyclopedia of Health, Illness, Behavior, and Society***,** 2085-2088.

MURPHY, P., BURGE, F. & WONG, S. T. 2019. Measurement and rural primary health care: a scoping review. *Rural and Remote Health,* 19**,** 1-10.

MURRAY, C. K. & JONES, S. L. 2016. Army Medical Department at War: Healthcare in a Complex World. *U.S. Army Medical Department journal***,** 199-208.

MURRAY, C. K. M. D. 2017. Field Wound Care: Prophylactic Antibiotics. *Wilderness & environmental medicine,* 28**,** S90-S102.

NAPOLITANO, L. M. 2021. Hemostatic defects in massive transfusion: an update and treatment recommendations. *Expert Review of Hematology,* 14**,** 219-239.

NETTESHEIM, N., POWELL, D., VASIOS, W., MBUTHIA, J., DAVIS, K., YOURK, D., WAIBEL, K., KRAL, D., MCVEIGH, F. & PAMPLIN, J. 2018. Telemedical Support for Military Medicine. *Military Medicine,* 183**,** E462-E470.

NGUYEN, N. H., SUBHAN, F. B., WILLIAMS, K. & CHAN, C. B. Barriers and mitigating strategies to healthcare access in indigenous communities of Canada: a narrative review. Healthcare, 2020. MDPI, 112.

NIERMEYER, S., MOLLINEDO, P. A. & HUICHO, L. 2009. Child health and living at high altitude. *Archives of disease in childhood,* 94**,** 806-811.

NIMEGEER, A., FARMER, J., MUNOZ, S. A. & CURRIE, M. 2016. Community participation for rural healthcare design: description and critique of a method. *Health & Social Care in the Community,* 24**,** 175-183.

NOTARA, V., KOKKOU, S., BINDAKOS, E., SAKELLARI, E. & SKANAVIS, C. 2023. Differences between Urban and Rural Environments on Cardiovascular Health: A Systematic Review. *Journal of Environmental Pathology, Toxicology and Oncology,* 42.

NUOPPONEN, A. 2010. Methods of concept analysis-a comparative study. *LSP Journal-Language for special purposes, professional communication, knowledge management and cognition,* 1.

NZWEUNDJI, J. G. & AGBOR, G. A. 2019. Refugee health problems in the central African subregion: The role of traditional medicine. *Journal of the Cameroon Academy of Sciences,* 14**,** 189-201.

ODHAIB, S. A., MANSOUR, A. A., KHALIFA, S. F., SHEGEM, N., THANNON, W., ABI SAAD, M., ABDULRAZAQ, H., BELKHADIR, J., SANDID, M. & MASOOD, S. N. 2022. Impact of humanitarian crises on diabetes care in Iraq and Syria—IDF-MENA region. *Journal of Diabetology,* 13**,** S38-S47.

OLIVER, S. J. 2013. The role of traditional medicine practice in primary health care within Aboriginal Australia: a review of the literature. *Journal of ethnobiology and ethnomedicine,* 9**,** 1-8.

ORTE, C. J. S., NWOSU, N., MANIAGO, J., MATIBAG, R., CORPUZ, A. & CABALUNA, J. 2021. Health Promotion Practices in Nursing: A Scoping Review. *Pakistan Journal of Medical and Health Sciences,* 15**,** 2273-2278.

OSE, S. O. 2016. Using Excel and Word to structure qualitative data. *Journal of Applied Social Science,* 10**,** 147-162.

PACE, S. 2016. Contested concepts: negotiating debates about qualitative research methods such as grounded theory and autoethnography. *Constructing Methodology for Qualitative Research: Researching Education and Social Practices***,** 187-200.

PAGE, M. J., MCKENZIE, J. E., BOSSUYT, P. M., BOUTRON, I., HOFFMANN, T. C., MULROW, C. D., SHAMSEER, L., TETZLAFF, J. M., AKL, E. A. & BRENNAN, S. E. 2021. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *Bmj,* 372.

PAGEL, J. I. & CHOUKÈR, A. 2016. Effects of isolation and confinement on humans-implications for manned space explorations. *Journal of Applied Physiology*.

PALAFOX, N. A. & HIXON, A. L. 2011. Health consequences of disparity: the US Affiliated Pacific Islands. *Australasian Psychiatry,* 19**,** S84-S89.

PAMPLIN, J. C., DAVIS, K. L., MBUTHIA, J., CAIN, S., HIPP, S. J., YOURK, D. J., COLOMBO, C. J. & POROPATICH, R. 2019. Military Telehealth: A Model For Delivering Expertise To The Point Of Need In Austere And Operational Environments. *Health Affairs,* 38**,** 1386-1392,A1-A2.

PAMPLIN, J. C., FISHER, A. D., PENNY, A., OLUFS, R., RAPP, J., HAMPTON, K. K., RIESBERG, J., POWELL, D., KEENAN, S. & SHACKELFORD, S. 2017. Analgesia and Sedation Management During Prolonged Field Care. *J Spec Oper Med,* 17**,** 106-120.

PATTARINI, J. M., SCARBOROUGH, J. R., LEE SOMBITO, V. & PARAZYNSKI, S. E. 2016. Primary care in extreme environments: Medical clinic utilization at Antarctic stations, 2013–2014. *Wilderness & environmental medicine,* 27**,** 69-77.

PAWLUCH, D. & NEITERMAN, E. 2010. What Is Grounded Theory and Where Does It Come from? *In:* BOURGEAULT, I., DINGWALL, R. & DE VRIES, R. (eds.) *The SAGE handbook of qualitative methods in health research.* London: SAGE Publishing.

PERSOFF, J., ORNOFF, D. & LITTLE, C. 2018. The role of hospital medicine in emergency preparedness: a framework for hospitalist leadership in disaster preparedness, response, and recovery. *Journal of hospital medicine,* 13**,** 713-718.

PICARD, M., SABISTON, C. M. & MCNAMARA, J. K. 2011. The need for a transdisciplinary, global health framework. *The Journal of Alternative and Complementary Medicine,* 17**,** 179-184.

POSSELT, B. N., VELHO, R., O'GRIOFA, M., SHEPANEK, M., GOLEMIS, A. & GIFFORD, S. E. 2021. Safety and healthcare provision in space analogs. *Acta Astronautica,* 186**,** 164-170.

POWELL, D., MCLEROY, R. D., RIESBERG, J., VASIOS, W. N., 3RD, MILES, E. A., DELLAVOLPE, J., KEENAN, S. & PAMPLIN, J. C. 2016. Telemedicine to Reduce Medical Risk in Austere Medical Environments: The Virtual Critical Care Consultation (VC3) Service. *J Spec Oper Med,* 16**,** 102-109.

PYNN, G. 2015. Contextualism in epistemology.

QUESADA-ROMÁN, A., VILLALOBOS-PORTILLA, E. & CAMPOS-DURÁN, D. 2021. Hydrometeorological disasters in urban areas of Costa Rica, Central America. *Environmental Hazards,* 20**,** 264-278.

QUINN, J. M., BENCKO, V., BONGARTZ, A. V., STOEVA, P., ARSOV, A. A., DE PORZI, S., BOHONEK, M., TI, R., TAYLOR, J., MITCHELL, J., REINHARD, V., MAJOVSKY, P., KUCA, J., KRAL, P., FAZEKAS, L. & BUBENIK, Z. 2020. Nato and evidence-based military and disaster medicine: Case for vigorous warrior live exercise series. *Central European journal of public health,* 28**,** 325-330.

RAILLANI, H., HAMMADI, L., SAMED, M. M. A., EL BALLOUTI, A. & BARBU, V. S. 2020. Humanitarian logistics in the disaster relief supply chain: state of the art. *WIT Transactions on Engineering Sciences.* Southampton: WIT Press.

RANAPURWALA, S. I., WING, S., POOLE, C., KUCERA, K. L., MARSHALL, S. W. & DENOBLE, P. J. 2017. Mishaps and unsafe conditions in recreational scuba diving and pre-dive checklist use: a prospective cohort study. *Injury epidemiology,* 4**,** 1-7.

RASMUSSEN, T. E., BAER, D. G., CAP, A. P. & LEIN, B. C. 2015. Ahead of the curve: Sustained innovation for future combat casualty care. *The journal of trauma and acute care surgery,* 79**,** S61-S64.

REDDOCH-CARDENAS, K. M., BYNUM, J. A., MELEDEO, M. A., NAIR, P. M., WU, X., DARLINGTON, D. N., RAMASUBRAMANIAN, A. K. & CAP, A. P. 2019. Cold-stored platelets: A product with function optimized for hemorrhage control. *Transfusion and Apheresis Science,* 58**,** 16-22.

REED, R. C. & BOURN, S. 2018. Prehospital emergency medicine – UK military experience. *BJA Education,* 18**,** 185-190.

REHMAN, A. A. & ALHARTHI, K. 2016. An introduction to research paradigms. *International Journal of Educational Investigations,* 3**,** 51-59.

ROBINSON, A. & CHESTERS, J. 2008. Rural diversity in CAM usage: The relationship between rural diversity and the use of complementary and alternative medicine modalities. *Rural Society,* 18**,** 64-75.

ROBINSON, A. & COOPER, S. 2007. Trusted information sources: The preferred option for complementary and alternative medicine users. *Complementary Health Practice Review,* 12**,** 120-138.

RODGERS, B. L. 1989. Concepts, analysis and the development of nursing knowledge: the evolutionary cycle. *Journal of advanced nursing,* 14**,** 330-335.

RODGERS, B. L. & KNAFL, K. A. 2000. *Concept development in nursing: Foundations, techniques, and applications,* Philadelphia, PA, Saunders.

ROSENBERG, M. W. 1998. Medical or health geography? Populations, peoples and places. *International Journal of Population Geography,* 4**,** 211-226.

ROYAL, P. & SMITH, M. 2020. A UK Military nurse practitioner on Exercise SAIF SAREEA 3: the first Overseas deployment. *BMJ Mil Health,* 166**,** 425-428.

RUSSELL, P. W., BENJAMIN, M. & ANDREW, C. 2020. Prolonged Field Care and Fresh Whole Blood. *Marine Corps Gazette,* 104**,** 59-64.

RUYTERS, G. & STANG, K. 2016. Space medicine 2025–a vision: space medicine driving terrestrial medicine for the benefit of people on Earth. *Reach,* 1**,** 55-62.

SALIYA, C. A. 2023. Research Philosophy: Paradigms, World Views, Perspectives, and Theories. *Social Research Methodology and Publishing Results: A Guide to Non-Native English Speakers.* IGI Global.

SBARAINI, A., CARTER, S. M., EVANS, R. W. & BLINKHORN, A. 2011. How to do a grounded theory study: a worked example of a study of dental practices. *BMC medical research methodology,* 11**,** 1-10.

SCALLAN, N. J., KEENE, D. D., BREEZE, J., HODGETTS, T. J. & MAHONEY, P. F. 2020. Extending existing recommended military casualty evacuation timelines will likely increase morbidity and mortality: a UK consensus statement. *BMJ Military Health,* 166**,** 287-293.

SCHLOTMAN, T. E., LEHNHARDT, K. R., ABERCROMBY, A. F., EASTER, B. D., DOWNS, M. E., AKERS, L. T. C. K. S. & CONVERTINO, V. A. 2019. Bridging the gap between military prolonged field care monitoring and exploration spaceflight: the compensatory reserve. *NPJ Microgravity,* 5**,** 1-11.

SCHROEDER, G. S., CLARK, J. C., GALLAGHER, M. & PANDYA, S. 2021. Medical guidelines for suborbital commercial human spaceflight: A review. *Acta Astronautica,* 187**,** 529-536.

SECULES, S., MCCALL, C., MEJIA, J. A., BEEBE, C., MASTERS, A. S., L. SÁNCHEZ-PEÑA, M. & SVYANTEK, M. 2021. Positionality practices and dimensions of impact on equity research: A collaborative inquiry and call to the community. *Journal of Engineering Education,* 110**,** 19-43.

SEVER, M. S., VANHOLDER, R. & LAMEIRE, N. 2020. Acute kidney injury in active wars and other man-made disasters. *Seminars in Nephrology,* 40**,** 341-353.

SHACKELFORD, S. A., DEL JUNCO, D. J., RIESBERG, J. C., POWELL, D., MAZUCHOWSKI, E. L., KOTWAL, R. S., LOOS, P. E., MONTGOMERY, H. R., REMLEY, M. A., GURNEY, J. M. & KEENAN, S. 2021. Case-control analysis of prehospital death and prolonged field care survival during recent US military combat operations. *Journal of Trauma & Acute Care Surgery,* 91**,** S186-S193.

SHIRAH, B., BUKHARI, H., PANDYA, S., EZMEIRLLY, H. A. & EZMEIRLLY, H. 2023. Benefits of Space Medicine Research for Healthcare on Earth. *Cureus,* 15.

SINGER, M. & BAER, H. 2018. *Critical medical anthropology*, Routledge.

SMITH, G. D. & WAINSCOT, A. 2021. Military healthcare challenges: deployed Role 1 healthcare delivery on Operation TRENTON. A personal view. *BMJ Military Health,* 167**,** 345-349.

SMITH, K. B., HUMPHREYS, J. S. & WILSON, M. G. 2008. Addressing the health disadvantage of rural populations: how does epidemiological evidence inform rural health policies and research? *Australian journal of rural health,* 16**,** 56-66.

SMITH, M., JOHNSTON, K. & WITHNALL, R. 2021. Systematic approach to delivering prolonged field care in a prehospital care environment. *BMJ Military Health,* 167**,** 93-98.

SMITH, M. & WITHNALL, R. 2018. Developing prolonged field care for contingency operations. *Trauma,* 20**,** 108-112.

SMITH, S. W., BRAUN, J., PORTELLI, I., MALIK, S., ASAEDA, G., LANCET, E., WANG, B., HU, M., LEE, D. C. & PREZANT, D. J. 2016. Prehospital indicators for disaster preparedness and response: New York City emergency medical services in hurricane sandy. *Disaster medicine and public health preparedness,* 10**,** 333-343.

SMITH, W. W. R. M. D. P. F. 2017. Integration of Tactical EMS in the National Park Service. *Wilderness & environmental medicine,* 28**,** S146-S153.

SNYDER, M. & WILSON, K. 2015. “Too much moving… there's always a reason”: Understanding urban Aboriginal peoples' experiences of mobility and its impact on holistic health. *Health & place,* 34**,** 181-189.

STAINTON, R. 2010. Contextualism in Epistemology and the Context Sensitivity of ‘Knows.’. *Knowledge and skepticism,* 5**,** 113-139.

STEFANOV, M., STOEV, S., KIM, J. & KIM, S. 2020. Western medicine versus Eastern medicine: do both have a common root, scientific background, and worldwide recognition. *Altern Ther Health Med,* 26**,** 38.

STEPANEK, J., BLUE, R. S. & PARAZYNSKI, S. 2019. Space medicine in the era of civilian spaceflight. *New England Journal of Medicine,* 380**,** 1053-1060.

STEWART, I. J., SNOW, B. D., CLEMENS, M., SOSNOV, J. A., ROSS, J. D. P., HOWARD, J. T. P. & CHUNG, K. 2017. Hyperkalemia in Combat Casualties: Implications for Delayed Evacuation. *Military Medicine,* 182**,** E2046-E2051.

STEWART, R. A. 2023. Building a rural and remote health workforce: an overview of effective interventions. *Medical Journal of Australia,* 219**,** S3-S4.

STRASSER, R. 2016. Learning in context: education for remote rural health care. *Rural and Remote Health,* 16**,** 1-6.

SURESH, M. R., VALDEZ-DELGADO, K. K., STAUDT, A. M., TREVINO, J. D., MANN-SALINAS, E. A. & VANFOSSON, C. A. 2021. An assessment of pre-deployment training for army nurses and medics. *Military Medicine,* 186**,** 203-211.

SURJAN, A., KUDO, S. & UITTO, J. I. 2016. Risk and vulnerability. *Sustainable development and disaster risk reduction***,** 37-55.

SUTTON, K. & ISAACS, A. 2020. Recovery in Mental Illness Among Rural Communities. *Handbook of Rural, Remote, and very Remote Mental Health***,** 1-25.

SYAHRIR, I. & VANANY, I. 2015. Healthcare and disaster supply chain: literature review and future research. *Procedia manufacturing,* 4**,** 2-9.

TAFFORIN, C. 2015. Comparison of spatiotemporal adaptive indicators in isolated and confined teams during the Concordia stay, Tara Drift and Mars-500 experiment. *Journal of Human Performance in Extreme Environments,* 12**,** 2.

TANIELIAN, T. & FARMER, C. 2019. The US Military Health System: promoting readiness and providing health care. *Health Affairs,* 38**,** 1259-1267.

TEOW, Y. E. E., NG, S. C., AZMI, A. H. M., HAMZAH, M. R., KAUR, J., MATHIARASU, D. S., MOGAN, D., ONG, S. C., SUBRAMANIAM, Y. P. & SWENESON, T. 2021. A cross-sectional evaluation of complementary and alternative medicine use in a non-urban Malaysian population. *Journal of community health,* 46**,** 515-521.

TERRY, G., HAYFIELD, N., CLARKE, V. & BRAUN, V. 2017. Thematic analysis. *In:* WILLIG, C. & ROGERS, W. S. (eds.) *The SAGE handbook of qualitative research in psychology.*

THE ENDNOTE TEAM 2013. EndNote. EndNote X9.3.3 ed. Philadelphia, PA: Clarivate.

THOMSON, S. B. 2010. Sample size and grounded theory. *Journal of Administration and Governance,* 5**,** 45-52.

TIMMERMANS, S. & TAVORY, I. 2007. Advancing ethnographic research through grounded theory practice. *In:* BRYANT, A. & CHARMAZ, K. (eds.) *The SAGE handbook of grounded theory.* London: SAGE.

TRAN, B. X., NGUYEN, L. H., NONG, V. M. & NGUYEN, C. T. 2016. Health status and health service utilization in remote and mountainous areas in Vietnam. *Health and quality of life outcomes,* 14**,** 1-9.

TRAVERS, S., CARFANTAN, C., LUFT, A., AIGLE, L., PASQUIER, P., MARTINAUD, C., RENARD, A., DUBOURG, O., DERKENNE, C., KEDZIEREWICZ, R., FRANCHIN, M., BAY, C., CAP, A. P. & AUSSET, S. 2019. Five years of prolonged field care: prehospital challenges during recent French military operations. *TRANSFUSION,* 59**,** 1459-1466.

TUCKETT, A. G. 2005. Applying thematic analysis theory to practice: A researcher's experience. *Contemporary nurse,* 19**,** 75-87.

UNITED NATIONS DEPARTMENT OF ECONOMIC AND SOCIAL AFFAIRS. 2018. *2018 Revision of World Urbanization Prospects* [Online]. New York: Population Division of the United Nations Department of Economic and Social Affairs. Available: https://population.un.org/wup/Publications/Files/WUP2018-Report.pdf [Accessed 11 September 2020].

UNITED NATIONS OFFICE FOR THE COORDINATION OF HUMANITARIAN AFFAIRS. 2022. *Humanitarian needs overview Yemen* [Online]. Geneva: United Nations. Available: https://www.unocha.org/yemen [Accessed 15 January 2023].

VAN GENT, J.-M., DAVIS, K., HENRY, N., ZANDER, A., KUETTEL, M., EDSON, T., NELSON, T. & TADLOCK, M. 2018. The Initial Impact of Tele-Critical Care on the Surgical Services of a Community Military Hospital. *Military Medicine,* 183**,** E494-E499.

VAN WYCK, D., LOOS, P. E., FRIEDLINE, N., STEPHENS, D., SMEDICK, B. C., MCCAFFERTY, R., RUSH, S. C., KEENAN, S., POWELL, D. & SHACKELFORD, S. 2017. Traumatic Brain Injury Management in Prolonged Field Care. *J Spec Oper Med,* 17**,** 130-140.

VAN WYK, N. 2005. Similarities in the meta-paradigm of nursing and traditional healing: an attempt to contribute to the integration of traditional medicine and western medicine in Africa: overview. *Health SA Gesondheid,* 10**,** 14-22.

VASILEIOU, K., BARNETT, J. & FRASER, D. S. 2022. Integrating local and scientific knowledge in disaster risk reduction: A systematic review of motivations, processes, and outcomes. *International Journal of Disaster Risk Reduction***,** 103255.

VASIOS, W. N., 3RD, PAMPLIN, J. C., POWELL, D., LOOS, P. E., RIESBERG, J. & KEENAN, S. 2017. Teleconsultation in Prolonged Field Care Position Paper. *J Spec Oper Med,* 17**,** 141-144.

VELASQUEZ, J. R. 2021. Neurophysiology of Space Medicine: A Literature Review.

VINCENT, S. & O'MAHONEY, J. 2018. Critical realism and qualitative research: An introductory overview. *The Sage handbook of qualitative business and management research methods*.

WADE, D. T. & HALLIGAN, P. W. 2004. Do biomedical models of illness make for good healthcare systems? *Bmj,* 329**,** 1398-1401.

WAISBERG, E., ONG, J., MASALKHI, M. & LEE, A. G. 2023. Space Medicine: The Next Frontier of Medical Education. *Prehospital and Disaster Medicine***,** 1-3.

WAKERMAN, J., BOURKE, L., HUMPHREYS, J. S. & TAYLOR, J. 2017. Is remote health different to rural health? *Rural and Remote Health,* 17**,** 1-8.

WALDMAN, R. J. & TOOLE, M. J. 2017. Where is the science in humanitarian health? *The Lancet,* 390**,** 2224-2226.

WALKER, D. & MYRICK, F. 2006. Grounded theory: An exploration of process and procedure. *Qualitative health research,* 16**,** 547-559.

WALKER, L. O. & AVANT, K. C. 1983. *Strategies for theory construction in nursing,* Prentice Hall Upper Saddle River, NJ, Pearson.

WALKER, L. O. & AVANT, K. C. 2018. *Strategies for theory construction in nursing,* Prentice Hall Upper Saddle River, NJ, Pearson.

WALSH, D. & DOWNE, S. 2006. Appraising the quality of qualitative research. *Midwifery,* 22**,** 108-119.

WALSH, S. M., VERSACE, V. L., THOMPSON, S. C., BROWNE, L. J., KNIGHT, S., LYLE, D. M., ARGUS, G. & JONES, M. 2023. Supporting nursing and allied health student placements in rural and remote

Australia: a narrative review of publications by university departments of rural health. *Medical Journal of Australia,* 219**,** S14-S19.

WALTON, M. E. & KERSTMAN, E. L. 2020. Quantification of medical risk on the international space station using the integrated medical model. *Aerospace Medicine and Human Performance,* 91**,** 332-342.

WANG, S., HOU, Y., LI, X., MENG, X., ZHANG, Y. & WANG, X. 2021. Practical implementation of artificial intelligence-based deep learning and cloud computing on the application of traditional medicine and western medicine in the diagnosis and treatment of rheumatoid arthritis. *Frontiers in Pharmacology,* 12**,** 765435.

WARRELL, D. & ANDERSON, S. 2014. Royal Geographical Society (with IBG). *Expedition Medicine.* Oxford: Routledge.

WEINERT, C., NICHOLS, E. & SHREFFLER-GRANT, J. 2021. Be Wise: A complementary and alternative medicine health literacy skill-building programme. *Health Education Journal,* 80**,** 327-336.

WEISS, E. L. & BATCHELOR, T. 2019. Expedition medicine. *Travel medicine.* Elsevier.

WELLS, W., LANE, T. & OLSON, N. 2018. Point of View Telemedicine at Point of Care. *Cureus,* 10.

WESTERHAUS, M., FINNEGAN, A., HAIDAR, M., KLEINMAN, A., MUKHERJEE, J. & FARMER, P. 2015. The necessity of social medicine in medical education. *Academic Medicine,* 90**,** 565-568.

WHITE, S. 2003. Autoethnography: An appropriate methodology. *Qualitative Research Journal,* 3**,** 22-32.

WHITE, S. & SMITH, M. B. 2020. Effects of heat: UK exercise Saif Sareea 3 and interpreting military climatic guidance. *BMJ Military Health,* 166**,** 401-405.

WHITING, M. D., DENGLER, B. A., RODRIGUEZ, C. L., BLODGETT, D., COHEN, A. B., JANUSZKIEWICZ, A. J., RASMUSSEN, T. E. & BRODY, D. L. 2020. Prehospital detection of life-threatening intracranial pathology: an unmet need for severe TBI in Austere, rural, and remote areas. *Frontiers in Neurology,* 11**,** 599268.

WHYBOURN, L. A., FOTHERGILL, D. M., QUATROCHE, A. J. & MOSS, N. A. 2019. A Critical Review of Casualties from Non-combat Submarine Incidents and Current US Navy Medical Response Capability with Specific Focus on the Application of Prolonged Field Care to Disabled Submarine Survival and Rescue. Groton, CT: Naval Submarine Medical Research Laboratory.

WILLIAMSON, J., RAMIREZ, R. & WINGFIELD, T. 2015. Health, healthcare access, and use of traditional versus modern medicine in remote Peruvian Amazon communities: a descriptive study of knowledge, attitudes, and practices. *The American journal of tropical medicine and hygiene,* 92**,** 857.

WOOD, S. M., ALSTON, L., BEKS, H., MC NAMARA, K., COFFEE, N. T., CLARK, R. A., SHEE, A. W. & VERSACE, V. L. 2023. Quality appraisal of spatial epidemiology and health geography research: A scoping review of systematic reviews. *Health & Place,* 83**,** 103108.

WORLD HEALTH ORGANIZATION. 2020. *Basic documents: constitution of the World Health Organization* [Online]. Geneva: World Health

Organization. Available: https://www.who.int/about/governance/constitution [Accessed 15 February 2023].

WYLER, B. A., YOUNG, H. M., HARGARTEN, S. W. & CAHILL, J. D. 2022. Risk of deaths due to injuries in travellers: a systematic review. *Journal of travel medicine,* 29**,** taac074.

ZAFREN, K., BRANTS, A., TABNER, K., NYBERG, A., PUN, M., BASNYAT, B. & BRODMANN MAEDER, M. 2018. Wilderness mass casualty incident (MCI): Rescue chain after avalanche at Everest Base Camp (EBC) in 2015. *Wilderness & environmental medicine,* 29**,** 401-410.

ZANARDINI, L., GRÖMER, G., LOUSADA, J. & PATERNOSTRO, S. Training for Analog Mars Simulations. 2018 SpaceOps Conference, 2018. 2449.

ZWECK, J. 2016. Analysis of methods used to reconstruct the flight path of Malaysia Airlines flight 370. *siam REVIEW,* 58**,** 555-574.

file:///Volumes/HARRIS/UCL/PhD/ULT, L., GROGAN, C., HALL, J. & IMRAY, C. 2020. Updated guidance on medical provision for wilderness file:///Volumes/HARRIS/UCL/PhD/ion of the United Nations Defile:///Volumes/HARRIS/UCL/PhD/can journal of tropical medicine and hygiene, 92,

List of appendices

Appendix 1 Research topic context mapping

Environment or situation	Permanent or temporary remote environment[17]	Case studies of health risks and disasters
Aerospace	Permanent	Malaysia Airlines Flight 370 (Zweck, 2016). On 08th March 2014, Malaysia Airlines Flight 370 lost contact with Air Traffic Control en route from Kuala Lumper International Airport to Beijing Capital International Airport, 38 minutes after take off. An international search and rescue mission was launched in the Andaman Sea and Indian Ocean, informed by a satellite in geosynchronous orbit transmitting ‘pings’ to a ground station in Perth, Australia and flightpath mapping. However, no aircraft debris or survivors have been found.

[17] This table refers to the environment, not the people within the environment. In other words, space is a permanently remote environment, as indicated in Table 2; however, people travel in space temporarily, which is not the focus of this table. Focusing on the environment provides clarity of the context of this research.

Conflict zone, war	Temporary	Iraq War and the public heath disaster (Harding and Libal, 2019). The public health system was destabilised as a result of the 2003 Iraq invasion, which included the deliberate targeting of health care practitioners by terrorist groups in retaliation to the invasion. The exact mortality rate from the war is not known, because foreign political administrations prohibited Iraqi counting of the dead. However, without a public health system the health disaster continues long after the war has ended. After the invasion clean water provision, electricity and sewage system were destroyed in vast areas of the country, exposing the population to disease and illness; in Baghdad a cholera epidemic occurred in 2007. In 2006 one survey concluded 12.3 million Iraqis to be without a reliable food sources or dependent on public distribution of food.

Crisis	Permanent or temporary	Yemen’s humanitarian crisis (Lopour, 2016). A disaster crisis is a disruptive event that negatively impacts a social system, such as political instability. The humanitarian crisis in Yemen was caused by civil war and conflicts, which has resulted in the humanitarian crisis – over 170,000 people have left the country; and over 82,000 people have fled to neighbouring countries that have their own crises. Therefore, the availability of health care services is extreme limited for this population. In Yemen, more than 21.2 million people are in need of humanitarian aid, which is more than any other country in the world: Syria 13.5 million, Iraq 11.0 million and Afghanistan 8.1 million.

Deserts	Permanent	Desert dust storms and Chronic Obstructive Pulmonary Disease (COPD) exacerbation in Crete (Lorentzou et al., 2019). Four extreme desert dust storms occurred during 2018 that affected Crete. People living with COPD are susceptible to air pollutants, which may can lead to respiratory dysfunction or failure. A COPD exacerbation can result in needing to be transferred to a hospital emergency department. In 2018, the extreme desert dust storms caused a x3.6 increase in COPD exacerbations needing hospitalisation for emergency care and a x4.2 increase in COPD admission to hospital; thus additional pressure on the health system was caused.
Natural hazards	Permanent or temporary	Hurricane Sandy in 2012 and the effect on New York City Emergency Medical Services (Smith et al., 2016). Hurricane Sandy was a category 3/5 hurricane that hit New York in 2012. The total financial cost of Hurricane Sandy was $70 billion. In lower Manhattan, three hospitals were destroyed (including a regional trauma centre), which resulted in the remaining hospitals needing to accommodate a huge additional number of emergency department visits and admissions. The local ambulance services saw an increase of between 37.2% to 63.6%, caused huge disruptions to health care services.

Jungle, forest	Permanent	Dengue virus transmission and infection in Colombian jungle settlement (Castellanos et al., 2016). Dengue virus infection is transmitted via mosquitos and causes more than 100 million cases per year. Mild cases are asymptomatic (or with mild fever) but severe cases lead to vascular leakage, haemorrhage and organ failure. People who are asymptomatic often do not seek medical review, or cannot because of their remote location. This study found in Quibdó, a remote Colombian jungle settlement, 51.7% of the population to be positively diagnosed with asymptomatic dengue fever and declared an outbreak due to the risk of an endemic.
Mountains	Permanent	Nepal 2015 earthquake and the avalanche on Mount Everest (Zafren et al., 2018). The 2015 earthquake (7.8 magnitude) in Nepal triggered an avalanche on Mount Everest that slid into Everest Base Camp for the first recorded time in history. The top half of the camp was destroyed; 15 people were killed and 70 injured initially. A search and rescue chain of helicopters and first responders was established, but helicopter rescues were delayed by poor weather conditions.

Oceans	Permanent	Diving barotrauma, injuries and pre-dive safety checklist (Ranapurwala et al., 2017). In 2012, 426 recreational divers participated in a study to investigate the efficacy of pre-dive safety checklists. 79% of participants used a written or memorised checklist, whereas the others used no checklist. 18.2% of participants experienced minor injuries and 11.2% major injuries. Injuries included lacerations, muscular injury and barotrauma (acute respiratory illness caused by rapid ascent to atmospheric pressure).
Off-shore	Permanent	Prolonged work-leave rotation for offshore oil and gas workers' injuries (Massey, 2018). Many off-shore oil and gas plants have a prolonged work-leave rotation patterns for their workers, between a ratio of 4 and 24 weeks work to 4 weeks rest. This study investigated the incidence of workplace injury during the work periods. Despite the occupational risk remaining consistent, the incidence of injury was significantly higher at the beginning of their rotation in comparison to the end. There were no significant findings in the duration of the work period, but all work-leave rotation periods saw a decline in workplace injury overtime.

Polar regions	Permanent	Primary care in Antarctica research stations medical clinics (Pattarini et al., 2016). During a year between 2013-2014 at three research stations in Antarctica, there were 658 people required health care, with over 1550 patient interactions in total. The most frequent health care needs were: 18% orthopaedic, 17% respiratory infection, 14% dermatological complaints and 6% gastrointestinal illness. Across the three research stations, there were 11 health care staff present during the summer and 5 during the winter.

Space	Permanent	Exposure to radiation in low-Earth orbit, spaceflight and deep space (Chancellor et al., 2018). Earth's magnetic field and atmosphere protect the surface from over-exposure to solar radiation (although not completely). However, in low-Earth orbit significantly less magnetic field and atmospheric protection exists. Therefore, astronauts are exposed to increased amount of radiation, which can lead to radiation sickness and increased risk of cancers and, or neurological degenerative diseases. The National Aeronautics and Space Administration (NASA) do not allow their astronauts, for the duration of their career, to be exposed to 3% or more of 'risk of exposure-induced death' radiation. However, NASA and other space agency are planning for longer space flights and exploration of deep space, which will result in astronauts being exposed to harmful amounts of radiation for longer periods and requirement of health care in the remote environment of space.

Appendix 2 Literature review methods

Method	Overview	Rationale for not being selected
Critical review	A critical appraisal of the data or findings from a literature review, on top of a description and synthesis.	A critical review focus is too narrow in order to establish the research gaps of PFC.
Mapping review	A review of literature to illustrate the gaps in research to inform future literature reviews or research.	A mapping review focuses only on research gaps and misses the opportunity to critique current research of PFC.
Meta-analysis	The combinations of data or statistics from literature that uses the same data collection methods and has the same exclusion and inclusion criteria.	Few quantitative studies have been conducted about PFC; therefore, not enough literature exists to conduct a meta-analysis.
Mixed methods review	A literature review that includes quantitative, qualitative, and/or mixed methods studies.	A mixed methods review is not as comprehensive when compared with a traditional literature review.

Overview review	A summary of the literature based on a survey of the characteristics.	There is no literature about PFC using surveys
Qualitative systematic review	Repetition of the same literature searching strategy for all relevant databases with the aim to be comprehensive on a specific subject using thematic analysis.	Repetition of the same data collection method limits a qualitative systematic review; thus, some literature may be missed that provides important insights to PFC.
Rapid review	A review within a short timeframe using systematic review methods to determine what is known.	Systematic review methods are too linear, which risks missing PFC literature.
Scoping review	Initial review of the literature to determine volume of evidence available to inform a research study.	A scoping review is limited in depth and, therefore, does not provide rigorous insights into PFC and the research gaps.
State-of-the-art review	A literature review of material recently published to provide a synthesis of current evidence.	This literature review is not limited by time to ensure all literature can be included.

Systematic review	Repetition of the same literature searching strategy for all relevant databases with the aim to be comprehensive on specific subject.	Systematic review methods are linear, therefore, using this method may miss PFC literature.
Systematic search review	To answer broad questions using critical review methods to provide a synthesis of evidence.	The research question for this literature review is specific and, therefore, a systematic search review is inappropriate.
Systematised review	Similar to systematic review; however, not as comprehensive.	This literature review aims to be comprehensive.
Umbrella review	A broad review of a topic from multiple sources compiled into one easy-to-read document.	This literature review is conducted with rigour and written to a high academic standard.

Based on (Grant and Booth, 2009).

Appendix 3 Concept analysis: PFC definitions (from literature review)

Literature review citations		PFC definition	Analysis
1	(Ball and Keenan, 2015)	The capabilities of PFC are to: 1. Monitor 2. Resuscitate 3. Ventilate 4. Control the airway 5. Control pain 6. Examine and diagnose 7. Provide nursing care 8. Provide surgical intervention 9. Perform telemedicine 10. Aeromedically evacuate patients.	This article reports on the US Special Operations Command PFC Working Group, described as medical subject matter experts, who are evaluating the pre-deployment training of US SF in PFC for utilisation in austere environments. Although published in peer-reviewed journal, this article contains no citations or empirical evidence.

2	(Christensen, 2018) (DeSoucy et al., 2017) (Keenan, 2015) (Keenan and Riesberg, 2017) (Mesar et al., 2018) (Powell et al., 2016) (Travers et al., 2019) (Whybourn et al., 2019)	Field medical care that is utilised beyond doctrinal planning timelines with limited resources by a SF medic or higher to decrease patient mortality and morbidity, which is sustained until the patient is transported to an appropriate care setting.	This definition is cited by Keenan (2015) as being written by the North Atlantic Treaty Organisation (NATO); however, the original article is not published or available in grey literature. Where this definition is referred to in other papers, Keenan (2015) article is cited as the source; that is, the original source is not published (Whybourn et al., 2019). Critical appraisal of the evidence that informs this definition is not possible. This definition focuses on military utilisation of PFC by referring to SF medics.
3	(Dobson and Letson, 2020)	Stabilise a patient and reduce risk of secondary injury.	This brief definition is similar to Smith et al. (2021) definition; however, reference to secondary injuries is made. Secondary injuries refers to injuries that occur is the original injury (or illness) are not treated. An example given is shock if a severe bleed is not stopped.

4	(Pamplin et al., 2017) (van Wyck et al., 2017)	PFC is provided by a Role 1 medicine past the point of Tactical Combat Casualty Care (TCCC) guidelines, when evacuation is not possible.	Role 1 refers to health care practitioners within military health care systems who practice prehospitally. TCCC is a US military term for prehospital trauma life support in conflict or war zones. PFC is described as taking place after TCCC guidelines by a Role 1 medic.
5	(Russell et al., 2020)	A contingency model of medical care for increasing the survival time of critically injured people in austere environments when evacuation is delayed beyond doctrinal timelines.	This definition echoes the NATO definition but emphasises the unpredicted delay of evacuation from an austere (conflict or war zone) environment, therefore, also focusing on military health systems.

6	(Schlotman et al., 2019)	PFC refers to military medics who provide prehospital medical care to severely injured personnel without support from well-resourced health services when evacuation is delayed. With minimal resources, long-distance travel to health services, and no option for evacuation, exploratory spaceflight is the ultimate example of PFC.	Military health systems are referred to as the users of PFC, which is identified as having minimal resources, no access to health services, and delayed evacuation. Exploratory spaceflight is provided as an extreme example, which, in the context of national and corporate collaboration for space exploration, suggests PFC also applies to civilian health care too.

7	(Smith and Withnall, 2018)	Care provided to patients in a prehospital environment when there has been a delay in meeting medical planning guidelines. There are two phases – static and evacuation. The location of PFC in the static phase may influence health; namely, the level of risk from natural, environmental, or anthropogenic (human, such as conflict) hazards. The evacuation phase may be via land, sea, and/or air, which may also influence health in terms of changing access to resources, health services, and further delaying evacuation. Careful planning should be undertaken in order to provide effective PFC.	This definition, cited by Smith and Withnall (2018) refers to a UK Ministry of Defence, Joint Services Publication (JSP) 950, The Operational Patient Care Pathway (Ministry of Defence, 2014). Thus, this definition is based on policy that has been written by subject matter experts, which has been peer-reviewed. Two phases of PFC suggest PFC is a process, therefore health needs may change overtime depending on the environment and context. Emphasis on planning advocates a proactive approach to PFC to mitigate risks to health.

8	(Smith et al., 2021)	The process of a Role 1 medic providing continuing patient care in a prehospital setting from the point of initial assessment until evacuation to definitive care with limited resources. The aim is to stabilise, delay, or reverse the physiological deterioration of a patient with major illness or injury.	This definition highlights PFC as a process of continued care in prehospital environments. An emphasis on protecting and promoting the physiological health of patients until evacuation is possible.

Appendix 4 Concept analysis: PFC definitions (non-scientific)

Literature review citations		PFC definition	Analysis
9	(Ministry of Defence, 2014)	PFC is when the 10-1-2+2 model of health care service is delayed, and the following guidance is required to care for patients: Ask (about comfort), Fluids, Infection, Tubes, Analgesia, Records, Sanitation, protect from the Environment.	This definition cites a previous version of the 10.1.2 (2)+2 model of military health system; however, demonstrates consistency in identifying PFC as being after this planned model of care. The additional guidance is originally listed as a footnote but there are no citations to explain what evidence this acronym is based on.

10	(Ministry of Defence, 2019)	A category of prehospital emergency care: 1. Care under fire (immediate lifesaving care); 2. Tactical field care (preparation for evacuation); 3. Enhanced field care (care provided by MDT in a field hospital); 4. Prolonged care (care after 10.1.2 (2)+2 model of care, which includes prolonged hospital care and PFC).	This definition is part of wider guidance of medical support for NATO forces, focusing on the MoD. The 10.1.2 (2)+2 model is a guide to military health services: a first aid kit for bleeding and airway control within 10 minutes, an advanced health care provider interventions within 1 hour, trauma surgery within 2 hours after the point of injury, delivery of trauma surgery within the next 2 hours, and evacuation for further surgery within the subsequent 2 hours. This model of trauma care has evolved since the 2000s and 2010s conflicts in the Middle East and has been informed by analysis of military case studies (Scallan et al., 2020). Thus, PFC is defined as care when one or all of the above is delayed.

Appendix 5 Concept analysis: relative terms and phrases

Citation		Definition	Relative term/phrase	Analysis and usage
1	(Ball and Keenan, 2015)	1	Special Operation Forces (SOF) provider	SOF personnel are deployed in small numbers to remote, rural, and/or austere environments. This relative term ties PFC to military health services; however, in other literature, PFC is not limited to the military operating in conflict or war zones – humanitarian response and civilian wilderness expeditions are included.
2	(DeSoucy et al., 2017) (Russell et al., 2020)	2	Tactical medical providers [in] PFC situations	This phrase comprises of (1) describing the provider of PFC as a military medic and (2) in PFC circumstances. The use of the PFC concept to describe the context PFC is utilised is an alternative phrase to describe the environment when PFC is provided. DeSoucy et al. (2017) identifies a PFC situation as being in any physical environment with minimal resources, limited access to health services, and delayed evacuation. Russell et al. (2020) includes the aim during delayed evacuation is to protect the survival of the patient until evacuation is possible.

3	(Keenan, 2015)	2	Care in an austere or field environment.	The term care has broad interpretations, suggesting that the health needs of patients in a prehospital (austere or field) environment are not limited to biomedical health needs. Rather, care implies patients have holistic health needs and, therefore, PFC providers needs to be trained to be able to meet all health needs of patients.
4	(Keenan and Riesberg, 2017)	2	Highly trained remote medical providers in remote and austere locations as a member of small teams without direct supervision or access to western medical services when evacuation is measured in days, not hours.	There are multiple components to this phrase relating to PFC. The term ‘remote’ implies geographically remote environments and/or locations where access to health services is limited or prohibited. Prolonged, autonomous practice is emphasised, which correlates with advocating PFC providers should be highly trained; therefore, having the knowledge, competence, and confidence to meet patients’ health needs. The phrase ‘remote medical provider’ suggests a biomedical focus; however, the term medical could be used as a hyponym of the term health, which is inclusive of holistic health care.

5	(Dobson and Letson, 2020) (Travers et al., 2019)	2	Combat medics trained in combat rescue.	Combat rescue is the equivalent of TCCC in the French military. In relation to usage of PFC in practice, combat medics are not registered health care professions but have advanced first aid training in airway management including pneumothorax decompression (treatment for a collapsed lung caused by air or blood in the pleura (membrane) around the lungs) and cricothyroidotomy (temporary tube inserted into the airway to enable breathing and oxygenation); and haemorrhage (bleeding) control including tourniquets, venous (veins) and intraosseous (bone) access for fluid and medication administration. This phrase suggests PFC providers do not need to be registered health care providers, providing they have an appropriate level of training in the knowledge and skills needed to meet patients' health needs. (Based on the included literature, 'combat medic' is a term used by French and Australian militaries; the UK military refers to combat medical technicians (Charnell and Rainey, 2019)).

6	(Whybourn et al., 2019)	2	Independent Duty Corpsman (IDC) who operates autonomously in remote or austere environments, which includes patient treatment and providing medical advice to commanders.	IDC is a US military term for the designated health care provider aboard a submarine. The medical department onboard a submarine is described as having minimal health resources and equipment due to storage space limitations. IDC undertake over 12 months of training, including health physics and barotrauma (health needs bespoke to the underwater environment) before being deemed as competent to practice PFC onboard a submarine in remote and austere environments. In addition, the expectation that IDC advise commanders on health suggests IDC are integrated into the leadership team when deployed. Whybourn et al. (2019) highlights PFC is relevant to military and civilian wilderness and expedition medicine; that is, PFC during expeditions in remote environments. The term ‘operate’ refers to providing clinical practice (PFC), rather than performing a surgical operation.

Appendix 6 Research participant eligibility criteria

Eligibility = 1 or 2, and 3
Criterion 1
A registered health care practitioner. Examples of UK governing bodies: • General Dental Council • General Medical Council • General Pharmaceutical Council • Health Care Professionals Council • Nursing and Midwifery Council.
OR
Criterion 2
A qualified first aider who has: • Completed at least a 16-hour training programme • Successfully passed a competency assessment • Holds a valid and current certificate of competence.
AND
Criterion 3
Experience of providing prolonged, prehospital care. Evidence mapped against Royal College of Surgeons of Edinburgh's Wilderness Medicine competencies (Mellor et al., 2020). At least a score of 1 in A-D. **(A) Non-technical expedition experience:** 1. Experience within UK expedition leadership as a team member 2. Experience leading expedition teams in the UK 3. Experience within overseas expedition leadership as a team member 4. Experience leading expedition teams overseas **(B) Expedition experience (UK and abroad):** 1. Travel experience 2. Expedition experience not related to mountain environments 3. Expedition experience in mountain environments 4. Experience of planning and leading expeditions in mountain environments

(C) Activity proficiency during and, or not during an expedition (mountaineering experience, UK and aboard): 1. At least one experience of mountain activities 2. Completion of a certified training and, or mountaineering awareness course 3. Completion of mountaineering leadership and, or instruction qualification, with over 100 hours of documented experience 4. Mountaineering expert, working as a guide or instructor (self-employed, for a company or outdoor education provider), or elite mountaineering professional sportsperson. **(D) Prehospital health care experience:** 1. Completion of an advanced first aid course specific to mountain environments and, or expedition context (16 hours or more) 2. Registered health care practitioner with experience of mountain and, or expedition health care provision 3. Medical doctor or prescribing health care practitioner with a minimum of four months or more experience of mountain and, or expedition health care provision in the UK or overseas 4. Consultant medical doctor or prescribing health care practitioner with a minimum of four months or more experience of leading mountain and, or expedition health care provision in the UK or overseas.
Data was collected about which professions are represented by the Governing Bodies of registered health care practitioner participants; this was not an inclusion criterion: • General Dental Council (and which specialty, if any) • General Medical Council (and which specialty, if any) • General Pharmaceutical Council (and which specialty, if any) • Nursing and Midwifery Council (and which professional background and, or specialty) • Health and Care Professions Council (and which professional background and, or specialty).

Appendix 7 Pre-interview survey findings

SECTION, Question	Number[18]
SECTION 1	
Age range (years)	
18-24	0
25-34	3
35-44	4
45-54	2
55-64	0
65-74	0
75+	0
Rather not say	1
Gender	
Female	3
Male	7
Rather not day	0

[18] The total number includes data collected from the research participants who contributed to the grounded theory study only, not the pilot study or case studies.

SECTION 2	
What is your experience of being in a UK, overseas or outer space remote environment?	
I have been on holiday (travelled) in a remote environment for leisure.	0
I have worked, volunteered or lived in a remote environment; however, not in a healthcare provision role.	1
I have worked, volunteered or lived in a remote environment to provide healthcare.	8
I have worked, volunteered or lived in a remote environment to plan or lead the provision healthcare.	1
Prefer not to say.	0
None of these options are an accurate description of my experience.	0
What is your experience of non-healthcare activities in UK, overseas or outer space remote environments?	
I have at least one experience of taking part in non-healthcare activities in remote environments.	2
I have completed at least one training or awareness course in a non-healthcare remote environment activity.	4
I have completed at least one leadership, instructional or technical qualification, with 100 hours or more of documented experience, of a non-healthcare activity in remote environments.	3
I am a subject matter expert working as a professional guide or instructor (self-employed, for a company or outdoor education provider), or I am an elite professional sportsperson, of a non-healthcare activity in remote environments.	1
Prefer not to say.	0
None of these options are an accurate description of my experience.	0

What is your experience of healthcare and/or non-healthcare team working and leadership in remote environments?	
I have experience of being a team member in remote environments of the UK.	0
I have experience of leading teams in remote environments within the UK.	1
I have experience of being a team member in remote environments overseas or outer space.	3
I have experience of leading teams in remote environments overseas or outer space.	6
Prefer not to say.	0
None of these options are an accurate description of my experience.	0
What is your experience of training for prehospital healthcare provision (prolonged field care) in UK, overseas or outer space remote environments?	
I have completed an advanced first aid or prehospital healthcare course (that lasted for 16 hours or more and had a pass/fail assessment) specific to remote environments.	1
I am a healthcare practitioner on a professional register and with experience of providing healthcare in remote environments.	8
I am a healthcare practitioner on a professional register who can prescribe medications and I have four months or more experience of healthcare provision in remote environments.	1
I am a consultant level healthcare practitioner on a professional register who can prescribe medications and I have four months or more experience of planning and, or leading healthcare provision in remote environments.	0
Prefer not to say.	0
None of these options are an accurate description of my experience.	0

Which UK healthcare professional register(s) are you a member of?	
I am a non-registered healthcare provider.	0
I am currently registered with the General Dental Council.	0
I am currently registered with the General Medical Council.	2
I am currently registered with the General Pharmaceutical Council.	0
I am currently registered with the Nursing and Midwifery Council.	3
I am currently registered with the Health and Care Professions Council.	4
Prefer not to say.	0
I am currently registered on an overseas healthcare professional register.	1
I am NOT currently registered with a healthcare professional register in the UK or overseas, but I used to be.	0
TOTAL PARTICIPANTS:	10

Appendix 8 Grounded theory semi-structured interview questions

Theme 1 – Conceptualisation and context of PFC	
1	What is your understanding of PFC in remote environments?
2	What is an example of an experience you have had about providing PFC in a remote environment?
3	How was the environment you were in remote?
4	What resources did you have available to you?
5	How did you sustainably use the resources available to you?
Theme 2 – PFC in practice	
6	Maintaining confidentiality, what physical and psychosocial health care needs did patients have when you provided PFC in any remote environment you have experience of?
7	How did the remoteness of your location effect the health of patients?
8	What were the risks to health?
9	How did you provide interdisciplinary PFC in the remote environment?
10	Considering everything that you have mentioned so far, what challenges did you experience when providing PFC in remote environments?
11	How did PFC mitigate the risks to health?
Theme 3 – PFC training	
12	What training did you have to provide PFC in remote environments and how did the training help you to prepare?
13	(What non-health care training did you have that is transferable to remote environments?)

14	(How do you train others to provide PFC?)
15	(What training have you had about training others in the field?)
16	What other training would have made you feel more prepared for providing PFC in remote environments?
Other	
17	Is there anything else you would like to tell me about PFC?

Appendix 9 Open coding concepts

Access to clinical supervision is another layer of risk mitigation
Access to knowledge, e.g., phone
Access to light
Access to limited health services and resources, but not enough or unknown quantities
Activity has influence of health
Advanced kits
After more time in the environment, more severe injury
Aide memoirs to mitigate risk of forgetting protocol
Applying transferable experiences and knowledge
Ask for case reports of previous experiences of PFC to inform risk assessment
Austere environment = not designated health service but built to house health care
Autonomous clinical decision-making and practice
Available equipment was what could be carried
Awareness of environmental and circumstantial risks
Awareness of risk management from training
Balance of enough kit with capability of activity
Be familiar with the unfamiliar
Be trained and experienced so you can train others
Biomedical health needs
Briefing beforehand = medical intelligence assessment
Build rapport before deployment

Can be in limited health service but without the option of evacuation
Capability to meet likely health needs
Care of injury or illness
Care until evacuation, resupply, or recovery
Caring for a patient for a given time
Caring for family as well as patient, i.e., communication
Chance to miss-diagnose
Change management required to integrate PFC into health systems
Change of plan
Circumstantial risk
Clean water sources to maintain good health
Clear, concise, and effective record keeping
Climatic injury = risk from environment and activity
Clinical deterioration after injury/illness and longer in the environment
Clinical environment set up
Clinical practice in atypical environment – remote, rural, austere
Confident, competent, and credible
Conflict is a circumstantial risk to health
Conscious of when kit is used it is gone
Consider all options
Consider chain reaction of decisions about risks to health and impact for patients
Coping strategy of exposure to risk
Covert of clandestine reasons for deployment

CPD (continued professional development) required for currency/competence
Creating MDT (multidisciplinary team)
Critical thinking about influences of health, resources, clinical decision-making
Daily health clinics to monitor health needs and mitigate risks to health
Decision-making informed by dynamic risk assessment and health needs
Define evacuation capability
Define limits of PFC capability
Define scope
Delayed evacuation
Delegation
Despite training, PFC experience feels unprepared
Different culture – food, language
Diverse pre-deployment training
Doctors are specialised
Document experience
Documentation and record keeping
Duty of care to everyone, including self
Effective clinical decision-making can mitigate risks to health and costs
Emergency nursing
End of life care
Enough resources for 24 hours for a one-day event
Enough to respond to likely emergency to sustain life
Environment – altitude

Environmental influence of health and risk to health
Evacuation possible but delayed
Evidence-based decision-making
Existing health needs when in environment
Expanding PFC capability within legal scope of practice
Expect the unexpected
Experiential learning in classroom to evoke PFC strategy
Experimentation is risk to health
Extended duration of care
Familiar with clinical guidance and assessment tools
First aid and nursing = acute care and continuity of care
Forward planning for PFC before deployment and when it is needed
Fracture
Fundamental care is valid part of acute care and PFC, e.g., toileting
Future integration of technology into PFC
Gain access to communication where needed and possible
Gain diverse experience that is relevant to the environment you are going to
Generalist knowledge
Geopolitics can be risk to health
Greater than one hour
Growing influences of health – tiredness, hunger – increases risks to health
Health care in austere environment with limited resources
Health needs of patients and team members = security

Health needs outside of clinical expertise
Health needs over longer duration prehospitally
Health needs surpassed what resources were available
Health screening / monitoring
Health service that was next available had limited resources
High-fidelity simulation training = preparedness
Historical lack of awareness of risks to health
Holistic care, as well as enhanced care
Humanitarian health = PFC
Hygiene needs
Identify accesses to lines of communication
Improvisation is key to meet patient health needs
In country support
In x-environment doing y-activity treating z-health needs to a high-standard
Inappropriate equipment if not experienced/trained in PFC
Increasing incidents of PFC in urban environments
Infection control = risk to health
Influences of health relative to environment and activity
Influencing factors of delay
Interdisciplinary care new approach
Involve everyone
Kit for likely illness and injury (e.g., marathon = foot care)
Kit needed to monitor physiological health
Kit needs to be balanced and appropriate

Kit out of a bag
Know limitations of knowledge
Lack of awareness about holistic health needs
Lack of support from in-country services to provide health care for team
Leadership = didactic vs democratic
Leadership role
Learn from other health disciplines, practitioners, and experiences to increase PFC capability
Learn from past experiences, self and others
Learning from other countries and their practices
Length of time PFC is needed needs to be balanced with health risks
Limited access to health service the patient needs
Limited clinical supervision
Limited communication and evacuation routes
Limited diagnosis tools
Limited evacuation options
Limited preparation and capability
Limited resources available
Limited resources to meet health needs
Limited training
List options of evacuation in order of priority – access, speed, cost, etc.
Local cultural practices and influences of health
Locals have health needs too
Logistics is part of providing person-centred care and the health system

Long distance from health services and systems
Maintain currency
Maintained health for duration of the time in the environment
Maintaining patient dignity and privacy
Manage expectations of team in the environment, e.g., resources
Managing communication outwards to stakeholders
Managing multiple challenges
Managing risks to health – conflict, limited evacuation options, no immediate access to health services
Maritime = limited space = limited resources = exposed to weather = environmental risk
MDT skill set capability
Medical intelligence assessment
Medications
Meeting and maintaining physical health needs to mitigate risk of disaster
Mental health needs
Military background
Minimal resources
Minor illness and injury that can deteriorate, e.g., infection
Minor injury was not planned for = no capability to meet health needs
Mitigate further risks to health
Monitor health needs
Monitor health risks
Multi-day travel
Multiple risks and challenges to manage

Multiple roles in remote environment
Near misses due to PPE
Need PFC grounded theory to guide clinical decision-making
Need to maintain currency
Need to sustainably use resources
Need trainer with experience of PFC
NHS standard
No access to health services
No authority – patient choice
No immediate access to health services that would be needed to meet the patient's health needs
No specific PFC training
No two PFC are the same
Not immediate fix of health need
Not rapid evacuation
Nurse, doctor available
Nursing
Nursing care awareness
One hour training not enough to feel prepared
One PFC provider is limitation in capability
Open to learning
Optimum use of resources, based on patient's health needs
Other disciplines of health
Other health services will be put under strain if extra demand is made

Pack enough equipment for 24 hours for 4-hour deployment
Pain management capability for long duration
People who have died still have health needs for duration of time in the environment
Personal hygiene to maintain good health
PFC = military health system, role 1 - 4, when that system does not work
PFC = what you can do with what you have
PFC began from point of stabilisation
PFC can apply to urban environments that have limited access to health services and resources
PFC capability = providing continuity of care
PFC includes health promotion
PFC is maintaining health status
PFC is when you adjust your healthcare due to deviation from expectation of care
PFC may not be needed
PFC not based on specific duration of time
PFC not time dependent
PFC provided by healthcare professional
PFC provider needs to be able to provide interdisciplinary care
PFC provider remains with patient
PFC training need
PFC unique experience that may not occur for a long time
PFC while waiting for next step (evacuation, resupply, or recovery)
Physical health affects mental health and vice versa

Physical remoteness = distance from health services
Plan A, B, C
Plan ahead
Planning for the unexpected
Potential for more than one person having health needs at the same time
Practical training and theory
Practice education of team members about health, risks to health, and self-care
Practice experience
Practise with kit so you know how to use it
Pre-deployment training includes training with resources that are available
Pre-deployment training of team for likely situations
Prevent illness and injury
Prevent of illness and injury is safe approach
Proactive approach to PFC CPD
Professional qualifications
Professionalism
Prolonged pain management
Promote and protect health
Promote awareness of health needs and when to seek advice
Promote self-care = resource management
Promote self-sufficiency of team members
Protect life until access to health services
Protocol relevant to environment and resources

Providing healthcare for longer than expected
Providing physical and psychological care for longer than expected, beyond the level of training
Psychological care after traumatic event (which may be related to the activity historically)
Rapport and trust
Reading for CPD
Recognise challenges
Recognise need more training in PFC
Recognise other transferable training
Reflect on training to do date that may not be purposefully for PFC
Refresher training to maintain currency
Refugee health = humanitarian health = PFC in remote environments
Relevant previous training can be applied
Relevant training/experiences to activities in remote environments
Reliant on financer of deployment
Remember to care for team's health needs too
Remote ≠ physical distance only
Remote can be closer to home than one would think
Remote clinical supervision for advice
Remote environment = lack of logistic and communication with supervision
Remoteness = geographical distance
Remoteness caused delay in access to health services and resources
Required to provide care for longer than expected
Requires health services that were not immediately available

Research before deployment
Resource management
Resources = people
Resources = what could be carried
Resources available are what can be transported to the environment
Resources available were what could be carried
Resources needed to meet holistic health needs
Resources spread out to where they are likely needed, balanced with overall stock
Resources usually expected not available
Resources were spread out
Responsible for managing team safety and health needs
Restricted airspace
Resupply of kit not an option so sustainable use of resources
Risk assessment
Risk management
Risk to health = D&V
Risk to health = mental health
Risk to health = musculoskeletal injury
Risk to health = physical remoteness, not being able to go home quickly
Risk to health = recreational drugs
Risks to health = animal world
Risks to health relative to demographics of team members
Rota to ensure team health needs are met

Safety network
Self – Team – Others = priority order
Self-awareness of PFC capability and limits
Self-care
Self-help is a risk – unconsciously incompetent
Self-reflection and awareness of PFC capability
Self-sufficiency
Shift pattern to ensure team safety and PFC capability
Short distance can still be remote
Simulation courses provide familiarity to PFC
Single points of failure = logistics, communication, circumstance, environment
Sleep = health need = risk mitigation
Small healthcare team available of paramedics and 1 nurse
Small number of medical resources
Special forces
Specialist engineers but not PFC providers
Specific training in PFC increased feeling of preparedness
Specific training relevant to activities and environment
Strategy in place
Sufficient stock of essential equipment, e.g., medications, for the duration of time in the remote environment
Sustainable kit management based on capability to meet likely health needs
Teaching and training and clinical practice are complementary in maintaining and enhancing PFC capability

Team awareness
Team based clinical decision-making
Team dynamics awareness
Team involvement enabled other actions/planning
Team management and communication
Team management can be a challenge
Team members may have relevant skills
Team members need understanding of roles
Team requirement to be able to provide PFC to meet patient health needs
Team roles depend on the environment and activities
Team working
Team working and people management skills
Teamwork
Technology extended PFC capability
Technology limitation
Technology to mitigate risk and manage crises
Thinking ahead to how health needs change
Time = influence of health
Time can = remote = PFC
Too many resources
Train for specific environments and activities
Train team members in basic skills that may be needed for PFC
Trained in training
Training = preparation

Training and team training
Training days to mitigate risks to health
Training experiences
Training for environment
Training, equipment, knowledge, experience, planning = risk to health mitigation
Transferable qualifications and training
Transferable skills to environment/activity
Transport limited
Transport risk to health
Transportable equipment
Transporting patient to health service
Trauma likely health need
Understand limitations
Unexpected environmental risk to health
Unexpected lack of resources
Unexpected longer duration of care
Updated resources
Use all resources / create resources intuitively and sustainably = repurpose kit
Use initiative and intuition to repurpose resources to meet health needs
Use resources available
Use resources knowing you will not be able to use one-time resources again
Vehicle expedition in remote environment

Vehicle risks
Vulnerability to natural hazards are risks to health
Weather risk
Western medicine
Wider reading outside health discipline
Within 1 hour

Appendix 10 Symposium break-out rooms semi-structured questions

1. Space medicine/health (orbit, lunar, and interplanetary missions)

    a. What is space medicine and space health?

    b. What are the risks to health to astronauts exploring other planetary bodies?

    c. What are the legal considerations for medical research and practice in space?

    d. What can be contributed to the practice of prolonged, holistic healthcare during exploratory space missions of other planetary bodies by an interdisciplinary healthcare practitioner from the perspectives of space medicine?

    e. Based on answers to the previous question, what can be contributed to the practice of prolonged, holistic healthcare in remote environments on Earth by an interdisciplinary healthcare practitioner from the perspectives of space medicine?

    f. What is a realistic healthcare scenario during the exploration of another planetary body related to space medicine?

2. Global health and public health

    a. What is global health and public health? How are they similar and how do they differ?

    b. What lessons learnt from the COVID19 pandemic can be applied to space health during deep space exploratory missions?

    c. What can be contributed to the practice of prolonged, holistic healthcare during exploratory space missions of other planetary bodies by an interdisciplinary healthcare practitioner from the perspectives of global health and public health?

d. Based on answers to the previous question, what can be contributed to the practice of prolonged, holistic healthcare in remote environments on Earth by an interdisciplinary healthcare practitioner from the perspectives of global health and public health?

e. What is a realistic healthcare scenario during the exploration of another planetary body related to global health and public health?

3. Planetary healthcare systems (medicine, nursing, and allied health

f. What are medicine, nursing and allied health disciplines? How are they similar and how do they differ?

g. (Compare the difference between military and civilian healthcare systems.)

h. How can peer-learning amongst the multidisciplinary team be facilitated?

i. What can be contributed to the practice of prolonged, holistic healthcare during exploratory space missions of other planetary bodies by an interdisciplinary healthcare practitioner from the perspectives of medicine, nursing, and allied health?

j. Based on answers to the previous question, what can be contributed to the practice of prolonged, holistic healthcare in remote environments on Earth by an interdisciplinary healthcare practitioner from the perspectives of medicine, nursing, and allied health?

k. What is a realistic healthcare scenario during the exploration of another planetary body related to medicine, nursing, and allied health?

4. Anthropology (biosocial, medical and data science / digital health)

l. (What is anthropology? What are biosocial, medical and data science/digital health anthropology? How are they similar and how do they differ?)

m. What are the unique biosocial conditions of long-term space mission that inform human illness and well-being?

n. How do we account for environment, ecology, infrastructure, resources, and human biology in creating models of health in remote environments and outer space?

o. In terms of health, care, and the human body, how do we calculate "space-normal" in models of healthcare?

p. What can be contributed to the practice of prolonged, holistic healthcare during exploratory space missions of other planetary bodies by an interdisciplinary healthcare practitioner from the perspectives of anthropology?

q. Based on answers to the previous question, what can be contributed to the practice of prolonged, holistic healthcare in remote environments on Earth by an interdisciplinary healthcare practitioner from the perspectives of anthropology?

r. (What is a realistic healthcare scenario during the exploration of another planetary body related to anthropology?)

5. Disaster sciences (gender, climate change, business continuity)

   s. What is disaster science? What are the disaster sciences?

   t. What constitutes a disaster within the context of healthcare during the exploration of another planetary body?

   u. What are the risks to health in space? How could the risks to health in space be mitigated to reduce the risk of disaster?

v. What can be contributed to the practice of prolonged, holistic healthcare during exploratory space missions of other planetary bodies by an interdisciplinary healthcare practitioner from the perspectives of disaster science?

w. Based on answers to the previous question, what can be contributed to the practice of prolonged, holistic healthcare in remote environments on Earth by an interdisciplinary healthcare practitioner from the perspectives of disaster science?

x. What is a realistic healthcare scenario during the exploration of another planetary body related to Disaster Sciences?

Appendix 11 Symposium findings

Breakout room specialty	Participant's thoughts on realistic healthcare scenarios related to the breakout room specialty
Anthropology	Perhaps a crew member is feeling 'off'. Nothing is wrong physiologically, but the mission is around the halfway point, and they are lethargic, uncommunicative, and snapping at their crew. How does this small group of people manage this situation to ensure mission success? What can we do to equip them for this situation before they leave?
Anthropology	Psychosocial considerations for a new lunar colony
Anthropology	The conditions of space make it so that individual are unable to experience physical intimacy (close contact like hugs) which affects mental health.
Anthropology	I think is the differentiation feeling of the crew when they return to earth, this can include their mannerisms, conduct, how they approach situations, and if they are emotional close or selective. Also, it can be focus on how they re-integrated to society, because up there, they have a very limited group of people, so when they return to earth and they go back to their cities or towns with hundreds or thousands of people, the question is: how will that affect them.

Anthropology	Implement different levels of preventative measures or health-promoting measures to determine at what level the crew members feel as though they are thriving and when that changes to surviving. For example, this can include changes to dietary choices, entertainment, contact with loved ones, views of the outside, privacy/alone time, etc... It will allow for the determination of the minimum amount required to maximize space health while preventing detriments to health. It also allows for limiting resources to only what is required.
Anthropology	The crew are given a small container which they could fill with personal items. Having never experienced the extreme isolation of deep space exploration, some crew members opt for mementos of family and friends, which only causes them distress when they look at them because they know that communicating with family and friends is very limited. Some crew members instead choose to fill their container with sensory items like food condiments and fragrant dried flowers which the other crew members covet. Conflicts arise when these coveted items get stolen. The impacts of sensory deprivation result in mental breakdowns which compromise the success of the mission.
Disaster sciences	Space infrastructure
Disaster sciences	How to leave ~0 footprint behind during the analog mission to keep the location thriving and sustainable.
Disaster sciences	Space Eco Tourism
Disaster sciences	Preparing for an environmentally sustainable mission plan for private space enterprises

Disaster sciences	The disaster that happen on Mars
Disaster sciences	Citizen science type discussion on what risk is acceptable - can be individual, group or the potential impact of their decision on the planet
Disaster sciences	Loss of life in space. Or perhaps loss of evacuation possibility. Stranded on Mars. Think "The Martian".
Disaster sciences	The most deadly disaster factor that it can be presented during a space flight/mission is the human factor, I believe that while commercial flight will be the driving for the development of space exploration and off living in new worlds, the people need to have a extensive training course that will prevent many difficult scenarios, and in regards to the last breakout room (anthropology) this course should be a little militarise, mostly for the prevention of human error and create an order that may prevent catastrophe situations.
Disaster sciences	Some sort of life-threatening
Disaster sciences	Create a simulated emergency that knocks out the comms (or imparts a comm delay or brief blackout) and have the crew figure out how to bring themselves to safety. They would need to establish leadership roles rapidly, determine what equipment/resources could be spared and what it would mean to reach safety (Is this repairing the problem? Is this evacuating and returning home?).
Global health and public health	N/A

Global health and public health	Explore different methods of creating connection between the remote crew and the outside world. Determine how mental health is effected by having connections and not having connections.
Global health and public health	Developing probiotics to promote health in space
Global health and public health	Working out the teamwork with limited expertise and how they can supplement the skills for mental health needs for a diverse group of people
Global health and public health	Understanding which healthcare practitioners will be most suited for long duration space missions e.g. nurses specialising in extreme environment care
Global health and public health	Maybe cross infection intra-planet or anything else
Global health and public health	Needing access to a specialist, however the specialist is hard to get time with, costs a lot of money, and is too far away to travel to in order to meet. But also the situation requires urgent medical attention.
Global health and public health	a medical complaint that would normally warrant X-ray, CT or MRI on Earth - how would work up this diagnosis in space without these facilities?
Global health and public health	Probably three important ones are the impact of isolation and small crews on wellbeing and human factors issues, food and nutrition, and what happens if an infectious/virulent pathogen takes hold - how to deal with this...

Global health and public health	The link on AI on global public health care
Global health and public health	During a mission a mission a team member feels depressed and sad as they miss their home.
Global health and public health	Considering how we would manage a disease outbreak in an astronaut population in a confined environment on a space station or other planetary body
Global health and public health	Analogues such as submarines and polar bases.
Global health and public health	Some sort of problem and telecommunications are 'lost' midway leading analogue astronauts to have to communicate and improvise solutions
Global health and public health	A simulated accident in which two analog astronauts face the same or similar injuries. The rationing of medication, the use of limited equipment and the sole health practitioner's time/attention must all be determined based on two individuals requiring similar/shared resources which are limited to begin with. The decision-making process and whether that is done by the commander, the healthcare professional, the patients or the group as a whole would be interesting to see and could inform future mission protocols.
Planetary health systems	What happens if the medical lead is incapacitated? Are engineers, scientists, etc. able to meet the necessary standards to deliver proper care when required.
Planetary health systems	Anti-biotic 3D printing of drugs support

Planetary health systems	Prolonged care with effects on entire crew requiring a multi-disciplinary response. Combine physical and mental illness that effects the person responsible for habitat electronics or life support for example.
Planetary health systems	Maybe the impact of terraform on Mars
Planetary health systems	Investigating countermeasures that can be taken when a required drug is not available
Planetary health systems	running out of medications (3D print new ones?), psychological issues and crisis like suicide or psychosis which puts the crew and equipment at risk
Planetary health systems	A surgeon with a disability that has developed (e.g., movement disorder/Parkinson's) and cannot perform surgery so needs to talk others through it who do not have this skill or another discipline - but engaging the teamwork in a clinical process and the human factors issues that arise.
Planetary health systems	Provision of medical supplies on a long duration mission
Planetary health systems	An injury that requires a certain medication/treatment this is not available. Need to determine on the spot alternative ways to manage the injury, prevent further pain/trauma and ensure it cannot spread to the others (if infectious). This requires inventive thinking and a deep, holistic understanding of medicine and healthcare.
Planetary health systems	How about someone gets a lungful of Moon dust and then gets a chemical pneumonitis and this needs to be managed medically, but then they need rehab and ongoing monitoring to return to their normal respiratory function (or Mars dust if you prefer).
Space medicine and space health	Bone deterioration and osteoporosis, SANS and eye diseases such as glaucoma

Space medicine and space health	A fracture on arrival to a gravity field.
Space medicine and space health	Psychological distress of crew member following long period of isolation. Trauma following exploration. Surgery in space. Advanced life support in space
Space medicine and space health	Lack of accessibility to poor people.
Space medicine and space health	A Senior Staff member is traumatically injured and knows there are not sufficient resources to survive and begging for the medical practitioner to end their life
Space medicine and space health	Major incident causing certain near loss of life of crew member. How do we care for them? End-of-life palliative care? How do we take care of the surviving crew?
Space medicine and space health	A crew member becomes seriously injured on an EVA. How do you give appropriate acute care, and what is the longer-term plan for that crew member? How do you support that injured member while also supporting the crew during a difficult time.
Space medicine and space health	Perhaps an astronaut has arrived at Mars after a prolonged period of microgravity, and falls, fracturing their forearm. Many considerations here. How best to treat, how to continue settling on the planet with one crew member compromised, and perhaps after such a long flight there are interpersonal tensions that will make re-allocation of labour etc. more complicated. Which decisions does the medical practitioner have to make, and which fall to other team members e.g. commander.
Space medicine and space health	I think the realistic scenario that related to this topic is something like how to perform surgery in spacecraft or how to make medicine from limited sources in the spacecraft.

Space medicine and space health	Major trauma; psychological breakdown needing individual support/isolation/restraint? Provision of end-of-life care; decision making in helping a colleague in life-threatening situation whilst staying safe/integrity of the mission/crew
Space medicine and space health	How Space Tourism impacts human side effect or global health in the long run?
Space medicine and space health	It may be difficult within the constraints of an analogue mission, but perhaps a scenario where whatever the problem is can't be fixed with the current available tools e.g. catastrophic haemorrhage or sepsis. It could lead to a conversation about the limits of care and help identify key psychological support needed to teams
Space medicine and space health	Treatment of an acute fracture (closed/open) on the ISS
Space medicine and space health	When a reasonably and practicability of the medical emergencies are thought out and catered for
Space medicine and space health	VR/AR training for space surgery
Space medicine and space health	In my perspective, medicine can relate to space medicine is several aspects. For instance, with different conditions in the space, medicine specialized for astronauts can save lives of many people.
Space medicine and space health	Radiation toxicity - prevention and treatment
Space medicine and space health	Astronauts require special medical healthcare services as well.
Space medicine and space health	Improve the medical devices for the humanity that lives in the earth and in space

Space medicine and space health	Trauma during EVA activities from collisions with heavy objects, crush injuries, penetrating injuries, etc. Otherwise I would look at the NASA Space Medicine Exploration Medical Condition List for a priority list of possible healthcare issues.
Space medicine and space health	Treatment in cases of eruption of epidemics and diseases on spaceships
Space medicine and space health	In the event of a mortality in space what is the correct decision between abandoning the body, bring the body back to Earth but risk the health of the crew members, or design a safe and special crematorium?
Space medicine and space health	On a long-term space mission, an astronaut suffers with kidney stones and requires treatment in space.
Space medicine and space health	Unforeseen allergic reaction in space. There's a general increase in children having allergies, but there are also allergies that are picked up as environment or lifestyle changes.
Space medicine and space health	For example, someone on the crew (either in space or analog) experiences mild symptoms of depression feeling lonely and having no motivation to get up. You would not want to make them take anti-depression medication immediately but rather cure this with creating a better environment: a morning routine, contact with their relatives/friends, deep conversation, a relaxing virtual reality environment and coaching by a peer and/or AI.
Space medicine and space health	Remote medical care provision Natural disasters, pandemics Preventive medicine Prevention of muscular atrophy and osteoporosis in an aging society Paediatric education for the space era Building physical strength

	International cooperation in medical research with enhanced collaboration with other occupations such as space engineers
Space medicine and space health	Simulated scenario in which the life support system encounters a failure impacting the health and safety of the crew. This will require a collaboration to repair the issues, monitor any detriments to health (potentially toxicities in the air, contaminated water systems, etc...) as well as lead to the development of anxiety surrounding the life support system for the duration of the mission. Physical and psychological health will need to be considered and the entire crew will be impacted by the same hazard including the chosen healthcare professional.