WHAT IS THE VALUE OF DOMICILIARY MEDICATION REVIEW SERVICES? A MIXED-METHOD EXPLORATION AND ANALYSIS OF MEDICINES OPTIMISATION IN DOMICILIARY SETTINGS

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This thesis describes research conducted in the School of Pharmacy, UCL between April 2015 and July 2021 under the supervision of Professor Ian Bates and Dr Bridget Coleman. I, Patricia McCormick 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 .

Abstract

Medication reviews are recognised as essential to identifying and optimising problematic polypharmacy. Domiciliary medication reviews (DMRs) which have become more prevalent in recent years, are identified as comprehensive and patient-centric medication reviews. Despite their popularity, there is little evidence on where the value of DMRs lies.

This research aimed to understand the value of domiciliary medication reviews using mixed methods.

The research was underpinned by a systematic review of the literature to understand the existing landscape around DMRs. Correlational techniques were used to explore the relationships between demographics and intervention variables. The deeper service-based perceptions and views of both patients and DMR pharmacists were sought using semi-structured interviews and focus groups.

The systematic review revealed a very profession-centric view of DMRs that suggested the impact of these services could be measured using traditional clinical outcomes. The literature rarely went beyond describing clinical process measures. The quantitative analysis revealed that individuals have differing needs that go beyond the scope of the medications they take. Results suggested that a 'one size fits all' approach to service delivery will not work optimally, and instead a holistic and more comprehensive approach is needed. The qualitative analysis suggested that conducting medication reviews in the domiciliary setting afforded advantages over traditional healthcare settings. For individuals the medicines expertise of professionals is important but so too is the socialisation aspect of the review. The time spent conducting a review was essential for a comprehensive review and ensuring individuals felt heard.

This multi-method and multi-perspective study enabled a richer understanding of where the added value of DMRs services might lie. It is suggested that the value lies in a well thought out service, delivered by knowledgeable medicines experts (pharmacists), who are able to connect with patients and understand their needs, even when they are not medication related.

Impact Statement

Medication reviews are important to ensure medications are appropriate for an individual. They can improve willingness to take a medication, reduce unintended problems linked to medications and improve clinical outcomes. In-depth medication reviews conducted in a persons' home by a pharmacist, known as domiciliary medication reviews (DMRs) were becoming more prevalent. The rise in popularity suggested they were beneficial services for the individuals who used them. However, the published literature painted a mixed picture of the impact these services were able to have on usually quoted economic and clinical outcomes. The outcomes chosen in the literature were "medically" centric, and rarely went beyond describing process measures. The summative value of these reviews was not known. In a healthcare system with limited resources it is important to understand the value of any service in order to ensure the appropriate use of resources and maximise the benefits for the users of a service (patients).

The research described in this thesis is the first in-depth exploration of the holistic value of domiciliary medication reviews. By suggesting that focusing solely on outcomes is too simplistic and describing that the value of domiciliary medication reviews is linked to the whole medication review process, this research provided a new contextual view of the value of domiciliary medications.

The impact of this research will be seen in several areas. Inside academia it has demonstrated that real-world research based on operating healthcare services can provide novel insights into the complex relationships between individuals, their health and healthcare professionals. The research has also highlighted that a mixed methods approach can help obtain a comprehensive picture of an intervention. Suggestions for further work included in the conclusion chapter will also provide starting points for other professionals to begin their research journeys.

Outside of academia there will be an impact for service delivery. Insights into relationships between data variables such as time taken to conduct a review and the number of interventions from a DMR could be used for service planning purposes. The findings of the qualitative analysis and the associated publications have started a conversation about the utility of the outcomes and the need to re-think them, in order to truly demonstrate the value of these services. Highlighting training and development needs for DMR pharmacists beyond clinical knowledge will be useful for workforce training and planning.

The findings from this research have been disseminated through national and international conferences and journals. Dissemination of learning from the service delivery at the beginning of the project resulted in the work being short-listed for a NICE shared learning award. Presenting at the NICE conference sparked conversations about service delivery. It has also resulted in regular contact from pharmacy professionals seeking advice when they set up their DMR services about how to provide truly patient centric services.

Finally, the research presents an opportunity for DMR pharmacists to be recognised as advanced practitioners who can manage the complex needs of an individual.

Acknowledgements

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Finally I would like to express my thanks to my family and friends, especially my husband Richard, for their encouragement throughout this long journey.

Research related publications and poster presentations

1. McCormick, P., Coleman, B. & Bates, I. The value of domiciliary medication reviews: a thematic analysis of patient views. *Int J Clin Pharm* (2021). https://doi.org/10.1007/s11096-021-01288-1

Background Medication reviews are recognised as essential to tackling problematic polypharmacy. Domiciliary medication reviews (DMRs) have become more prevalent in recent years. They are proclaimed as being patient-centric but published literature mainly focuses on clinical outcomes. However, it is not known where the value of DMRs lies for patients who participate in them. *Objective* To determine the value of domiciliary medication reviews to service users. Setting Interviews took place with recipients of domiciliary medication reviews residing in the London boroughs of Islington and Haringey. *Method* Semi-structured interviews analysed using thematic analysis. *Main outcome measure* Themes and sub-themes identified from interview transcripts. *Results* Five themes were identified: advantages over traditional settings, attributes of the professional, adherence, levels of engagement and knowledge. *Conclusion* For many patients, the domiciliary setting is preferred to traditional healthcare settings. Patients appreciated the time spent with them during a DMR and felt listened to. Informal carers felt reassured that the individual medication needs of their relative had been reviewed by an expert.

2. McCormick, P., Chennells, R., Coleman, B. and Bates, I. (2020), The outcome of domiciliary medication reviews and their impact: a systematic review. Int J Pharm Pract. doi:10.1111/ijpp.12649

Introduction: Medication reviews in the domiciliary setting are becoming more prevalent internationally. Understanding the benefits of these reviews is essential to ensuring quality healthcare services. To date there has not been a systematic evaluation of the outcomes of these services and their impact on patients. **Aim:** To systematically review the literature on the outcomes of Domiciliary Medication

Reviews (DMRs), with a view to understanding the impact of medication reviews in this setting. **Methods:** A search strategy using terms for medication reviews, the domiciliary setting, outcomes and assessment of outcomes was developed. Cochrane Central Register of Controlled Trials, MEDLINE, EMBASE, CINAHL, Science Citation Index, Proquest Dissertations and Theses Global and International Pharmaceutical Abstracts databases were searched, in combination with reference list review and hand searching. Controlled and uncontrolled studies were included. Outcomes were categorised according to the ECHO model. A narrative synthesis was developed. **Key findings:** 19 out of 31 papers included demonstrated an improvement in outcome. Clinical outcomes were the most commonly measured and humanistic outcomes the least commonly measured. DMR services are presented as providing benefit. However, it is difficult to quantify the impact of services from the published outcomes. **Conclusions:** Future work should focus on demonstrating the meaningful changes to patients that domiciliary medication reviews have enabled.

3. McCormick, P., Bates., The use of multiple linear regression analysis on Domiciliary Medication Review data to understand the relationship between participant variables and outcomes (2019), Poster Abstracts. Int J Pharm Pract, 27: 6-31. doi:10.1111/ijpp.12509

Medication reviews conducted in an individual's home are becoming more prevalent as a pharmaceutical service. Previous DMR research has reported outcomes without further analysis of impact. In a bid to understand impact, data from a Whittington Health DMR service was analysed using multiple linear regression. The analytical goal was to develop and enable provision of a service that would use resource more efficiently and obtain the best outcomes from the service. The aim of the study was to use multiple linear regression analysis to enable a greater understanding of the relationships between DMR demographic variables and outcomes, with a view to service improvement. The project was registered at Whittington Health NHS trust (ref: 205/16–98). Ethics approval was not required.

Two dependent variables were selected; total number of interventions was chosen because of the emphasis on this variable as a reported outcome of DMRs in the literature and total time spent was chosen as an understanding of how long a DMR will take has practical applications for service modelling and delivery. Four independent variables were chosen for both models; age, gender, number of drugs and number of visits. In addition, each dependent variable served as an independent variable in the alternate model. Variables were chosen from demographic data collected during DMR visits to see whether routinely collected data could predict the dependent variables. Multiple linear regression analysis of data collected from January 2015 – June 2017 (n = 251) was conducted using SPSS®.

For the total number of interventions at least 27% of the variable variance can be explained by the model ($R2 = 0.27$). Number of drugs (Beta = 0.315, $P < 0.01$) and total length of visits (Beta = 0.318, $P < 0.01$) were significant predictors of the total number of interventions. For the total time spent conducting DMRs at least 60% of the variance can be predicted by the model ($R2 = 0.60$). It was found that age (Beta = -0.136, $P < 0.01$), number of prescribed drugs (Beta = 0.140, $P < 0.01$), number of domiciliary visits (Beta = 0.59, $P < 0.01$) and number of interventions (Beta = 0.192, $P < 0.01$) were significant predictors of the total time spent conducting a DMR.

The results indicate that two variables may be able to predict the number of interventions resulting from a DMR 27% of the time and four variables may predict the amount of time a DMR will take 60% of the time. There are numerous factors which affect an individual's health status2; being able to explain 27% and 60% of the variance in each model respectively is promising. Key independent variables have been identified, which if targeted could result in more interventions from DMRs and optimised services which would enable service improvement. To the best of our knowledge this is the first-time demographic variables have been identified which could predict the number of interventions from a DMR and the time taken to

conduct a DMR. Limitations of this work include the small sample size and that data originated from one DMR service. Future work should test the generalisability of the results. The results of the regression modelling could provide a starting point for all services to carry out service requirement modelling.

4. Ip, S.S.Y., McCormick, P., Murphy, Y., Martin, C., Chennells, R., Shah, P and Taylor, H., 2015. Complex Care of Older People and Integrated Care Pharmacy Team at Whittington Health International Journal of Integrated Care, 15(8) DOI: http://doi.org/10.5334/ijic.2359
5. Clinical Pharmacy Congress poster presentation. Abstract can be found at: http://www.pharmacycongress.co.uk/files/saturday_am_abstract_book1.pdf
6. NICE shared learning example: https://www.nice.org.uk/proxy/?sourceurl=http://www.nice.org.uk/usingguidance/sharedlearningimplementingniceguidance/examplesofimplementation/eximpresults.jsp?o=836
   This work has also been selected for poster and oral presentation at the NICE conference in October 2015

Abbreviations

ADR	Adverse Drug Reaction
ASQ	After Scenario Questionnaire
CCG	Clinical Commissioning Groups
DMR	Domiciliary Medication Review
DUSOI-A	Duke Severity of Illness Checklist-A
DRP	Drug Related Problem
ECHO	Economic, Clinical and Humanistic Outcomes
ED	Emergency department
EQ-5D	EuroQoL 5D
GP	General Practitioner
HCP	Health Care Professional
ICAT	Integrated Care Aging Team
IDAOPI	Income Deprivation Affecting Older People Index
KPI	Key Performance Indicator
MAI	Medication Appropriateness Index
MAR	Medication Administration Record
MCA	Multiple Correspondence Analysis
MDT	Multi-Disciplinary Team
MLR	Multiple Linear Regression
MRP	Medication Related Problem
NCC MERP	National Co-ordinating Council for Medication Error Reporting
NHS	National Health Service
NICE	National Institute for Clinical Excellence
NPSA	National Patient Safety Agency
PCI	Pharmaceutical Care Intervention
PIMS	Potentially Inappropriate Medicines
PIR	Patient Intervention Record
QALY	Quality Adjusted Life Year
QOL	Quality of Life
RCT	Randomised Control Trial
RPS	Royal Pharmaceutical Society
RUE	Rapid Usability Evaluation
SF-36	Short-form Health Survey-36
SPSS	Statistical Package for Social Sciences
SUS	Software Usability Scale
UKCPA	United Kingdom Clinical Pharmacists Association
VAS	Visual Analogue Scale
VIF	Variance Inflation Factor

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Chapter 1 Systematic review of the literature

1.1 Introduction

As the number of medications taken by an individual has risen (Guthrie et al., 2015) so too has the focus on medication reviews. Problematic polypharmacy has been shown to increase the likelihood of adverse drug reactions, drug interactions, medication-related hospital admissions, quality of life scores and the likelihood of non-compliance (Duerden et al., 2013). The National Institute for Clinical Excellence (NICE) recommends medication reviews to combat problematic polypharmacy, as medication reviews have been shown to have a positive impact on these negative outcomes (National Institute for Clinical Excellence (NICE), 2015).

Medication reviews can vary in levels of complexity from *ad hoc* identification of compliance problems (level 0 reviews) to full clinical reviews with access to patient notes and in conjunction with the patient (level 3 reviews) (Task Force on Medicines Partnership & The National Collaborative Medicines Management Services Programme, 2002). Level 3 reviews are considered the gold standard as they result in improved clinical outcomes through increased medicines optimisation and joint decision making (Petty et al., 2005).

In the United Kingdom, traditionally, medication reviews have occurred in community pharmacy (e.g. Medicines Use Reviews and New Medicines Service) hospital (e.g. medicines reconciliation and comprehensive medication reviews) and primary care settings (e.g. clinical review in the GP surgery) (Petty et al., 2005). The impact of traditional medication reviews is reported as; increasing compliance, reducing adverse drug reactions and improving patient safety (Huiskes et al.) Recently, comprehensive medication reviews in individual's homes, known as domiciliary medication reviews (DMRs), have become more prevalent (Loh et al., 2016). It is proposed that DMRs permit longer, more in-depth reviews with objectives and interventions that the professional and individual have chosen together (Boyatzis & Batty, 2004).

However, there have been no head-to-head comparisons of medication reviews in the domiciliary and traditional settings and there is also no clear guidance or consensus on how the DMR services should be carried out or how their impact should be evaluated.

Whittington Health is an Integrated Care Organisation. Rather uniquely it provides services across both primary and secondary care, with the aspiration of providing integrated services that will increase health outcomes for patients (Whittington Health NHS Trust, n.d.-a). In March 2012 Whittington Health successfully obtained funding, jointly from health and social care for a DMR pilot. This enabled a hospital pharmacist to work within a social services team: the Islington Reablement Service, to conduct medication reviews for service users. The new service aimed to resolve medication needs identified, enabling optimisation of medicines, avoidance of adverse drug effects and support individuals to manage their medications independently (Mccormick, 2015). The service was deemed successful, and the position was permanently funded.

Since the establishment of this role Whittington Health has created other similar positions to enable further domiciliary medication reviews including the Integrated Community Ageing Team (ICAT) pharmacists (Whittington Health NHS Trust, n.d.-c) and Haringey locality pharmacist. This coincided with anecdotal evidence that other NHS organisations around the country were creating similar posts.

The rise in the prevalence of DMR services suggests that they are felt to be having a positive impact. Locally, the value of the pilot was demonstrated through the collection of activity data and a user satisfaction survey. However, it was felt that this did not capture the complexity of the service; a holistic patient-centric service examining every aspect of medication management. Being able to appropriately evaluate these relatively novel services should ensure resource is being used effectively and that outcomes are being achieved that matter to the individual.

A systematic review was carried out to try and understand the value of domiciliary medication review services through the critical examination of outcomes that are reported in the literature.

1.2 Methods

The systematic review was conducted according to PRISMA guidelines (Liberati et al., 2009). Studies were described in a narrative synthesis (Popay et al., 2006). Outcomes were categorised according to the Kozma definitions for economic, clinical and humanistic outcomes (Kozma et al., 1993). The Kozma ECHO model is used widely within pharmaceutical healthcare research (Alves-Conceicao et al., 2018; Jokanovic et al., 2017; Wilhelmsen & Eriksson, 2019). It was chosen for use within this systematic review as it permits the capture of outcomes that are of importance to patients, a key aspect of the research, through the use of a humanistic outcome category.

1.2.1 Scope of the literature review

This literature review includes domiciliary medication reviews that described the measurement of outcomes. An intervention was considered a medication review if it met the definition of a level 3 review as outlined in *A Room for Review* (2002). This definition was chosen as it is an established definition of a comprehensive medication review which provides a distinction between other types of medication reviews, e.g. those that do not involve the patient or are focused only on compliance checks, which are not always highlighted as less comprehensive in the literature. No blanket decisions on inclusion or exclusion of international papers were made. To ensure the definition of a comprehensive medication review was met, the description provided of the medication review was reviewed and assessed for each paper that was selected for full text screening.

The search was not limited by country as it was felt it was important to review international evidence as well as local to establish whether parallels can be drawn between practices in different countries. Non-English language titles were excluded only after establishing that an English translation was not available. Non-domiciliary settings were excluded (e.g., community pharmacies and care homes) as this review aimed to identify the outcomes and impact achieved from conducting medication reviews while a person is resident in their home. Studies focusing on a single morbidity were excluded as it was felt that these studies would focus on condition specific outcomes, which could limit the generalisability of findings to the work described in this thesis. The search was not limited by profession or age of adult participants to ensure as wide a search as possible was conducted to capture all relevant evidence.

1.2.2 Sources used

To establish a comprehensive picture of the existing knowledge around DMRs, both primary and secondary sources were used to capture any relevant literature. The following section provides brief descriptions of the sources and the rationale for their use. Databases were searched from inception to August 2021.

Databases:

Medline

Biomedical database containing comprehensive published literature including systematic reviews, original papers and conference abstracts. Accessed via Ovid.

Embase

Biomedical database containing comprehensive published literature including systematic reviews, original papers and conference abstracts. Embase is similar to Medline but additionally includes pharmacy and medication-related journals. Accessed via Ovid

CINAHL Plus

Biomedical database containing comprehensive published literature with a focus on nursing and allied health professionals. Accessed via EBSCOhost

Science Citation Index

Scientific database used to access bibliographic information. I used this database to estimate the influence of a paper by examining the number of times it had been cited and by whom. This database was also useful for finding relevant articles that were not revealed from Medline or Embase search strategies. Accessed via Clarivate Analytics.

Research registers

ProQuest dissertations and Theses Global

Database of full text dissertations and theses.

International Pharmaceutical Abstracts

Database of abstracts published in pharmaceutical and medical journals

1.2.3 Systematic review search strategy

The search strategy for the systematic review was developed and uploaded to PROSPERO (McCormick et al., 2018). A literature search of the following databases

was conducted: Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE (OVID), EMBASE (OVID), CINAHL (EBSCO), Science Citation Index (Web of Science), Proquest Dissertations and Theses Global (Proquest) and International Pharmaceutical Abstracts (OVID). A combination of subject heading and free-text searching was used. For most subject headings used, terms were exploded to capture as many results as possible. The exception was "Outcome and Process assessment" as a "Healthcare" sub-heading existed. For free-text terms multi-purpose (.mp) searching was used. The search strategy was adapted to the subject headings of databases. The search strategy for Medline is described in **Table 1-1**.

1	Data Collection (MeSH)
2	Home Care Services (MeSH)
3	"Drug Utilization Review" (Free-text)
4	Outcome Assessment, Health Care (MeSH)
5	medic* review (Free-text)
6	"drug use review". (Free-text)
7	"outcome measure" (Free-text)
8	"home" (Free-text)
9	Residence Characteristics (MeSH)
10	Medication Therapy Management (MeSH)
11	Outcome and Process Assessment (Health Care) (MeSH)
12	1 or 4 or 7 or 11
13	2 or 8 or 9
14	3 or 5 or 6 or 10
15	12 and 13 and 14

Table 1-1: Medline search strategy

Reference lists of relevant papers and systematic reviews were reviewed to ensure all relevant articles had been identified. Published papers and popular journals were hand searched to identify additional papers that were not discovered from literature databases. Grey literature was sought by searching the National Institute for Clinical

Excellence (NICE) Evidence Search, The Kings Fund and other targeted resources to try and find further relevant studies. Papers were initially reviewed separately by two reviewers (PM & RC) to decide whether they met the inclusion criteria. If there was non-agreement a third reviewer (BC) read the paper and cast the deciding vote.

1.2.4 Inclusion criteria

Studies of empirical design, where a DMR was the intervention and there was information on its effect were included. Study participants were deemed eligible if they were over 18 years old and resided in their own home. No restriction was placed on the type of professional conducting the DMR. The following definition of medication review was taken: *"A structured, critical examination of a patient's medicines with the objective of reaching an agreement with the patient about treatment, optimising the impact of medicines, minimising the number of medication-related problems and reducing waste" (Room for Review,(2002)).*

1.2.5 Exclusion criteria

If participants were less than 18 years old or if they did not reside in their own home e.g. care home residents, papers were excluded. Papers which described DMRs that targeted treatments for a single clinical condition were also excluded as they do not involve a comprehensive review of every medication, a requirement of a level 3 medication review (2). In addition, all papers that did not meet the definition of a comprehensive medication review were excluded. If no outcomes were reported, or they were reported but authors did not include a measurable change as a result of the DMR papers were also excluded. Systematic reviews were excluded but reference lists were searched to identify potentially relevant studies. Finally, papers were excluded if an English language translation could not be located.

1.2.6 Quality and bias assessment

When evaluating randomised control trials the focus was on the potential bias within studies rather than the quality of the trials. This was in line with the Cochrane Collaboration's methods, which in 2005 moved away assessing quality using distinct scales and instead reviewing quality through the lens of bias (Higgins et al., 2011). Cochrane experts felt that the definition of quality was ill-defined and that assessment of the quality of trial reporting and trial conduct were commonly combined which was inappropriate.

For randomised control trials (RCTs) bias was assessed using the Cochrane Risk of Bias Assessment tool (Higgins et al., 2011). Each randomised control trial was reviewed to establish the potential for bias within the seven sources of potential bias outlined in the tool. The reporting instructions in the tool were followed and each source was assigned a low, high or unclear risk of bias. The detailed guidance notes in chapter eight of the Cochrane handbook v5.1 (Higgins & Green, 2011) were used to decide the level of bias for each criterion, and notes were kept on the rationale for the level chosen to ensure a consistency of approach across all randomised control trials.

Quality and bias in observational studies was assessed using the Joanna Briggs Institute (JBI) Checklists for cohort and prevalence (no comparator arm) studies (The Joanna Briggs Institute, 2017). Similar to the approach recommended by the Cochrane Institute the JBI checklists consider quality of studies by focusing on bias. JBI checklist assess quality through the extent to which a study has considered and addressed the possibility of bias in design, methods and analysis of studies (Aromataris & Munn, 2017).

Each cohort study was reviewed against the 11 criteria within the checklist and each prevalence study was reviewed against the nine criteria listed within the checklist. For both cohort and prevalence studies a response of yes, no, unclear or not applicable was recorded for each criterion. The guidance notes in chapter seven of the Joanna Briggs reviewers manual (Moola et al., 2017) were used to decide the level

of bias, and notes were kept on the rationale for the level chosen to ensure a consistency of approach across all cohort and prevalence studies.

Cochrane and Joanna Briggs tools were chosen as they are commonly used in the published literature.

When evaluation of bias within all studies was completed a Red-Amber-Green (RAG) rating (Moore, 2021; Pollock et al., 2018) was used to visually represent the level of potential bias linked to the criterion described within each assessment tool. A rating was chosen if methods were likely to have introduced bias, an amber rating was chosen if there was potential for a method to introduce bias and green if there was no indication that a method has introduced bias. In addition, a grey categorisation was used if insufficient information provided by the authors of included papers to assess bias.

1.3 Results

A total of 1547 papers were reviewed, 1448 papers from database searching and 99 from other sources. A total of 32 papers met the inclusion criteria (Figure 1**Error! Not a valid bookmark self-reference.**).

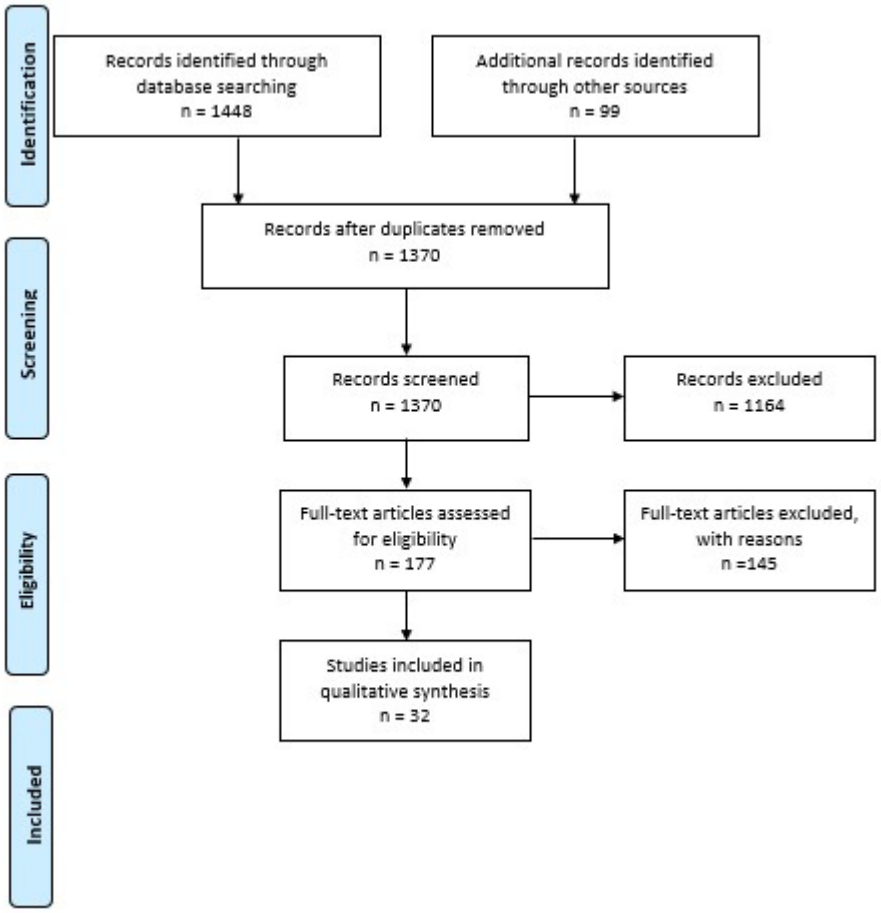


Figure 1: Flowchart describing article selection

The full text was screened for 177 eligible papers. A total of 145 papers were excluded at this stage (Table 1-2).

Table 1-2: Summary of full text articles excluded

Reason for exclusion	N
Review did not take place in domiciliary setting	26
Study was investigating single disease state	11
No measurable changes reported	7
Did not meet full definition of medication review as defined in methods	74
Systematic review	10
No outcomes reported	9
Setting unclear	6
No English translation available	1
Study on patients < 18 years old	1
Total	**145**

Thirty-two papers were included in the systematic review. The papers were published from 1996 to 2017, with the majority being published after 2000 (**Figure 2**). The individual year with the most published papers was 2016 (n=4).

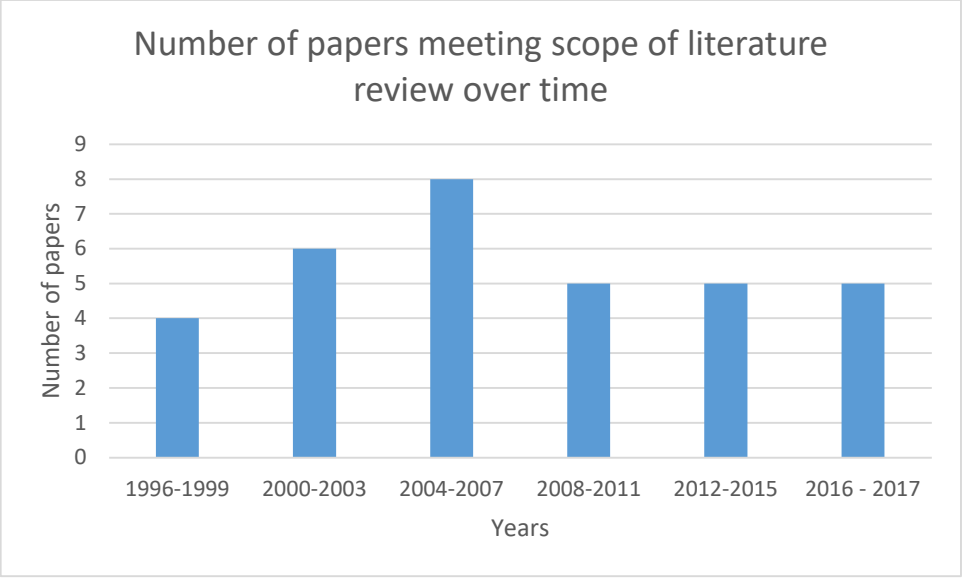


Figure 2: Growth of the literature

There were 31 papers published in peer reviewed journals and one university report describing a study (a corresponding peer reviewed paper could not be found). The 32 papers (**Table 1-3**) described 29 studies with one randomised control trial being discussed in two papers (Krska et al., 2001; Krska et al., 2007) and another in three papers (Holland et al., 2005; Holland et al., 2006; Pacini et al., 2007).

The published papers comprised three study types: randomised control trials (RCTs) (n = 12), cohort studies (n=3) and prevalence studies (n=17).

Table 1-3: Summary of the population characteristics and study interventions of papers included in systematic review

1st author	Paper title	Study design	Size	Country of study	Population Characteristics	Intervention
Bellone, J. M	Post-discharge interventions by pharmacists and impact on hospital readmission rates	Cohort	131	USA	Age (mean): 47.7 years Gender: 60% female Medicines (mean): 8.5 Co-morbidities (mean): 5.1 Support: not reported Service: Primary Care Health Centre Recruitment: random sample of patients who had received service	Post-discharge pharmacist home medication review (no further details provided) vs standard care (no home medication review)
Black and Glaves	Integrated Strategies will work best	Prevalence	305	UK	Age: not reported Gender: not reported Medicines: not reported Co-morbidities: not reported Support: not reported Service: Community Intermediate Care Recruitment: Patients who had received a review	Pharmacist home medication review (no further details provided)
Castelino, R. L (2010) (1)	Drug Burden Index and potentially inappropriate medications in community-dwelling older people: the impact of Home Medicines Review	Prevalence	372	Australia	Age (mean): 76.1 years Gender: 55% female Medicines (mean): 10.7 Co-morbidities (mean): 6.0 Support: not reported Service: HMR Service Recruitment: Patients who had received a review	Single pharmacist home medication review with recommendations to GP

1st author	Paper title	Study design	Size	Country of study	Population Characteristics	Intervention
Castelino, R. L (2010) (2)	Retrospective evaluation of home medicines review by pharmacists in older Australian patients using the medication appropriateness index	Prevalence	270	Australia	Age (mean): 75.3 years Gender: 55% female Medicines (mean): 11.6 Co-morbidities (mean): 6.7 Support: not reported Service: HMR service Recruitment: Patients who had received a review	Single pharmacist home medication review with recommendations to GP
Cheen, H	Evaluation of a multidisciplinary care transition program with pharmacist-provided home-based medication review for elderly Singaporeans at high risk of hospital readmissions	Cohort	499	Singapore	Age (mean): 73.6 years Gender: 49% female Medicines (mean): 14.9 Co-morbidities (CCI): 6.8 Support: not reported Service: Post-discharge intermediate care service Recruitment: Patients at high risk of DRPs (including polypharmacy, renal/hepatic impairment, frequent hospital admissions, high morbidity)	Single post discharge pharmacist home medication review vs standard care (post discharge visit but no medication related interventions)
Coleman	Delivering domiciliary pharmaceutical care from a health centre pharmacy	Prevalence	100	UK	Age (mean): 73.9 years Gender: 66% female Medicines (median): 7 Co-morbidities: not reported Support: 56% housebound Service: Single GP surgery	Initial pharmacist home medication review, with follow up at three months for study evaluation.

1st author	Paper title	Study design	Size	Country of study	Population Characteristics	Intervention
					Recruitment: Patients aged over 65 with 5 or more regular medications, OR under 65 with 5 or more regular medications and additional pre-defined indicator of potential medication problems	
Dilks	Pharmacy at home: service for frail older patients demonstrates medicines risk reduction and admission avoidance	Prevalence	346	UK	Age: not stated Gender: not stated Medicines: not stated Co-morbidities: not stated Support: not stated Service: Community Health and Social Care service Recruitment: Frail older people, as identified by a range of health and social care staff, taking 5 or more medicines	Initial pharmacist home medication review with follow up visits as needed from pharmacist or pharmacy technician.
Elliot, R. A	Pharmacist-led medication review to identify medication-related problems in older people referred to an Aged Care Assessment Team: A randomized comparative study	RCT	80	Australia	Age (mean): 85.5 years Gender: 65% female Medicines (mean): 8.0 Co-morbidities (mean): 5.5 Support: 65% managing medicines independently Service: Primary care assessment team for older people with frailty Recruitment: ACAT service users on 2 or more medications	Single pharmacist home medication review with recommendations to GP after direct referral to a clinical pharmacist vs usual care (GP requests a pharmacist home medication review if felt needed)

1st author	Paper title	Study design	Size	Country of study	Population Characteristics	Intervention
Gilbert, AL	Collaborative medication management services: improving patient care	Prevalence	>1000	Australia	Age (median): 72 years for men and 74 years for women Gender: not reported Medicines (mean): 9 Co-morbidities (mean): 6 Support: not reported Service: HMR service Recruitment: 5-10 patients per GP practice with pre-defined indicators of potential medication related problems.	Case conference with GP, then pharmacist home medication review, then follow up case conference
Hanna, M	The impact of a hospital outreach medication review service on hospital readmission and emergency department attendances	Prevalence	398	Australia	Age (mean): 72.1 years Gender: 51% female Medicines: not reported Co-morbidities: not reported Support: 47.6% had a carer Service: Hospital outreach service Recruitment: Patients identified as being at high risk of medication misadventure, using a risk assessment tool, during a hospital admission	Pharmacist home medication review with patient. Subsequent report sent to GP and community pharmacy
Holland, R. (2005)	Does home-based medication review keep older people out of hospital? The HOMER randomised controlled trial	RCT	872	UK	Age (mean): 85.4 years Gender: 61.1% female Medicines (mean): 6.4	Pharmacist home medication review: follow-up visit 6-8 weeks later vs usual post discharge care

1st author	Paper title	Study design	Size	Country of study	Population Characteristics	Intervention
					Co-morbidities: breakdown of eight co-morbidity types provided in paper. Most common = cardiovascular Support: not stated Service: Post-discharge review Recruitment: More than 80 years old, following discharge from emergency hospital admission, and on 2 or more prescribed medications.	
Holland, R. (2006)	Delivering a home-based medication review, process measures from the HOMER randomised controlled trial	As above, follow up analysis of initial RCT data.				
Hsia, D E	The benefits of in-home pharmacy evaluation for older persons	Prevalence	21	USA	Age (mean): 75.1 years Gender: 100% male Medicines (mean): 6 Co-morbidities (mean): 6.3 Support: not reported Service: Veterans home care service – therapeutic services offered at home Recruitment: Three or more medicines with suspected medication problems	Pharmacist home medication review, with follow-up visit to assess changes
Krska, J (2001)	Pharmacist led medication review in patient over 65: a randomised controlled trial in primary care	RCT	332	UK	Age (mean): 74.8 years Gender: 56.5% female Medicines (mean): 7.3	Pharmacist home patient interview plus

1st author	Paper title	Study design	Size	Country of study	Population Characteristics	Intervention
					Co-morbidities (mean): 3.9 Support: not reported Service: Patients registered to study GP surgeries Recruitment: Patients over 65 years, taking at least 4 medicines and 2 chronic conditions	pharmaceutical care plan vs interview alone
Krska, J (2007)	Is hospital admission a sufficiently sensitive outcome measure for evaluating medication review services? A descriptive analysis of admissions within a randomised controlled trial	As above, follow up analysis of initial RCT data.				
Lenaghan, E.	Home-based medication review in a high-risk elderly population in primary care - The POLYMED randomised controlled trial	RCT	136	UK	Age (mean): 84.5 years Gender: 67.6% female Medicines (mean): 9 Co-morbidities: not reported Support: 6% using compliance aid Service: Patients registered at study GP surgery Recruitment: Over 80 years old, taking at least 4 daily medicines and one further risk factor from predefined list of high-risk indicators.	Pharmacist home medication review: follow-up visit after 6-8 weeks vs standard care

1st author	Paper title	Study design	Size	Country of study	Population Characteristics	Intervention
Lowe CJ	Effects of a medicine review and education programme for older people in general practice	RCT	161	UK	Age (mean): 77.5 years Gender: 67% female Medicines (mean): 4.2 Co-morbidities: not reported Support: not reported Service: Patients registered at study GP surgery Recruitment: Community residing patients aged 65 years or over, and taking 3 or more regular medications	3x Pharmacist home visits with knowledge and compliance assessments, medication related interventions and education vs 3x pharmacist home visits with knowledge and compliance assessments only
MacAuley	Provision of clinical pharmacy services in the home to patients recently discharged from hospital: A pilot project	Prevalence	27	Canada	Age (mean): 81.1 years Gender: 67% female Medicines (mean): 11.9 Co-morbidities: not reported Support: 27% not independent with medication management and 70% used an adherence tool Service: Homecare service Recruitment: Patients following hospital discharge who meet at least 1 of pre-defined referral criteria. Referred by home care nurses.	Pharmacist home medication review with up to two follow up visits or telephone consultations.
Moultry, A	Perceived Value of a Home-Based Medication Therapy	Prevalence	18	USA	Age (range): 60-70 years (44.4%), 71-80 years (50%), 90 and older (5.6%) Gender: 61.1% female	Pharmacist home medication review

1st author	Paper title	Study design	Size	Country of study	Population Characteristics	Intervention
	Management Program for the Elderly				Medicines range: 1-3 (22.2%), 4-6 (16.7%), 7 or more (61.15) Co-morbidities: not reported Support: not reported Service: Home medication review service Recruitment: Patients aged 60 years plus who had received a medication review.	including advice on natural disaster preparedness.
Naunton, M.	Evaluation of home-based follow-up of high-risk elderly patients discharged from hospital	RCT	121	Australia	Age (median): 74 years Gender: 66% female Medicines (median): 8 Co-morbidities: not reported Support: not reported Service: Post-discharge medicines review Recruitment: Patients discharged from medical wards of one hospital, Aged 60 years or over with 2 or chronic conditions	Pharmacist home medication review within 5 days of discharge
Naylor and Oxley	Assessing the need for a domiciliary pharmaceutical service for elderly patients using a coding system to record and quantify data	Prevalence	86	UK	Age: not reported Gender: not reported Medicines (median): 8 prescribed and one OTC Co-morbidities: not reported	Pharmacist home medication review including variable number of follow up visits

1st author	Paper title	Study design	Size	Country of study	Population Characteristics	Intervention
					Support: not reported Service: Community pharmacy Recruitment: Housebound patients in defined geographical area as identified by GPS, carers, district nurses or community pharmacy records.	
Nissen , L	Rural community pharmacists integrating care for people with complex needs	RCT	192	Australia	Age (mean): 69.8 years Gender: 58% female Medicines: not reported Co-morbidities: 57% have one or more diagnoses Support: not reported Service: Community pharmacy Recruitment: Hospitalised patients taking 5 or more medications with at least one long-term condition that requires close medical supervision	Pharmacist home medication review
Olessen, C.	Impact of pharmaceutical care on adherence, hospitalisations and mortality in elderly patients	RCT	630	Denmark	Age (median): 74 years Gender: 53% female Medicines (median): 7 Co-morbidities: not reported Support: not reported Service: N/A – research pharmacists Recruitment: Patients over 65 years old taking at least 5 medications	Pharmacist home medication review with telephone follow-up at 3, 6 and 9 months vs no intervention

1st author	Paper title	Study design	Size	Country of study	Population Characteristics	Intervention
					without assistance, from defined geographical area.	
Ong, K. Y.	Effectiveness of a multidisciplinary home-based medication review program in reducing healthcare utilization among older adult Singaporeans	Prevalence	107	Singapore	Age (mean): 75.6 years Gender: 55% female Medicines (mean): 12.6 Co-morbidities: 6.5 Support: not reported Service: Home-based medication review service Recruitment: Patients who met at least 2 inclusion criteria linked to number of medications and underlying conditions	Pharmacist home medication review with face to face or telephone follow up as needed.
Pacini, M	Home-based medication review in older people. Is it cost effective?	RCT	Y.	As per Holland, follow up economic analysis of initial RCT data.		
Pherson	Development and implementation of a post discharge home-based medication management service	Prevalence	50	USA	Age (mean): 60 years Gender: 54% female Medicines (mean): 11 Co-morbidities: 50% CHF, 66% diabetes, 22% COPD Support: not reported Service: post discharge medication review service Recruitment: Patients admitted to study hospital	Pharmacist home medication review with follow up telephone call

1st author	Paper title	Study design	Size	Country of study	Population Characteristics	Intervention
Quirke, J.	Home medicines reviews - do they change prescribing and patient/pharmacist acceptance?	Prevalence	49	Australia	Age (median): 63 years Gender: not reported Medicines (mean): 7 Co-morbidities: not reported Support: not reported Service: HMR service Recruitment: Patients who had received a review	Pharmacist home medication review as per national service specifications.
Reidt	Integrating a pharmacist into a home healthcare agency care model: impact on hospitalisations and emergency visits	Cohort	430	USA	Age (range): 18-50 years (27.5%), 51-64 years (32.3%), 65 years and over (39.9%) Gender: 70.1% female Medicines (range): 9 – more than 20 Co-morbidities (range): 2 – more than 15 Support: not reported Service: Homecare service Recruitment: Patients discharged from hospital referred for DN input, meeting other predefined eligibility criteria	Pharmacist home medication review
Schneider, J	Provision of a domiciliary service by community pharmacists	Prevalence	39	UK	Age: not reported Gender: not reported Medicines (mean): 8 Co-morbidities: not reported Support: not reported	Pharmacist home medication review

1st author	Paper title	Study design	Size	Country of study	Population Characteristics	Intervention
					Service: Community pharmacy Recruitment: GP identification of appropriate housebound patients having difficulty managing their medication	
Sorensen, L.	Medication reviews in the community: results of a randomized, controlled effectiveness trial	RCT	400	Australia	Age (mean): 72.3 years Gender: 63.1% female Medicines (mean): 9.1 Co-morbidities: not reported Support: not reported Service: HMR service Recruitment: Patients of participating GP surgeries, meeting one or more eligibility criteria indicating risk of medication related problems.	Multifaceted; GP education plus pharmacist visit +/-GP home visit, discussion with GP, action plan by GP, follow up by GP with options for onward referral vs standard care
Steele, K. M.	Home-Based Comprehensive Medication Reviews: Pharmacist's Impact on Drug Therapy Problems in Geriatric Patients	Prevalence	25	USA	Age (median): 88 years Gender: 72% female Medicines: not reported Co-morbidities: not reported Support: participants used a pharmacy chain delivery service Service: N/A – research pharmacists Recruitment: Patients >65 years old, on 3 or more chronic medications	Pharmacist home medication review with telephone follow up at 2 weeks.

1st author	Paper title	Study design	Size	Country of study	Population Characteristics	Intervention
Triller, D. M	Resolution of drug-related problems in home care patients through a pharmacy referral service	Prevalence	80	USA	Age: not reported Gender: gender Medicines: not reported (more than 9 medicines an inclusion criteria) Co-morbidities: not reported (more than 3 conditions an inclusion criteria) Support: not reported Service: Homecare service Recruitment: identified by nurse case manager as high-risk indicators for medication related problems.	Pharmacist home medication review
Abbreviations: HMR = Home Medication Review, DRP = drug related problem, CCI = Charlson Co-morbidity Index, GP = General Practice, ACAT = Aged Care Assessment Team, CHF = Congestive heart failure, COPD = Chronic obstructive pulmonary disease						

1.3.1 Overview of studies

The population characteristics varied across studies (**Table 1-3**).

1.3.1.1 Countries providing DMRs

. The 29 studies described in the published papers took place in six countries. The UK and Australia have published the most evidence (n=9 respectively), followed by the USA (n=7), Singapore (n=2), Denmark (n=1) and Canada (n=1).

1.3.1.2 DMR recipients

The majority of the studies found in the literature involved people over the age of 65 years (n=21). When the average (most commonly reported as mean) age of study participants was reviewed, most were between 71 and 80 years (n=14). Three papers involved populations with an average age less than 65 years (Bellone et al., 2012; Pherson et al., 2014; Quirke et al., 2006) Five studies did not report the age of study participants.

The majority of studies (n=20) contained more female than male participants. Only two studies contained more male than female participants. One study which focused on army veterans contained 100% male participants (Hsia Der et al., 1997). Seven papers did not report the gender spilt within study populations.

Participants also tended to be recipients of polypharmacy. The majority of studies involved patients who took an average (most commonly reported as mean) of 6-15 medicines (n=22). One study (Lowe et al., 2000) involved patients taking on average less than five medications. Four studies did not report medication demographics. There was limited detail within papers as to what was included in the number of medications metric e.g. prescribed medications or over the counter medications etc. There was no consensus on the definition of polypharmacy within the included studies. Some services used a minimum number of medications as an eligibility criterion Services also used various other eligibility criteria to determine who should

receive a DMR including, a previous recent hospital admission and use of another healthcare service were also used as eligibility criteria.

Papers were also examined for information on the level of social or medicines support they were in receipt of but this was not commonly reported. Coleman et al. (2001) reported that 56% of their study participants were housebound and Hanna et al. (2016) reported that 47.6% had a carer, but further detail on the level of support given was not described. Elliot et al. (2012) reported that 65% of study participants managed their medications independently, while MacAulay et al. (2008) reported 27% were not independent with medication management. Lenaghan et al. (2007) reported that 6% of their study participants used a compliance aid.

1.3.1.3 Professionals providing the DMR

Pharmacists conducted all the DMRs described in the reviewed papers. One study included a pharmacy technician role for some of the follow-up visits (Dilks et al., 2016), no further detail on the specific role of the technician was included. Little information on the professional background of the pharmacists conducting the review was included in papers. They were referred to as community, hospital, GP practice and consultant pharmacists or they were described as study pharmacists without further detail on their professional background. The link between the professional experience and the DMR services' outcomes was only explored for the HOMER trial (Holland et al., 2006). The authors found that professional characteristics - number of years qualified, experience of conducting medication reviews, obtainment of a higher degree and a hospital pharmacist background (vs community pharmacy) - made no difference to the study's primary outcome: hospital admission rate.

There were published papers describing medication reviews conducted by other professionals but they were not included in the systematic review as their

intervention did not meet the required definition of a comprehensive medication review or they did not describe any outcomes linked to the DMR.

1.3.2 Quality and bias within papers

All included studies had their risk of bias 'RAG rated' (Appendix 1, 2 and 3**).** There were varying levels of bias within studies.

Randomised control trials aim to evaluate the effectiveness of an intervention. They involve two or more groups randomly allocated to different investigative arms (Bowling, 2014). Double blind randomised control trials are highly regarded in research, particularly clinical trials. The inclusion of blinding within a RCT methodology reduces the likelihood of investigator bias (Kaptchuk, 2001). Nonetheless, blinding is not possible in studies where the intervention involves interaction with a professional. This is the case when investigating domiciliary medication reviews. Therefore, it can be argued that non-blinded RCTs is an appropriate methodology. However, a study can be considered high risk of bias if participants were unblinded and the outcomes measured were linked to their behaviours. This was the case for the HOMER study (Holland et al., 2005; Holland et al., 2006; Pacini et al., 2007), the POLYMED study (Lenaghan et al., 2007) and the study conducted by Nissen (2005); study participants were asked to report Patient Reported Outcome Measures (PROMs) or Quality of Life (QOL) measures.

Randomisation avoids bias that could be introduced from allocating participants with characteristics of interest to an investigative arm within a trial. By allocating participants randomly there is an increased likelihood that the effect observed in a trial is due to the intervention (Roberts & Torgerson, 1998). Randomisation is not an infallible process, and it is important to examine randomisation methods to assess whether participant samples represent the population under investigation and whether methods of randomisation have introduced bias into a study. A variety of randomisation methods were used within the RCTs (**Table 1-4**).

Most RCTs were considered to have a low risk of bias for randomisation methods, apart from Elliott (2012) because authors used permuted block randomisation. This is not considered best practice in an unblinded study due to the risk of selection bias (Kahan et al., 2015). Two studies (Lenaghan et al., 2007; Lowe et al., 2000) did not provide sufficient detail on randomisation methods and so, bias could not be assessed.

Table 1-4: Summary of randomisation methods for RCTs

Lead author, year	Country	Randomisation method
Eliot, 2012	Australia	Permuted block randomisation method with two block sizes
Holland, 2005* AND Holland 2006 AND Pacini, 2007	UK	Telephone randomisation using computer generated sequence; stratification according to mental test score & whether participation lived alone
Krska, 2001* AND Krska, 2007	UK	General Practices stratified according to deprivation status then random number tables used
Lenaghan, 2007	UK	Methods of randomisation not given. States third party randomisation
Lowe, 2000	UK	Methods of randomisation not given. States participants were randomly allocated only
Olesen, 2014	Denmark	Participant envelope selection which contained a code related to one of the study arms
Naunton, 2003	Australia	Allocated to intervention or control using a computer-generated list of random numbers by research pharmacist
Nissen, 2005	Australia	Computer generated random number list determined centrally at the University of Brisbane
Sorensen, 2004	Australia	Participating GPs as unit of randomisation

**Denotes paper randomisation methods were described within*

Bias can also be introduced if the person carrying out the intervention also measures the study outcomes. This was frequently the case for the RCTs included in this systematic review. However, the potential for bias varies according to the outcomes recorded and whether the professional affected these outcomes. The level of bias is lower for outcome measures that the professional was unlikely to have been able to affect e.g. hospital readmission and death rates, if the outcome data comes from an independent source and higher for measures such as change in compliance rates.

Research protocols for RCTs were unavailable, it is therefore, not possible to comment on bias linked to selective reporting.

Specifically for cohort studies a study can be considered high quality if researchers describe how the exposure in a study is measured in sufficient detail (The Joanna Briggs Institute, 2017). For the three cohort papers the exposure was the DMR. However, insufficient detail is provided to assess quality for this criterion. In two cohort studies (Bellone et al., 2012; Cheen et al., 2017) there were substantial differences between the baseline demographics of the control and intervention groups. Given this heterogeneity, it is possible that any difference in outcome observed was not solely a result of the intervention. This also means that even if a study was of sufficient quality, the risk of bias is sufficient to warrant over interpretation of results.

For the prevalence papers only two (Hsia Der et al., 1997; Ong et al., 2017) conducted sample size calculations before carrying out their interventions. For most papers statistical analysis was limited to the presentation of descriptive statistics including means and medians. Beyond this the information provided describing the data analysis was limited. This made it difficult assess whether bias been introduced from methodological flaws including too small or too large sample sizes, the presence of outliers or inappropriate choice of statistical test.

For both cohort and prevalence studies there was limited published information available to assess risks of quality and bias. These observational studies were not set up as rigorous scientific studies. Papers described observational outcomes from an established DMR service. This reflects the real-world nature of these services; they are started because of a perceived clinical need rather than an academic identification of a gap in knowledge. However, when authors publish their findings it is appropriate to try and assess methodology flaws in order to decide whether reported outcomes and assertions are reasonable.

1.3.3 Reported outcomes

Outcomes reported in studies, were categorised according to the ECHO (Economic, Clinical or Humanistic) model (**Table 1-5**, **Table 1-6** and **Table 1-7**).

Table 1-5: Systematic review economic outcomes

Broader outcome subheading	Outcome as specified in paper	Papers outcome used in	Results
Economic			
Reduction in cost of social services	Cost saving to social services	Black and Glaves	£115,000 in study period extrapolated to annual saving of £460,000.
Reduction in medication costs	Medication costs	Krska 2001	No difference in monthly drug costs
Reduction in cost of health services	Cost of hospital admissions over 6 months	Ong 2016	Reduction in cost of hospital stays over 6-month period, from US $16,957 to US$7,488 ($p < 0.001$)
	Total health costs (intervention, hospital admissions and primary care)	Pacini 2007	Intervention group cost £271 more than control group (£1695 vs £1424).
	Costs including cost of medication, cost of providing visit and cost of other health services utilised	Sorensen 2004	Net cost saving per intervention patient of AUS$54
Reduction in cost to health and social care.	Total costs (intervention and "costs to health and social care system")	Dilks 2016	Predicted £100k cost saving per year.

Table 1-6: Systematic review clinical outcomes

Broader outcome subheading	Outcome as specified in paper	Papers outcome used in	Results
Clinical			
Hospital readmissions	60-day hospital readmission rate	Bellone 2012	Reduction in number of readmissions in intervention group (43% vs 18.2%, p = 0.002) but confounding due to heterogeneity between groups.
	6-month re-admission rate	Cheen 2017	26% reduction in readmission rate (p = 0.007)
	90-day readmission rates	Naunton 2003	Reduction in readmission rates in intervention group (45% vs 28%, p = 0.05)
	30-day rehospitalisation rate	Reidt 2014	No significant reduction in rehospitalisation rate in intervention arm (92 vs 26, OR: 0.60 CI: 0.42-1.13, p > 0.05)
Hospital admissions	Emergency admissions over 6 months	Holland 2005	Increased hospital admissions vs control (234 vs 178, RR 1.30, 95% CI: 1.07 – 1.58, p = 0.009
		Sorensen 2004	No difference in number of hospital admissions or number of inpatient days for intervention vs control group (figures not reported).
		Lenaghan 2007	No significant difference in hospital admissions between intervention and control (21 vs 21, p = 0.80)

Broader outcome subheading	Outcome as specified in paper	Papers outcome used in	Results
Clinical			
		Ong 2017	41% reduction in hospital admissions after intervention (incidence rate reduction: 0.59, 95% CI: 0.47-0.73), P<0.001)
	Hospitalisation rate over 12 months	Hanna 2016	25% reduction in hospital admissions after intervention for 51-65 year olds after intervention (p <0.05). No significant difference for all other age groups (≤50 years and > 60 years)
	Hospitalisation rate over 2 years	Olesen 2014	No difference in 2-year hospitalisation rate for intervention vs control group (30 vs 28%, OR: 1.14, 95% CI 0.78 – 1.67)
	Preventability and type of Pharmaceutical Care Issues (PCIs) related admissions	Krska 2007	17 of 77 admissions were PCI related and 10 out of 17 PC admissions were considered preventable. 1 admission attributed to pharmacist intervention.
	Hospital admissions avoided	Dilks 2016	Extrapolated figure of 109 admissions avoided per year (does not report how many patients would need to be reviewed to achieve this).
Non inpatient health contacts (e.g. outpatient, GP, emergency department)	Number of Emergency Department (ED) visits	Cheen 2017	20% reduction in ED visits for intervention vs control (IRR = 0.80, 95% CI: 0.66–0.98, p = 0.030)
	Number of ED visits over 6 months	Ong 2016	41% reduction in ED visits after intervention (incidence rate reduction: 0.59, 95% CI: 0.47-0.73), P<0.001)

Broader outcome subheading	Outcome as specified in paper	Papers outcome used in	Results
Clinical			
	Number of ED visits over 30 days	Reidt 2014	Reduction in ED visits in intervention arm)55 vs 10, OR: 0.60 CI: 0.38-0.95, $p < 0.05$).
	Number of ED visits over 12 months	Hanna 2016	No significant difference in ED attendances between control and intervention groups
	Number of outpatient visits	Cheen 2017	Non-significant increase in outpatient visits increased 16% for intervention group (IRR 1.16, 95% CI: 0.95 – 1.41, $p = 0.150$)
	Number of non-admission hospital services	Sorensen 2004	No difference in number of non-admission hospital services for intervention vs control group (figures not reported).
	Number of GP visits	Sorensen 2004	No difference in number of GP visits for intervention vs control group (figures not reported).
Reduction in inappropriate prescribing	Reduction in Potentially inappropriate medications (PIMs)	Black and Glaves	62% reduction in PIMs after intervention
		Castelino 2010 (1)	Reduction in PIMs identified from 39.8% to 28.2% after intervention.
	Change in Medication Appropriateness Index (MAI) score	Castelino 2010 (2)	Statistically significant reduction in MAI score after intervention (from 18.6 ±11.3 to 9.3 ±7.5, $p < 0.001$).
	Change in number of drug/ medication related problems (D/MRPs)	Ong 2016	6.7% of DRPs resolved without physician involvement, 34.1% resolved with physician involvement.

Broader outcome subheading	Outcome as specified in paper	Papers outcome used in	Results
Clinical			
		Cheen 2017	36.4% of DRPs resolved 1 month after intervention.
		Naunton 2003	90 days after intervention, reduced number of DRPs in intervention group vs control (1 vs 2 DRPs per patient, $p < 0.0001$).
		Steele 2016	Reduction in number of DTPs after intervention (reduced from 3.4 to 1.48 per patient, $p < 0.05$).
		Gilbert 2002	82% of recommended actions following intervention resulted in improvement or resolution of DRP
		Elliot 2012	21 MRPs identified via usual care. An additional 79 MRPs identified following pharmacist review.
	Change in risk of meds related harm	Dilks 2016	Percentage of patients at high/extreme risk of medication related harm reduced from 76% to 21% after intervention.
	Pharmaceutical Care Issues	Krska 2001	PCIs resolved at follow up were greater in intervention vs control group (82.7% vs 41.2%, $p < 0.0001$)
	Change in adverse drug event rate	Sorensen 2004	'Positive trend (not statistically significant) in reduction in ADE rate in intervention group vs no reduction for control group (for ADES reported by patients and by GPs).

Broader outcome subheading	Outcome as specified in paper	Papers outcome used in	Results
Clinical			
Reduction in number/complexity of medications	Change in drug burden index (anticholinergic and sedative medications)	Castelino 2010 (1)	Patients with one or more DBI medication reduced from 60.9% – 39.8% after intervention. Total DBI score reduced from 206.9 – 157.3 after intervention.
	Impact on number of medicines prescribed	Lenaghan 2007	Reduction of 0.87 to the mean number of medicines prescribed per patient in intervention group compared to control group (95% CI: −1.66 to −0.08, p = 0.03).
Resolution of discrepancies between medication lists	Medication discrepancies	Hsia 1997	Reduction in number of medication discrepancies before vs after intervention (81 vs 44, mean per patient = 4.5 vs 2.3; Student's paired *t* test: *t* = 2.52, p = 0.021)
Proportion of recommendations that were accepted/ implemented	Percentage (%) interventions accepted by prescriber	Dilks 2016	79% of interventions accepted by prescriber.
		Krska 2001	GPs agreed with 95.8% of recommendations.
		MacAulay 2008	Physicians accepted 74% of recommendations.
		Nissen 2005	60.8% interventions accepted by GP

Broader outcome subheading	Outcome as specified in paper	Papers outcome used in	Results
Clinical			
		Reidt 2014	53% of recommendations accepted, 39% led to the client making an appointment to see their physician to address the recommendation, 8% of recommendations were rejected.
		Schneider 1996	37% of interventions proposed to GP acted upon. 50% of interventions proposed to dispensing chemist acted upon
		Triller 2003	64.6% recommendations accepted by prescriber
	Percentage (%) of recommended actions implemented	Gilbert 2002	42% of recommended interventions implemented
		Holland 2006	At least 35% of interventions enacted
		Naunton 2003	79% of recommended actions implemented by GP
	Medication change because of intervention	Naylor and Oxley 1997	48% of patients had a change in medications as a result of intervention
		Quirke 2006	84% of patients had least one change to medication; Of changes recommended, 76% were minor and 35% major
Compliance related issues	Changes in 5 Star Rating Performance measures	Steele 2016	Improvement seen in percentage of patients highly adherent to hypertension medications (p = 0.016). No improvement seen in other performance measures.

Broader outcome subheading	Outcome as specified in paper	Papers outcome used in	Results
Clinical			
	Medication hoarding (storage of out of date, duplicated or no longer required medication)	Holland 2006	Medication hoarding reduced from 40% to 19% of patients after intervention (24.1% difference in paired proportions, 95% CI 17.7 – 30.3%, p < 0.001)
	Unnecessary medications found in home	Hsia 1997	Reduction in number of unnecessary medications found in home before vs after intervention (2.9 vs 1.2 medications per patient, *t* = 2.19, p = 0.042) and expired medications found in home before vs after intervention (1.9 vs 0.1 medications per patient, *t* = 2.20, p = =0.052).
	Change in Compliance	Lowe 2000	Compliance higher in intervention group vs control group (91.3% vs 79.5%, p < 0.0001).
		Naunton 2003	Compliance at 90 days higher in intervention group vs control group (p < 0.0001).
		Olesen 2014	Similar rates in non-compliance for intervention vs control group (11% vs 10%, OR: 1.14, 95% CI: 0.65 – 2.00)
	Patient understanding/ medication related knowledge	Lowe 2000	Improved patient understanding of purpose of medications in intervention group (88% vs 70%, p<0.0005).
		Pherson 2014	All participants reported increased knowledge about medications (either 'quite a bit' or 'a lot') after intervention.

Broader outcome subheading	Outcome as specified in paper	Papers outcome used in	Results
Clinical			
		Quirke 2006	25% of participants report taking their medications differently as a result of intervention.
Multifactorial clinical markers inc. morbidity, mortality.	Mortality over 90 days	Naunton 2003	No significant difference in death rate between intervention and control group at 90 days (5% vs 8%, numbers too small for statistical analysis, total deaths = 8).
	Mortality over 6 months	Holland 2005	No difference in death rate between control and intervention group (49 vs 63 deaths, HR: 0.75, 95% CI 0.52 – 1.10, p = 0.14)
		Cheen 2017	There were 8 and 44 deaths in the intervention and control groups respectively (non-significant difference) (HR = 0.73, 95% CI: 0.29–1.81, p = 0.492)
		Lenaghan 2007	No significant difference in death rate between intervention and control group (1.3% difference in proportions, 95% CI: -12.1 – 14.7%, p = 0.81)
	Mortality over 2 years	Olesen 2014	Similar rates in 2-year mortality for intervention vs control group (7.5% vs 5%, HR: 1.41, 95% CI: 0.71 – 2.82)
	Use of health and social care services	Krska 2001	No difference between intervention and control group noted (categorised as a clinical outcome as no financial information provided).
	Severity of illness (by DUSOI-A score)	Sorensen 2004	'Positive trend' (not statistically significant) in reduction of mean DUSOI-A score for

Broader outcome subheading	Outcome as specified in paper	Papers outcome used in	Results
Clinical			
			intervention vs control group (reduction of 4.92 vs 1.34).
	Care home admissions	Lenaghan 2007	Non-significant reduction in care home admissions for intervention vs control group (3.0% difference in proportions, 95% CI: -11.0 – 5.0%, p = 0.3) [Pearson chi-square]).
Abbreviations: CI = Confidence interval, RR = risk reduction, OR = Odds ratio, IRR = Incident rate ration, GP = General Practice, PCIs = Pharmaceutical Care Issues, ED = Emergency Department, PIMs – Potentially Inappropriate Medicines, MAI = Medication Appropriateness Index, D/MRPs = Drugs/ medication related problems, ADE = Adverse Drug Event, DBI = Drug Burden Index, DUSOI-A = Duke's severity of Illness-A, HR = Hazard ration			

Table 1-7: Systematic review humanistic outcomes

Broader outcome subheading	Outcome as specified in paper	Papers outcome used in	Results
Humanistic			
Measures of patient self-management of health	Increased confidence in managing medications and illness	Coleman 2001	50% of patients felt more or a lot more confident about managing their medicines and 34% of patients felt more or a lot more confident about managing illness after intervention.
Quality of life measures	Quality of Life (EQ-5D and VAS scale)	Holland 2005	Holland: No significant difference in change in EQ-5D scores for intervention vs control (decrease of 0.13 vs 0.14, p = 0.84. Greater decrease in VAS scale measure of QoL for intervention group vs control (difference of 4.1, 95% CI 0.15 – 8.09, P = 0.042), i.e. lower quality of life for intervention group as measured by VAS scale, but no difference when measured by EQ5D scale.
		Lenaghan 2007	No significant difference in change in EQ-5D scores (decrease of 0.1 vs 0.02, 95% CI: −0.19 to 0.02 p = 0.10). No significant difference in VAS scores for intervention group vs improvement for control

Broader outcome subheading	Outcome as specified in paper	Papers outcome used in	Results
Humanistic			
			group (decrease of 1.98 vs increase of 2.87 units, 95% CI: -12.5 – 2.8, p = 0.21) i.e. no significant difference in quality of life as measured by either scale.
	QOL: (SF-36 scale)	Krska 2001	No difference between intervention and control group noted (further detail not reported).
		Nissen 2005	No difference between control and intervention arm for any of the functional health status domains
		Sorensen 2004	Physical component scores (PCS) and mental component scores (MCS) used. No differences between intervention and control group for either PCS (31.04 vs 30.49, p = 0.94) or MCS (48.67 vs 50.69, p = 0.11).
QALY	QALY (combined clinical and humanistic measure)	Nissen 2005	No difference in QALY between control and intervention arms.
	Cost per QALY (combined clinical, humanistic and economic)	Pacini 2007	Cost per QALY for intervention of £54454

Abbreviations: EQ-5D = EuroQoL-5D, VAS = Visual Analogue Scale, CI = Confidence interval, QOL = Quality of Life, SF-36 = Short-form health survey-36, QALY = Quality Adjusted Life Year, PCS = Physical Component score, MCS = Mental component score

1.3.3.1 Economic outcomes

An outcome was considered economic if the authors provided a monetary value associated with the outcome.

Black and Glaves (Black & Glaves, 2011) estimated a £460,000 annual saving to social services through a reduction of 24 care packages previously provided for medication support that were no longer needed when they helped individuals manage their medications independently.

Three studies (Ong et al., 2017; Pacini et al., 2007; Sorensen et al., 2004) assessed the difference in healthcare costs e.g. hospital admission and primary care appointment avoidance. Ong et al. (2017) were able to demonstrate a statistically significant reduction in costs. To a lesser degree Pacini et al. (2007) and Sorensen et al. (2004) were able to demonstrate costs reductions as a result of the DMR intervention but these differences were not found to be statistically significant.

Dilks et al. (2016) estimated that the Exeter Cluster Pharmacy team produced a combined annual saving of £100,000 to both the local health and social care systems. Costs were extrapolated from estimates of hospital admission avoidance calculated using the NPSA (National Patient Safety Agency, 2008) and Rio (V Williams et al., 2012) risk scoring tools. The NPSA tool is widely used to calculate the risk avoided from healthcare interventions, it was not specifically developed for medication related incidents, but it is widely used for this purpose. Healthcare systems have even integrated the matrix into their incident reporting systems. The Rio scoring tool has been adapted by DMR services to estimate the likelihood that an intervention would have resulted in a hospital admission avoidance and attributing a cost saving to this avoidance (V Williams et al., 2012) .

Krska et al. (2001) investigated the cost of medications as a result of their pharmaceutical care plan intervention but found that there was no difference in the monthly costs of medication between the intervention and standard care arms.

1.3.3.2 Clinical outcomes

Clinical outcomes were the most commonly reported type of outcome in the systematic review papers. They encompassed a diverse range of outcomes including polypharmacy linked outcomes such as the number of medication problems resolved or markers of inappropriate prescribing, to broader markers of clinical status, such as hospitalisation rates, emergency department attendance or death.

Four studies whose intervention population received a DMR post-admission looked at readmission rates at 1, 2, 3- and 6-months post-discharge. Reidt et al. (2014) showed no significant difference between intervention and control groups . Three studies showed a statistically significant reduced readmission rate in intervention patients (Bellone et al., 2012; Cheen et al., 2017; Naunton & Peterson, 2003).

Several papers whose study populations were community-residing looked at hospital admissions as an outcome. Four studies examined hospital admissions over a six-month period. One study showed an increased admission rate following intervention (Holland et al., 2005), two showed no difference (Lenaghan et al., 2007; Sorensen et al., 2004). Only one study demonstrated a reduction in admission rate following intervention (Ong et al., 2017). Two papers had longer follow-up periods. Hanna et al. (2016) demonstrated a 25% reduction in hospital admission rates for those aged 51-65 years only. Two other age groups: under 50 years and over 65 years did not see a reduction in hospital admission rates. Olesen et al. (2014) demonstrated no significant difference in hospitalisation rate seen at 2 years post intervention.

Two studies reported potential avoidance of hospital admissions, with Krska (2007) reporting that 10 out of 17 (59%) PCI related admissions were avoidable. Dilks et al. (2016) reported a projection of 109 admissions which could be avoided each year due to a home medication review intervention. Three studies were able to demonstrate a reduction in the number of emergency department visits as a result of the DMR intervention (Cheen et al., 2017; Ong et al., 2017; Reidt et al., 2014). Sorensen (2004) explored the use of GP visits and outpatient hospital services post-DMR, but no difference was found between study arms.

Several papers explored measures of inappropriate prescribing and all reported improvements in their chosen measures. These included Potentially Inappropriate Medicines (PIMs) (Black & Glaves, 2011); medication appropriateness index (MAI) score (Castelino, Bajorek, et al., 2010) , problems related to medications taken (Cheen et al., 2017; Elliott et al., 2012; Gilbert et al., 2002; Naunton & Peterson, 2003; Ong et al., 2017; Steele et al., 2016), risk of medication related harm (Dilks et al., 2016), pharmaceutical care issues (Krska et al., 2001); and adverse drug event rate (Sorensen et al., 2004). When complexity of prescribing was examined Castelino (2010) showed an improvement in Dug Burden Index (DBI) score and Lenaghan (2007) demonstrated a reduction in the average number of medications prescribed. Hsia (1997) did not show a significant reduction in medication discrepancies before and after intervention.

Many studies reported a measure of rate of acceptance of interventions or implementation of interventions by the primary prescriber. Between 35% and 95.8% of recommendations were accepted or implemented by the prescriber (Castelino, Hilmer, et al., 2010; Dilks et al., 2016; Gilbert et al., 2002; Holland et al., 2005; Krska et al., 2001; MacAulay et al., 2008; Nissen & Tett, 2005; Reidt et al., 2014; Schneider & Barber, 1996; Triller et al., 2003). Similarly, Naylor and Oxley (1997), and Quirke (2006) reported that 48% and 84% of patients' medication respectively changed as a result of the intervention.

Compliance was a frequently measured outcome and was appraised in various ways including presence of inappropriate medications in the home (Holland et al., 2005; Hsia Der et al., 1997), patient self-reports of compliance or understanding of medications and illness (Lowe et al., 2000; Pherson et al., 2014; Quirke et al., 2006), or changes in compliance as measured by researchers (Lowe et al., 2000; Naunton & Peterson, 2003; Olesen et al., 2014). All studies reported improvements in their chosen measures of compliance. Steele (2016) gauged compliance through insurance performance payments. Improvements were shown for compliance to hypertension medications, but not other measures, including presence of high-risk medications.

Mortality, measured at time points from 90 days to two years, was used as an outcome measure in five studies (Cheen et al., 2017; Holland et al., 2005; Lenaghan et al., 2007; Naunton & Peterson, 2003; Olesen et al., 2014). No significant difference in mortality rates was demonstrated in any study.

Other broad measures of clinical status included overall use of health and social care services (Krska et al., 2001), severity of illness (Sorensen et al., 2004), and care home admissions (Lenaghan et al., 2007). No significant difference was noted after intervention in any study.

1.3.3.3 Humanistic outcomes

Outcomes which directly or indirectly influenced participants' functional status or quality of life, as outlined in the ECHO model (5) , were interpreted as humanistic outcomes. Coleman et al. (2001) used feedback questionnaires to measure perceptions before and after intervention and reported an increase in participants' confidence in managing their medications (50%) and illness (34%). .

The most common humanistic outcome presented in the papers was quality of life (QOL) measures. The HOMER (Holland et al., 2005) and POLYMED (Lenaghan et al., 2007) trials used the EQ-5D scale to measure the difference in quality of life scores of their study participants. In addition, the HOMER trial also used the visual analogue scale (VAS). The EQ-5D is a frequently used QOL scale, particularly in the UK. It is a 5 question tool developed from the EuroQoL, and is a self-administered instrument designed to elicit a score indicating an individual's health-related quality of life (Bowling, 2014). The VAS is a visual scale consisting of a horizontal line with a number at each end, usually 0 and 1 representing the worse (death) and best health respectively (Bowling, 2014). Neither study was able to show a significant difference in QOL between intervention and control arms because of their DMR intervention; QOL scores worsened.

Sorensen et al. (2004), Krska et al. (2001) and Nissen (2005) captured QOL scores using the SF-36 scale. The SF-36 is another example of a self-administered quality of life instrument. It consists of 36 items and was developed from the RAND medical outcomes study (Wells et al., 1989). Again, none of these studies was able to achieve a difference in QOL of score between intervention and control arms because of their DMR interventions. Nissen did not show an overall improvement in QOL scores but did show improvements in one of the measures used, general health.

Both Nissen et al. (2005) and Pacini et al. (2007) chose to measure the Quality Adjusted Life Year (QALY). A QALY is an outcome measure that considers both reduction in mortality (clinical outcome) as well as the quality of life gained with the reduced mortality (humanistic outcome). A cost per QALY gained may also be reported, which is therefore a composite of economic, clinical and humanistic outcomes. It is used by the UK by NICE (National Institute for Clinical Excellence) to determine which treatments they should fund as well as other countries around the world (Bowling, 2014). Nissen et al. (2005) found no difference in QALY between control and intervention arms. Pacini et al. (2007) calculated the QALY for the DMR intervention described in the HOMER trial (Holland et al., 2005), they found that cost per QALY gained was £54,454; meaning the intervention was unlikely to be considered cost-effective. The NICE threshold for cost-effectiveness is usually set between £20,000 - £30,000 per QALY gained (Dillon, 2015).

1.4 Discussion

The papers included in the systematic review contained population samples with a variety of patient characteristics. The age demographics of most of the studies is similar to that of the Islington Reablement study population (mean age = 77.4 years). The focus on individuals over 65 years old is not unexpected as individuals over the age of 65 years are considered ‘older’ people in healthcare (NHS England, n.d.-b), and it is older people that are generally targeted for medication review services as they

are at greater risk of poor health outcomes as a result of medications (Hanlon et al., 1997; Leipzig et al., 1999a, 1999b).

Conducting DMRs with more females than males is also a common finding of the Islington Reablement population (59.4% female). The reason for a higher proportion of female participants was not explored in any paper. Potential reasons include historically females have been identified being likely to be prescribed more medications than males (Bloor, 2006; Roe et al., 2002) and are more likely to consult with a healthcare professional (Wang et al., 2013).

Studies also appear to contain samples which were taking a similar number of medications to the Islington reablement population (mean number of medications taken = 10.2)

For co-morbidities and level of support it is not possible to comment on whether the populations within the papers included in the systematic review are comparable to the Islington Reablement study sample described in this thesis (cross ref descriptive table) as this data was not routinely captured within the DMR patient record and was therefore not available for analysis.

There is heterogeneity amongst how DMR services were delivered, including whether they are targeted at post-admission or community residing patients and the number of visits a service involved. How services are delivered could be affecting the outcomes and impact of services but it is not possible to conclude this from the level of information provided in the published papers.

Most of the outcomes presented in the reviewed literature were clinical outcomes rather than economic or humanistic. A shift away from economic outcomes presenting the value of services in monetary values is expected as healthcare services transition to focus on quality (Ham et al., 2012). However, not presenting humanistic outcomes is unexpected given the claimed patient centredness of services.

The ECHO theoretical model was developed over 25 years ago, partly to demonstrate the limitations of evaluating pharmaceutical interventions through traditional clinical models and outcomes (Kozma et al., 1993). For DMR services impact is most frequently presented through a reduction in inappropriate prescribing and the number of interventions made that were accepted.

No study compared medication reviews in domiciliary environments with those conducted in other settings. Domiciliary medication reviews are likely to be less cost effective than those performed in other settings due to travel time required by health care professionals to reach patients' homes, but the literature suggests they are more in-depth and can provide better outcomes. The current published evidence does not fully back this assertion up. Even if it can be demonstrated that domiciliary medication reviews are beneficial, further research is needed to quantify the added benefit they bring over medication reviews in traditional healthcare settings. The following sections will discuss the economic, clinical, and humanistic outcomes presented by the included papers.

1.4.1 Economic outcomes

By focusing on economic savings, authors are ascribing the value of the DMR service in monetary terms. For example, counting the cost saving stopping a medication represents but ignoring the impact a reduced pill burden could have for an individual.

Dilks et al. (2016) estimated cost savings to health and social care services as a result of the DMR intervention. This is an important domain to investigate, considering the known overlap between the use of these services for the multi-morbid older patient. It is particularly relevant in the UK where the position of Secretary of State for Health has also been given responsibility for national oversight of the provision of social care.

Most of the papers describe newly set up services. It is likely providers were required to demonstrate the effectiveness of their service to those providing funding. If this

is the case there is a risk that a pressure to provide cost savings to prove the worth of a DMR will mean professionals focus on interventions that provide economic benefit, rather than holistic interventions aiming to resolve issues that are relevant to the service user. This goes against the intended patient centric nature of DMR services.

For the most part papers did not provide a cost associated with providing a DMR service or account for the cost of providing a DMR service in their economic analysis. Black and Glaves (2011), Ong (2017), and Krska (2001) attempted a cost analyses of savings without including the cost of providing the DMR service. Pacini (2007), Sorensen (2004) and Dilks (2016) did account for the cost of their services in their economic evaluations. Although, the cost of running a service in different locations and countries will vary, which could limit its usefulness as a measure, it should be included in cost analyses so readers can see a truer picture of the economic value of a service.

The economic outcomes that are provided are basic measures which do not consider all cost implications included with service provision. Quantifying outcomes, which will generally have been multi-factorial, particularly in the older populations is extremely difficult (World Health Organization, n.d.). Taking into consideration the basic nature of the economic outcomes presented within studies, these outcomes cannot be focused on as demonstrating the value of a DMR service.

1.4.2 Clinical outcomes

Kozma defines clinical indicators as separate from clinical outcomes. Clinical indicators are “measurements of a patient’s physical and biomedical status used to infer the degree of disease” (Kozma et al., 1993), for example blood pressure, or spirometry. ‘Medicine focussed’ measures such as measures of appropriate prescribing can be considered clinical indicators rather than clinical outcomes. They

show there is potential to make a difference in clinical outcomes but do not always demonstrate a difference themselves. Whereas clinical outcomes are "medical events that occur as a result of disease or treatment" such as stroke, or in the context of non-disease-specific medication reviews, events such as adverse drug reactions, hospitalisation, or death. For the purposes of this systematic review clinical indicators have been reported under the umbrella of clinical outcomes, as that is the domain in which they best fit. There is an argument that such measures do not represent true clinical outcomes. However, they are commonly used in papers described by DMR services, likely because they are relatively easy to measure by services, so it is important that they are considered.

For all clinical outcomes, prevalence studies are highly prone to bias due to regression to the mean which may limit their validity. For example, an increase in use of health services by a patient due to ill-health, may reduce over time due to resolution of the underlying problem, regardless of any interventions provided. Therefore, simply measuring the change in use of health services over time, without a comparator group, could give misleading results. Well-designed controlled studies can help to minimise the effect of regression to the mean but may still be prone to confounding effects of other services offered at the same time as a DMR.

Outcomes related to hospital occupancy (e.g. admission or readmission rates, number of inpatient bed days), are relatively simple to objectively measure, and can be meaningful outcomes to patients. The time period these are measured over should be carefully considered, using too short a time period would cause challenges in having a sufficiently powered study, due to relatively low frequency of hospital admissions. However, using too long a time period could risk changes in admission rates not being attributable to the original intervention. If hospital occupancy measures are used the reason for admission should be reviewed to investigate the link, or lack thereof to medications and the DMR intervention.

Although using extrapolated figures for preventability of admissions or admission avoidance can be problematic due to the wide range of confounding factors, they

may be useful ways of quantifying the benefit of services, which are difficult to evaluate because of risk of bias and ethical problems in randomising patients. If such measures are to be used it is key that validated tools are used for estimating prevented admissions, as this will increase the readers ability to confidently decide whether or not they agree with authors' assertions that DMRs have prevented admissions.

For 'medicine focussed' outcomes, such as appropriate prescribing, number of new medications, number of high-risk medications, all studies appeared to show benefit. It would be expected that improved access to pharmacists performing comprehensive medication review would improve such measures, but whether these measures are significant, or important to patients is not clear from the published evidence.

Similarly, for measures related to compliance, all studies showed improvement, but it is not clear that this translated to clinically meaningful outcomes. There is published evidence to show that improvement in medicines focussed outcomes can result in improved patient outcomes (Duerden et al., 2013). However, most of the studies included in the systematic review did not explore this in their populations.

Overall, although medicine focussed outcomes may be limited in their clinical significance, they can be more directly attributed to the DMR and so are less prone to confounding of results by other services offered to patients.

1.4.3 Humanistic outcomes

As DMR services are intended to be patient centric it is reasonable to assume that most of the published outcomes would be humanistic, demonstrating the impact that these services have on the individual. However, this does not appear to be the case. The reasons for this are not clear.

The validated QOL (also used to decide QALY value) measures regularly used in the literature are too broad and rarely focus on medication related domains but rather broader health measures. However, medications are generally a sign of multi-morbid patients, which in turn suggests a complex healthcare status. Given this complexity there is potential for DMRs to have a wide-reaching impact so there is an argument that QOL measures could be used cover this regardless of what intervention is made. Whilst it could be argued that an overall improvement in quality of life may be too ambitious for a medication review, this does not mean that humanistic outcomes should not be considered at all, and consideration as to what the impactful changes are from the patient's perspective.

The increased confidence measure used by Coleman et al. (2001) is more specific to the DMR intervention. However, it involves a health-care professional decided assumption that lack of confidence managing medications is a problem that service users will want tackled. If services are truly patient-centric, future work should also explore the opinions of patients and other relevant stakeholders on what they hope to gain from a DMR and their perceived benefit of the medication review.

Excluded outcomes

Studies reported outcomes that were excluded from this systematic review, including process measures and outcomes that did not demonstrate a measurable difference. Although these were not meet the inclusion criteria for this systematic review, it does not necessarily mean that they were not useful measures for the individual services. However, until studies can report a measurable difference, the generalisability and usefulness to other services is limited.

1.5 Limitations

The main limitation of the systematic review was difficulty in identifying subject headings to capture DMR evidence. The was mitigated by choosing wide terms which

would return many results and a rigorous screening process to ensure only relevant results were included in the review. There is a large heterogeneity in the evidence, including how DMR interventions were carried out, the participants targeted, and the outcomes presented. This limited the comparisons which could be made across studies. However, the heterogeneity in the published studies represents the 'real-world' and should not be discounted.

Bias is also a limitation of reviewed papers. Most of the studies were not set up as interventional research but describe services which are already operating. This likely represents the 'real world' nature of these services, whereby funding is received to set up a service quickly with an expectation that the worth of the service will be demonstrated by the collection of metrics after the fact. The services are not a result of rigorous trial of the DMR intervention. For prevalence studies it is particularly difficult to isolate the effect of the DMR. Simply measuring before and after metrics over relatively short time periods does not allow for regression to the mean effects to be accounted for. For example an individuals' use of healthcare resources may decrease over time if the underlying condition resolves. Patients targeted for DMR services may also be identified at the same time as having potential to benefit from other support services, making it challenging to isolate the effect of the DMR alone. Well-designed controlled studies can help to minimise the effect of regression to the mean but may still be prone to confounding effects of other services offered at the same time as a DMR.

Not all papers pre-defined the level of statistical significance. Some papers did but then did not explicitly state in the results whether results were significant, leading to the possibility of misinterpreting results as significant when they were not.

1.6 Conclusion

The systematic review showed that benefits from DMRs have been measured in a wide variety of ways. They have demonstrated a positive impact on, although not always, the cost of health and social care provision, hospital admission and re-admission rates, emergency department and other outpatient service visits, inappropriate prescribing, and confidence with managing medications. The review showed that despite many services claiming their interventions as patient centric the most common outcomes reported from DMR services are clinical outcomes rather than humanistic. The viewpoints of patients who use DMR services was rarely presented in the literature.

The literature presents a professional-centric view of the DMRs, suggesting the value and impact of DMR services can be represented by traditional clinical outcome and process measures. However, the dearth of outcomes presented in the literature do not always demonstrate that the DMR has had a positive impact. There are questions as to which traditional outcomes can demonstrate the value of DMRs and whether alternative novel outcome measures should be used.

The professional-centric view painted in the literature does not align with the patient-centric aims of DMR services. It is unclear whether the individuals who use DMRs relate to the commonly chosen outcome measures or whether they feel the value of the service is demonstrated by alternative, unpublished measures. To develop and deliver patient-centric services it is essential that the view points of the service users are sought and considered. It is important to understand the value of DMR services so that impactful services can be designed and developed.

The next chapters in this thesis take a critical look at where the value of DMR services lie through mixed-method exploration and analysis.

Chapter 2 Research questions, aims and objectives

The literature review in chapter one highlighted that there is a growing body of research, of varying quality looking at domiciliary medication reviews. The conclusion of most the authors is that domiciliary medication reviews produce benefit, but what this benefit is, and how it is presented varies. The body of evidence presenting measurable changes as a result of DMRs focuses on clinical outcomes and metrics, and there is a lack of humanistic outcomes demonstrating change reported despite the claimed patient-centric nature of these reviews. Given the gaps in the published evidence the true value of DMR services is not known.

There are multiple definitions of value in healthcare. The original - and most cited - definition of value was proposed by Porter & Teisberg et al. (2006), who suggested that value could be determined by the improvement in an individual's health outcomes balanced against the cost of achieving the improvement. Over time the definition of value has continued to evolve. However, what is consistent across definitions is the reference to patients and the difference an intervention makes to them (European Commission, 2019; Hurst et al., 2019; Institute of Medicine of the National Academies, 2008; Porter, 2010). For the purposes of this research, value is used to describe the consequences of a DMR service for the patient. Value is used as an all-encompassing term that recognises the benefits of DMRs may be different for different individuals and may be felt or experienced in different ways.

The studies described within this thesis set out to understand the value of DMRs through and in-depth exploration of available data and a thorough examinations of the perceptions of stakeholders: patients, professionals and commissioners involved with these services.

The principal research question is:

What is the value of domiciliary medication review services?

In order to explore this question the aims of this research are:

1. To analyse intervention data and look for relationships between demographics and outcome data
2. To evaluate the perspectives of DMR stakeholders: service users (patients), service providers (pharmacists) and commissioners

No hypothesis will be tested within this research. Instead, the aim of this exploratory research is to gain an understanding of the value and impact of DMR services through multi-method studies. Each study had a defined aim and objectives (**Table 2-1**). The positions investigated by studies were shaped by the existing published literature, hands-on experience of providing these services and initial results from thesis studies. The original contribution and aim of this thesis will be to evaluate where the value of domiciliary medication reviews might lie.

The mixed methods approach underpinning this work in appraised in the next chapter.

Before the studies described in this chapter were undertaken there was some initial path finding in the research process, focused on the development of an electronic data capture system for DMR data. This early work, and how it contributed to the research question is detailed in appendix four.

Table 2-1: Overview of study aims and objectives

Study	Aim	Objectives
An in-depth exploration of demographic and intervention data of a local DMR service	To investigate the value of DMR services through statistical interrogation of data collected from the Islington Reablement DMR service	To describe the demographics of service users To describe the interventions and outcomes that occur during a DMR To establish whether there are statistical relationships between service user demographics and outcomes
Patient perspectives on the value of domiciliary medication reviews	To determine the value of domiciliary medication reviews to service users (patients)	To determine service user expectations of DMRs To determine service user experience of DMRs To determine impact of DMRs on recipients lives To determine the preferred setting for medication review
Pharmacist perspectives on the value of domiciliary medication reviews	To determine the value of domiciliary medication reviews to the professionals who provide the service	To determine service provider expectations of DMRs To determine service provider experience of DMRs To determine the impact service providers perceive DMRs have on recipients lives To determine the preferred setting for medication review

Study	Aim	Objectives
Commissioner perspectives on the value of domiciliary medication reviews	To determine the value of domiciliary medication reviews to commissioners	To determine reasons that DMR services are commissioned To determine commissioner experience of DMR impact To determine whether commissioners agree with the opinions expressed by service users and service providers in relation to impact of DMR

Abbreviations: DMR = domiciliary medication review

Chapter 3 Material and Methods

3.1 Introduction

This research described in this thesis followed a mixed method methodology; a combination of quantitative and qualitative methods, to answer the research question. As the overarching research question was far reaching; multiple research methods were needed to pose this question in different ways to obtain a comprehensive picture of what the answer may be. This design was also dictated by the fact that the studies described in this chapter are the real-world research; developed around an established DMR services, with a focus on the Islington Reablement service for quantitative methods.

Quantitative research involves the measuring of outcomes in discrete units which can be compared, usually using statistical analysis to examine the correlations between variables (Bergman, 2008). Qualitative research methods seek to examine relationships between participants and environment through surveillance, dialogue and extrapolation of themes. Instead of testing some hypotheses, researchers more commonly aim to derive these from their findings (Bergman, 2008).

Combining qualitative and quantitative methodologies is known as mixed methods (Johnstone, 2004). In the past there has been debate in the literature over whether collective use of these methodologies to answer a research question is appropriate or even possible due to the perceived incompatibilities of the theories that underpin them. However, more recently other researchers argue that these traditional arguments are exaggerated, and even not valid, and the two methods can exist synergistically (Bergman, 2008; Pope & Mays, 2006).

When the aim of research was to examine not only whether an intervention is beneficial but why it is beneficial, a mixed methods methodology is apposite (Pope & Mays, 2006). The research presented within this thesis aimed to examine whether DMR services add value, and where this value lies. As this was exploratory research it was anticipated that using mixed methods would produce richer results for examination than a single research method.

There are a number of different mixed methods approaches that can be followed when conducting mixed methods research. Creswell and Clark (2011) have proposed that there are four main approaches. Explanatory sequential, exploratory sequential and embedded design all give priority to one method: either quantitative or qualitative over another. Whereas a convergent design does not give either method priority over the other (Creswell et al., 2011; Hadi et al., 2013). As the research aimed to explore the value of DMR services, with a focus on patient perspectives it was originally envisaged that an exploratory sequential design, with the priority given to qualitative patient interviews would be the most appropriate approach for this research. However, this assumed that the needs and perspectives of patients could not be studied as robustly through quantitative methods. Given that the published literature around DMR services focused on quantitative rather than qualitative data this was not a certainty. As a result if was decided that a convergent design was the most appropriate.

Convergent approaches can follow concurrent or parallel approaches (Creswell et al., 2011). As this research was real world, a pragmatic approach was taken. Studies were conducted in a concurrent approach, with data collection for quantitative methods conducted first, as this was the first study related approval obtained. Analysis of mixed methods data followed a parallel approach throughout the research period.

3.2 Methodology

The research described in this chapter follows an inductive approach. There are two main approaches to research; a deductive approach whereby studies are designed to test the hypothesis and theories of previous work and an inductive approach which involves generating data from which researchers can propose theories about their work (Bowling, 2014). An inductive approach was chosen as the research is innovative. To date no researcher has proposed a theory that describes the overarching value of DMRs.

Before the research in this thesis began time was taken to explore the research paradigm.

The three main ontological positions were considered: realism, idealism and materialism (Snape & Spencer, 2003). An idealism ontology was considered the most appropriate as it suggests reality is understood through the human mind and social meaning, this allowed for the potential of multiple realities of where the value of domiciliary medication reviews might lie. Realism and materialism ontologies, and their focus independent realities, separate from the human experience (Bennett et al., 2010; Ewing, 1934; Kivunja & Kuyini, 2017) , did not seem appropriate for this exploratory research which was focused on the views and perspectives of patients.

When reflecting on epistemology, positivism and constructivism were considered. Positivism aims to test assumptions about relationships under enquiry. Researchers who follow a positivism approach believe that there is a sole objective reality which can be discovered through robust investigations (Bowling, 2014; Keat, 1979). On the contrary, in constructivism multiple realities are possible at different times and researchers use their observations to postulate concepts that explain particular behaviours or outcomes (Bowling, 2014; Murphy, 1997). Again, as the research was exploratory rather than hypothesis testing, constructivism epistemology was considered the most appropriate.

Underlying this reflection on research paradigm was a knowledge that this research was real world research designed around live DMR services and the patients and professionals involved with the delivery of these services, which would likely throw up challenges that would require a pragmatic approach. A pragmatism approach is common with mixed methods research (Robson & McCartan, 2016) as it supports the use of any research approach to answer a research questions regardless of the original theoretical philosophy of the method (Bryman, 2006; Guest et al., 2011)

3.2.1 Reflexivity

The previous section considered the positionality of the PhD student through a reflection on research paradigm. When exploring positionality, reflexivity was also considered. Reflexivity is when researchers consider and acknowledge the influence that they have had on the research they have carried out (Cohen et al., 2011). When conducting this research the PhD student considered themselves and 'insider' (Given, 2008). The student's experience of working as a domiciliary medication review pharmacist would inevitably affect the research approach and methods. The first example of this was the shaping of the research questions and the focus on value for the patient. It was the PhD student's experience of evaluating the DMR service they had worked within and frustrations around the lack of focus on the patient perspective that led patient-centric view of value used. Being an 'insider' was considered an advantage as it enabled the PhD student to produce a description and discussion of results that reflected the real-world aspects of DMR services. It can be argued that being an insider in research has drawbacks, mainly linked to the subjectivity of the researcher and the bias they introduce (Holmes, 2020). The reflexivity of the researcher during the research journey, to limit bias, particularly in the qualitative studies is discussed within later thesis chapters.

3.3 Methods

The research described in this thesis involved multiple studies (**Figure 3**). The literature review informed the choice of research studies and associated methods. The focus on clinical outcomes including the number of medication related problems identified and number of interventions that took place prompted the in-depth exploration of DMR data. The absence of the perspective of the patient and other DMR stakeholders in the literature prompted the stakeholder analysis. Initial findings from patient interviews were used to update the topics guides for pharmacist focus groups and interviews. The focus on the complexity of patient needs in the quantitative and qualitative results prompted an exploration of the patient perspective in available DMR data, through the interrogation of categorical variables.

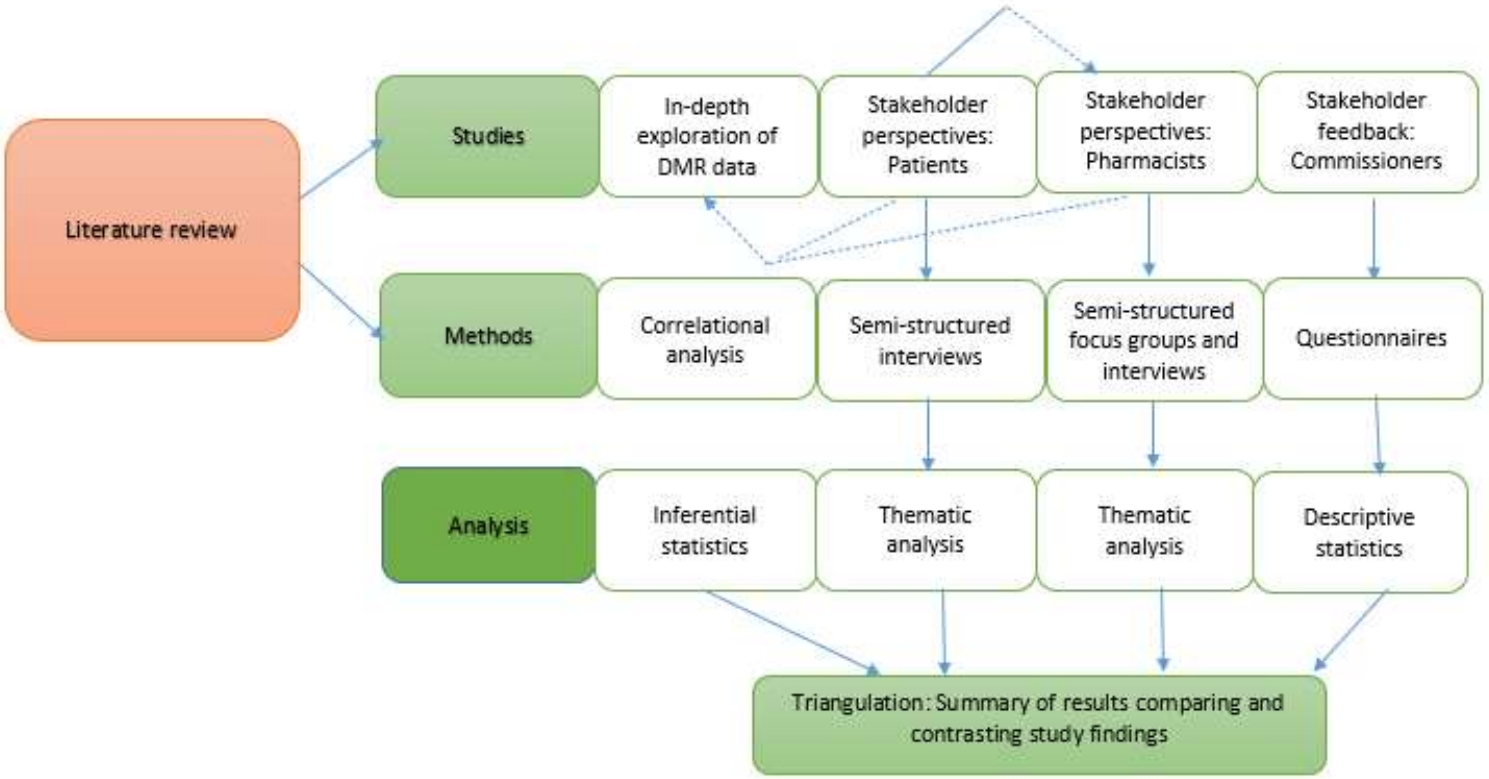


Figure 3: Overview of research methods

During the planning stage of this thesis various methods were explored and considered in relation to the objectives of the study. The following sections summarise the options that were considered and the reasons why the final methods were chosen.

3.3.1 Literature review

As the research described in this thesis was exploratory it was originally envisaged that the published literature would be presented as a scoping review. A scoping review was considered as it would enable the identification and mapping of the evidence base around DMR services (Munn et al., 2018).

However, as the research question emerged, focusing on the value of domiciliary medication review services, providing a general overview of the published literature did not seem sufficient. It was decided that the literature review in this thesis should have a clearer focus – a critical review of outcomes in the published literature to help understand the value of domiciliary medication reviews. When there is a clear question to be answered a systematic review is a more appropriate choice of literature review (Grant & Booth, 2009; Munn et al., 2018). A systematic review was also chosen as the rigour of methods can be ensured by following validated frameworks for conducting and reporting of the literature (Batten & Brackett, 2021).

Meta-analysis of data is commonly reported within systematic literature reviews (Higgins et al., 2019). However, as the reporting of inferential statistics was limited there was no scope for meta-analysis or pooling of statistical results. Instead, a narrative synthesis was used to pull together the main themes of the review. As a narrative synthesis enables the comprehensive, critical and objective analysis of the current knowledge on a topic (Popay et al., 2006), it was decided that this was an appropriate systematic review method to follow.

3.3.2 Quantitative data analysis

The quantitative data analysis aimed to explore the value of domiciliary medication reviews through an in-depth exploration of the available data variables from the Islington Reablement service. To do this, statistical tests appropriate for the investigation of multivariate relationships needed to be identified. Four statistical tests, each exploring available data in a different way were identified (Figure 4). As this was real world research the tests were limited to those appropriate for the analysis of data types routinely captured as part of the DMR process.

As the research was principally exploratory, and the data was collected by a non-experimental design a correlation analysis was identified as an appropriate statistical method. Correlation analysis explores the associations between pairs of variables, revealing if and where relationships exist between variables (Pallant, 2010). Correlational research is also recognised as an appropriate technique for investigating real-world data as it has external validity (Friedman et al., 2022).

As the correlation analysis revealed relationships between variables it was decided to undertake further analysis to try and get a clearer picture of some of the component variables of DMR services. Multiple linear regression analysis commonly follows a correlational analysis. It can reveal more detail on the nature of relationships between variables, with a focus on how independent variables can predict dependent variables (Cohen et al., 2014). It was important to explore these relationships from a service provision point of view, as an underlying ambition of the research was that findings could have applications within real-world services.

Much of the data available from the Islington Reablement DMR service was categorical. Pearson's correlation and multiple linear regression techniques are not appropriate for analysis of categorical data (Pallant, 2010). It was felt important to explore the available categorical variables as they were linked to patient problems and experiences which could not be measured by a neat number. Categorical correlational techniques were explored and multiple correspondence analysis was

revealed as an appropriate statistical test as it reveals patterns in complex data sets using data reduction techniques (Johnson & Wichern, 2007).

Finally a cluster analysis was carried out. Cluster analysis commonly follows multiple correspondence analysis, it uses the clusters revealed in multiple correspondence analysis to put cases into groups based on homogeneity amongst variables (Aldenderfer & Blashfield, 1984; Breakwell et al., 2006) This was an important analysis as it permitted the investigation of where individual patient need might sit based on available demographic data, to establish whether predictions could be made around patient characteristics and the problems they might be facing.

As this research was exploratory and not hypothesis testing it was important to interrogate the data in multiple ways. Each test had a purpose and revealed results that were used to start building a layered picture of where the value of domiciliary medication reviews might lie. The statistical analysis aimed to fulfil the ambition of a patient centric view of the value of DMRs by trying to investigate the expectations and experiences of patients through data analysis.

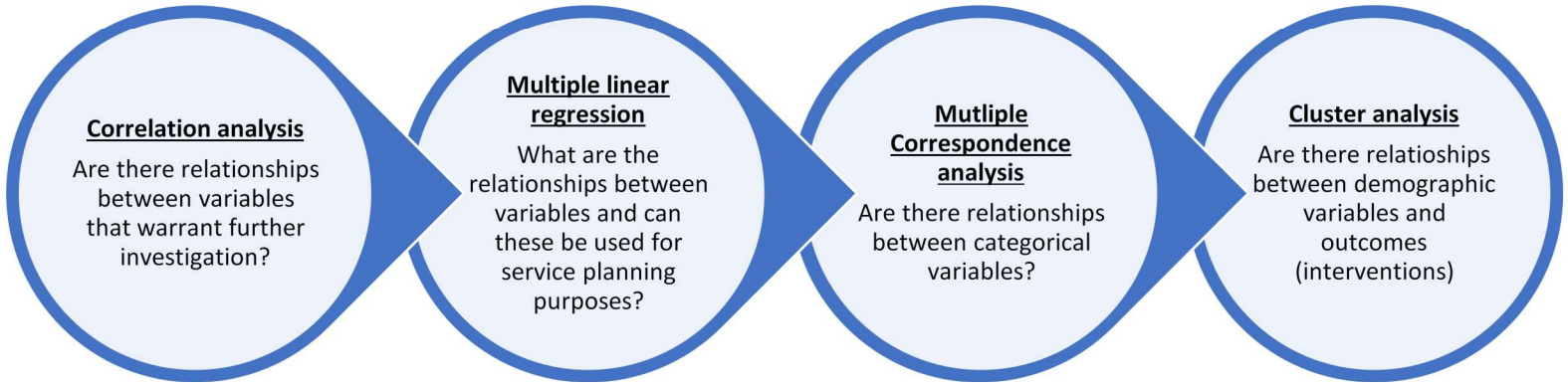


Figure 4: Summary of quantitative data analysis techniques

3.3.3 Qualitative research traditions

Robson argues that there are three principal traditions within qualitative research, further details on these traditions are provided below.

3.3.3.1 Grounded Theory

In grounded theory researchers seek to produce a theory linked to the subject or situation under study, where the theory is 'grounded' i.e. established from data and information obtained during the study (Pope & Mays, 2006; Robson & McCartan, 2016). Grounded theory is both a research tradition and a method for data analysis. Grounded theory analysis will be discussed in section 3.3.5.2.

3.3.3.2 Ethnography

The ethnographic approach developed from anthropologic studies, where certain groups were studied and described by researchers. Traditionally, this would have involved researchers becoming immersed in the group under study. More recently researchers have moved towards an ethnographic 'approach' using observations to elucidate a phenomenon rather than full immersion .

3.3.3.3 Case study

Case studies are used for in-depth investigation of a particular happening e.g. a healthcare service, to evaluate its importance and why it is of interest (Robson & McCartan, 2016). Multiple research methods are usually employed to obtain a comprehensive summary of important occurrences.

3.3.4 Stakeholder data collection methods

There are multiple methods that can be employed to gather the opinions of stakeholders, each with advantages and disadvantages (**Table 3-1**).

3.3.4.1 Surveys

Surveys are instruments used to capture fixed amounts of data, usually quantitative data. Although, open questions within surveys can be used to collect qualitative data. There are multiple ways of delivering surveys and response rates can be affected by method chosen. It is recommended that researchers who choose to use surveys should spend time considering their method of delivery and likely response rate. (Robson & McCartan, 2016). There is debate as to the usefulness of surveys. Marsh (1982) argues that respondents are 'uninvolved' and that responses are borne out of an obligation, politeness and boredom. There are also concerns that responses to questions may not be valid due to the false situation of completing a survey as opposed to having a conversation (Robson & McCartan, 2016). However, it is thought that these challenges can be overcome with well thought out, structured and contextually relevant questions (Bowling, 2014; Mischler, 1991). It is generally felt that surveys are suited more to explanatory work rather than exploratory (Robson & McCartan, 2016).

3.3.4.2 Interviews

There are three types of interviews: structured, semi-structured and unstructured. It is accepted within qualitative research that the type of interviews is selected according to the 'depth' of information required (Robson & McCartan, 2016). This is generally linked to how much is already known about the topic under review, i.e. has a theory been presented within the literature that a researcher wants to test and, are there pre-conceptions to what the answers might be? In which case a more structured approach may be appropriate. If a new phenomenon is under

investigation and the researcher wants to give the interviewee flexibility of response then an unstructured interview will provide more wide ranging data (Miller & Crabtree, 1999; Robson & McCartan, 2016).

3.3.4.3 Focus Groups

Focus groups can follow the same constructions as interviews; structured, semi-structured and unstructured. However, as focus groups involve group discussion with others it is uncommon to have completely structured methods. Focus groups are useful when the opinions of a social group are of interest or for initial data collection to gather ideas for later research (Robson & McCartan, 2016). Researchers who carry out focus groups should take time to consider whether they want to have homogenous or heterogenous groups as this could have consequences on how discussion flows and the data that arises from discussions (Brown, 1999).

3.3.4.4 Observational methods

Observational methods involve observing participants' behaviour without intruding on the actions that they are carrying out. There are two main ways of carrying out observational methods; participant observation which lends itself to qualitative research methods and structured observation which has a stronger link with quantitative methods. Observational methods are commonly used for exploratory research (Robson & McCartan, 2016).

Table 3-1: Advantages and Disadvantages of methods for gathering stakeholder opinion

Research method	Advantages	Disadvantages
Surveys	• Easy to administer • Reliability is easy to obtain if all respondents are presented with the same questions • Permits standardisation of data	• Internal validity at risk if questions are not clear • Sampling strategies will impact generalisability of results • Social desirability bias
Interviews	• Flexible process • Questions can be adapted as research progresses • Opportunity to delve deeper into interviewee responses	• Time consuming • Requires significant preparation • Responses could be limited by the skill of the interviewer e.g. does the interviewee feel at ease to talk openly and honestly?
Focus groups	• Efficient method of collecting data from multiple participants • Quick method • Group dynamic can produce data that is of interest	• Personalities within group may dominate • Facilitating group requires interviewer to have relevant skills • Confidentiality between participants may cause issue
Observational methods	• Direct method of research • Permit collection of 'real world' data • Researcher does not need developed skills for facilitating conversation	• Observer can affect scenario being researched • Time consuming

3.3.5 Stakeholder analysis methods

There are also multiple methods for carrying out analysis of qualitative data. However, Pope and Mays (2006) argues that there are three main methods; thematic analysis, grounded theory and framework approach. These analysis methodologies are discussed in the following sections.

3.3.5.1 Thematic analysis

In thematic analysis data is reviewed and analysed for themes. Depending on the level of research being carried out these can be simply reported, or further interrogation can take place to ascertain how themes are interconnected. Themes may be expected, as the researcher may have come across the themes during literature searching or earlier research (deductive), or they can emerge during data analysis (inductive) (Bowling, 2014; Pope & Mays, 2006).

3.3.5.2 Grounded Theory

Grounded theory is mainly an inductive method of analysis, although it can have deductive components (Glaser & Strauss, 1967). It has similarities to the methodologies for inductive thematic analysis. However, grounded theory is a repetitive process, whereby the themes that emerge form initial data are used in the on-going methods. For example, in interviews emerging themes may be used to construct new questions. Because of this, 'theoretical sampling' can become important if the researcher wants to establish the opinions of a particular group/ subset of individuals to review and prove the importance of emerging themes (Pope & Mays, 2006).

3.3.5.3 Framework approach

The framework approach is a deductive form of qualitative analysis, used when the objectives of research are set in advance of data collection (Ritchie & Lewis, 2003). The analytical process is pre-defined, enabling replication and appraisal of methods by other researchers. Whereas other qualitative analysis methods rely on the interpretation of the researcher and are not generally open to challenge. Framework approach analysis follows a methodology similar to thematic analysis, but the approach is more rigid (Pope & Mays, 2006).

3.3.5.4 Method chosen and rationale

This research aimed to postulate a theory of the value of domiciliary medication review services. As this has not been conclusively addressed in the literature to date there was not an accepted theory which can be put to stakeholders to gather their opinion. The answer to the research question had to come from stakeholders. It was decided that a grounded theory tradition would be appropriate for this research.

A combination of methods; semi-structured interviews, focus groups and questionnaires were chosen to gather stakeholder opinion. Each method was chosen according to the depth of data required from the study and time limitations. For all methods semi-structured techniques were used. A semi-structured approach was employed to ensure information was gathered on pre-conceived ideas reported in the literature; as to the value of these services, and to ensure any emerging themes were tested against multiple users.

Thematic analysis was chosen as the analytical method. As this research aimed to generate ideas and theories from data collected from the semi-structured interview, focus groups and semi-structured questionnaires to help answer the overarching research question, rather than test an existing hypothesis thematic analysis was the most appropriate method for analysis. In an area were in-depth research is lacking an inductive approach permits greater understanding of the value to domiciliary medication reviews to stakeholders (Boyatzis, 1998).

Codes and emerging themes from each transcript were compared to existing findings within the data, using to a constant comparison approach (Glaser, 1965; Glaser & Strauss, 1967). This was done for both academic and pragmatics reasons. In the literature it is proposed that a constant comparison technique within an overarching analysis approach (thematic analysis in this research) enables a researcher to develop a deep understanding of emerging themes which can result in a discussion of the results and generation of theories which are inherently linked to the data (Dye et al., 2000; Pope & Mays, 2006; Tesch, 1990). As this was exploratory research this was deemed an appropriate method to employ. It enabled the PhD student to meet the

data immersion criteria of thematic analysis (Braun & Clarke, 2006). As the patient and professional studies overlapped, constant comparison enabled the PhD student to identify emerging themes in the patient study and explore them within the professional study. This would not have been possible if analysis had started upon completion of all data collection.

3.3.6 Triangulation of results

Triangulation is when the results of two or more methods of data collection are compared (Pope & Mays, 2006). The results of each study in this thesis will be presented, similarities and differences in findings will be highlighted and overarching conclusions linked to the research questions will be drawn, in a final discussion and conclusion chapter.

3.4 Materials

The studies described in this thesis used a variety of materials.

3.4.1 Islington Reablement Service

The Islington Reablement service is a service provided in a person's home that aims to help them regain independence by supporting them to work towards goals. The service is available to anyone over the age of 18 years, but the majority of users are over 65 years old. Care workers known as 'enablers' work with individuals to help them meet their goals. The team was historically made up of physio- and occupational therapists, and social care workers (Windross, 2012). In 2012 a pharmacist (the PhD student) employed by Whittington Health was added to the team. The pharmacist provided medication management support after conducting

comprehensive medication reviews for individuals service users identified by members of the Reablement MDT as having a medication related need (Mccormick, 2015).

3.4.2 Whittington Health

Whittington Health is an Integrated Care Organisation providing both acute hospital services and community services in the London Boroughs of Islington and Haringey (Whittington Health NHS Trust, n.d.-a). The PhD student was employed by Whittington Health throughout the research period. The PhD student was employed as the Islington Reablement Pharmacist until June 2016 then moved to a different role within the organisation where they were not involved with the provision of domiciliary medication reviews. Whittington Health employs the pharmacists providing DMR services in the Islington Reablement Service, the Integrated Care Ageing Team (ICAT), Islington Proactive Aging Well Service (PAWS), formerly the north Islington Frailty Team and the Haringey Co-ordination and Prevention (HCAP) Service. Individuals who had received a DMR through one of these services were recruited for the service user (patient) interviews. The Pharmacists providing these services also participated in the service provider focus groups.

The ICAT service is available for patients over 75 years old who are deemed in need of a comprehensive geriatric review by a healthcare professional involved in their care (Whittington Health NHS Trust, n.d.-c). The PAWs service does not accept referrals, instead members of the team identify patients living with moderate frailty, as defined by the Rockwood Frailty Index (Searle et al., 2008) for a comprehensive geriatric review, by searching GP databases (Whittington Health NHS Trust, n.d.-d). The HCAP service is an MDT service for patients living with frailty (no minimum level stated) or complex long-term conditions. For patients referred to the service the team aims to implement targeted interventions that will avoid hospital admission (Whittington Health NHS Trust, n.d.-b). The comprehensive geriatric reviews

conducted by both the ICAT and PAW services involve a comprehensive medication review conducted by a pharmacist within the service. For the Reablement and HCAP services medications receive a medication review if they are specifically identified as having a medication related need. All services, except ICAT only work with patients within their own home. The ICAT service also provides services to care homes but this not included in this research which focuses on the domiciliary setting.

3.4.3 Patients and Carers

The patients and carers who participated in the studies were resident in Islington and Haringey. Islington and Haringey are amongst the most deprived boroughs in the country. The combined population of both boroughs is just over 500,000 people. The population size of the boroughs is growing, with the biggest growth occurring in the over 65s. Both boroughs are made up of ethnically diverse populations (Kamara et al., 2017). Only patients from the Islington Reablement service were included in the quantitative data analysis. Patients and carers from all of the domiciliary medication review services described in section 3.4.2 were included in the qualitative stakeholder analysis.

3.4.4 Clinical Commissioning Groups

Clinical Commissioning groups (CCG) are responsible for the planning and commissioning of healthcare services within their locality (NHS England, n.d.-a). CCGs were invited to participate in this research as part of the stakeholder analysis. When the research was being completed there were 195 CCGs in England (Office for National Statistics, 2018). No limitations were placed on which CCGs could participate in the research. A stepwise random sampling approach was used to identify CCGs, to approach via email and telephone, using publicly available contact

details, to invite them to participate in the research. Further details on this recruitment strategy is described in section 7.4.

3.4.5 Professional networks

The Royal Pharmaceutical Society (RPS) is the representative body of the pharmacy profession in Great Britain (Royal Pharmaceutical Society, 2020). The UK Clinical Pharmacist Association (UKCPA) is a professional network that aims to foster excellence in clinical pharmacy that will result in high quality patient care (UKCPA, 2017). Both organisations have online forums where pharmacy professionals support and collaborate with each other. The forums were used to recruit pharmacy professionals to participate in the service provider focus groups and interviews.

Chapter 4 An in-depth exploration of demographic and intervention data of a local DMR service

4.1 Introduction

The published literature around DMRs suggested the value of the service was linked to clinical outcomes, or at least this was the most common way the impact of services was demonstrated (McCormick et al., 2020). Data collected for the local Islington Reablement DMR service followed the same path of collecting similar traditional outcomes and simple demographic information on participants. However, it was unclear whether the data and outcomes collected demonstrated the value of DMRs.

In a bid to answer this question, an in-depth exploration of data from this service was undertaken. It was hoped that this exploratory data analysis work would give and insight into the value of DMRs, as well having the potential to be used for service planning purposes. This was taking methods further than most of the published literature, which tended to focus on the number of reported interventions from DMR services without considering wider impact and value.

4.2 Aim and objectives

The aim of this study was to:

To investigate the value of DMR services through statistical interrogation of data collected from the Islington Reablement DMR service

Underpinning this aim were three objectives:

- To describe the demographics of service users
- To describe the interventions and outcomes that occur during a DMR
- To establish whether there are statistical relationships between service-user demographics and outcomes

4.3 Methodology

Positivism is more traditionally aligned to quantitative research (Arghode, 2012). However, the data analysis carried out in this chapter was conducted within a larger mixed methods exploratory study an overall constructivism epistemology was followed.

4.3.1 Reflexivity

To avoid researcher impact on results all available variables were input into initial correlation analysis and modelling was based around variables that the data had revealed relationships between. Further investigation of variables was data driven rather than researcher driven.

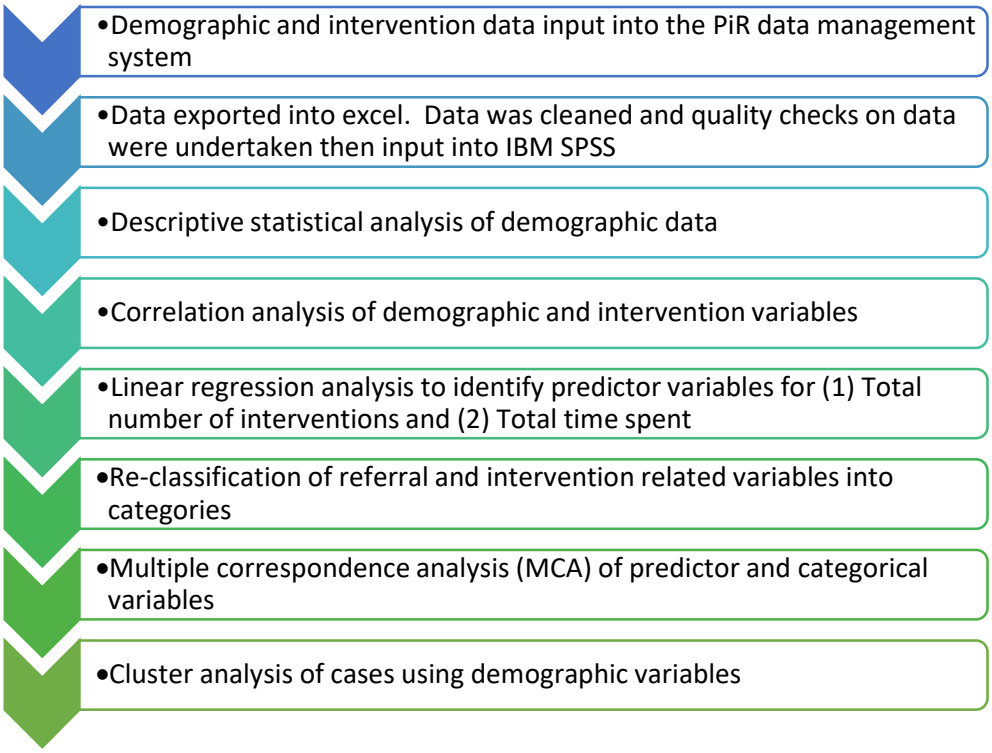
Time was taken to reflect on whether the PhD student could have affected the data collected and subsequently included in the analysis. However, the PhD student stopped working within Islington Reablement service before prospective data collection started, and therefore could have not affected the data collected.

At the start of the research journey the PhD student did not consider themselves confident in data analysis techniques. Without actions this could have resulted in incomplete or inappropriate analysis of data. To combat this, time was spent learning about statistical techniques through a combination of taught courses, tutorials with a PhD supervisor and self-directed reading. This increase in knowledge ensure appropriate tests had been chosen and the limitations were understood, which reduced the risk of results being overinterpreted. Particular attention was paid to statistical tests and bootstrapping that needed to be performed for each analysis to ensure the test results were produced from were values.

4.4 Methods

The Health Research Authority Decision tool (Health Research Authority (HRA), n.d.) was used to determine whether this work should be considered research through the answers provided to three questions. The development of PiR was not considered research. This outcome was then discussed with the research lead at Whittington Health who agreed this assessment. The project was registered as a service evaluation at Whittington Health NHS trust (ref: 205/16–98) and ethics approval was not required.

Data from the Islington Reablement DMR service were collected on a stepwise approach; one month of pilot data (23/11/15-18/12/15), one year of retrospective data (2016) and 6 months of prospective data (January – June 2017) were captured during the development of the PiR system. To maximise the number of cases available for analysis a further year of retrospective data (2015) was entered into the PiR system. Multiple data analysis steps were undertaken (Figure 5). Data collected during the provision of the Islington Reablement service were used as variables within the data analysis (Appendix 5). Data from the PiR system was exported into an excel file format. In excel data was cleaned; any missing data, incorrectly formatted data or corrupted data were rectified. Data quality was checked by comparing data codes to the original DMR visit record. A complete data set was imported into IBM SPSS Statistics for Windows version 26. To investigate the relationship between demographic, intervention and output data analysis of descriptive statistics, correlation analysis, multiple linear regression analysis , multiple Correspondence Analysis (MCA) and cluster analysis was carried out. Data analysis was carried out per patient (case). Further details on the methods for each statistical test are described later in the chapter.



Abbreviations: PiR = Patient Intervention Record, IBM SPSS = International Business Machine Corporation Statistical Package for Social Sciences

Figure 5: Flowchart of quantitative data analysis steps

4.4.1 Pre-analysis verification of data

Checking normality of data

Before parametric correlation and regression analysis techniques were applied to the data, normal distribution of data was checked. There are multiple methods used to determine the normality of data.

The K-S statistic can be used, however, there are arguments to suggest it is not a particularly sensitive test and its use is becoming less common (Ghasemi & Zahediasl, 2012). Having considered these limitations, it was decided that the K-S statistic was not suitable for assessing normality of PiR variables.

A visual inspection of the data through histograms and Q-Q plots were used. Histograms that appear to follow the bell curve distribution and data points plotted close to a straight Q-Q trend line are usually considered normal (Ghasemi & Zahediasl, 2012).

A final assessment of normality was assessed by comparing the means and medians of each variable. In normal distribution both the mean and the median should represent the central tendency of data (Pallant, 2010).

Gender is a dichotomous data but it is accepted practice that data with two outcomes can be entered into parametric tests.

Why zeros are included

It can be questioned why the zeros were left within the data, as some may view these as missing data. However, zeros did not represent missing data. The data point zero was most commonly observed with the four categories of PiR interventions: access, compliance, clinical and other. This was because not every recipient of a DMR will have an intervention in each category. The types of interventions they received was highly dependent on individual circumstances. For example, an individual may have had both compliance and clinical interventions but not have received any access or other interventions. For this reason, the zeros were included in the analysis to get a clear understanding of the activity from DMRs.

Why outliers are included

The decision to include or exclude outliers is widely debated. Again, for the analysis of PiR data a pragmatic approach was taken. The decision to include outliers in analysis was taken because of the knowledge that the outlier values could be found in the real world. An example for the variable; number of medicines – 30, 26 and 25

items were highlighted as outliers. There is an argument that these outliers can distort results (Pallant, 2010). However, they represent real world data; 3 participants in the sampling frame were taking 30, 26 and 25 medicines at the time of their DMR. Although professionals conducting DMRs would not expect every individual to be taking these high numbers of medications they would not be surprised if they found this to be the reality. In a time of problematic polypharmacy large numbers of medications taken is an increasingly common phenomenon. Before outliers were included in the data analysis, highlighted values from boxplots were cross checked with original DMR records to ensure they were genuine data points and not input errors.

4.4.2 Descriptive statistical analysis

Data was analysed cumulatively and at timepoints (pilot, 2015, 2016 and 6-months of 2017) to look for trends and differences within the data. Unless otherwise indicated both mean and median statistics were analysed to check for skewed data. The following variables were included in the descriptive analysis:

- Age of persons visited
- Gender of persons visited
- Number of visits
- Total length of visits
- Length of first visit
- Number of medicines
- Number of access interventions
- Number of compliance interventions
- Number of clinical interventions
- Number of other interventions
- Total number of interventions

Descriptive statistics of socioeconomic demographics were also analysed using indices of deprivations. Four areas were included in the analysis:

- Health and Disability
- Income
- Income Deprivation Affecting Older People Index (IDAOPI)
- Multiple deprivation

4.4.3 Correlation analysis

Recording of data from the Islington Reablement DMR service is an example of a non-experimental design as none of the variables under exploration have been intentionally influenced. In non-experimental design correlation analysis can be used to explore the relationships between two variables (Pallant, 2010) Correlation between variables was determined using Pearson's coefficient (r); correlation is demonstrated by a value from 0 to +1 or -1. A r value of 0 indicates no relationship between variables and a value of 1 indicates complete relationship between variables i.e. one variable predicts the value of another 100% of the time. The presence of a + or – sign indicates a positive or negative relationship between the two variables under investigations. Pairwise deletion was used.

The following variables were included in the correlation analysis:

- Age
- Gender
- Number of medicines
- Number of access interventions
- Number of compliance interventions
- Number of clinical interventions
- Number of other interventions
- Total number of interventions (*composite variable)

- Length of first visit
- Total length of visits (*composite variable)
- Number of visits

**Composite variable is an overarching variable which contains data from other variables within its total*

4.4.4 Sub analysis of age distributions

When reviewing the histograms (Figure 6) there was a suggestion of a bi-modal distribution: a younger population up to and including 60 years and an older population over 60 years old. The initial correlation output also showed that age was negatively correlated to other variables (section 4.5.3). It was decided to investigate the relationship of these two distributions with other variables further. Further investigation would indicate whether in fact two distributions exist or whether this was a statistical anomaly. If there are two distributions understanding the differences between the sample groups is important when trying to address the research questions as the answer may not be the same for both age groups.

The following tests were applied to the two age groups:

- Comparison of referral reasons
- Comparison of baseline number of medications
- Pearson's correlation analysis with both age distributions and all variables listed above

4.4.5 Multiple linear regression

Relationships between variables as shown through correlation analysis suggested that there was merit in exploring data further to ascertain predictive abilities of

variables. There are various methods for performing regression analysis depending on the distribution and linearity of data (Pallant, 2010). In this research multiple linear regression was employed to determine whether multiple independent variables could collectively predict a dependent variable.

Two dependent variables were chosen for further investigation. The first was the total number of interventions. This variable was chosen because of the emphasis placed on this variable in the published literature. If total number of interventions is key to the value of DMRs it would be advantageous to be able to predict this variable from initial referral data received when a DMR is requested. Understanding how the total number of interventions is related to independent variables is important when trying to answer the research question.

MLR question: ***To what extent can the total number of interventions arising from a DMR be predicted by the following independent variables: number of visits, gender, age, number of medicines and total length of visits***

The second dependent variable was total time spent conducting the DMR with the individual in their home. This was chosen to explore the potential to predict this variable. An understanding of how long a DMR will take could have practical applications for service modelling and delivery.

MLR question: ***To what extent can the total time spent conducting a DMR be predicted by the following independent variables: number of visits, gender, age, number of medicines and number of interventions***

The correlation analysis suggested the presence of two distinct age subgroups within the sample: up to 60 years old and over 60 years old. To verify this finding the linear regression modelling for total length of time spent with DMR participants was re-run for both age sub-groups.

MLR question: ***Does the age of DMR service users affect the ability of independent variables to predict the dependent variables; total number of interventions and total time spent conducting a DMR?***

Different multiple linear regression approaches can be used to test predictor variables within an analysis. By adding and/ or removing variable(s) from equations in different orders the approaches can help understand the relationship between the dependent variable and the predictor variables (Pallant, 2010). In this analysis the enter, stepwise, forward and backward methods were used for each regression analysis. There was no difference between the results of the models according to which method had been used, they all revealed the same predictor variables. As there was no difference in the data output only the results from the enter method are presented in this chapter.

When a multiple linear regression analysis is carried out multiple statistics are included in the data output (Table 4-1). These statistics describe relationships between variables included in the analysis.

Table 4-1: Data outputs for Multiple Linear Regression (adapted from Field 2018)

Name	Definition
R square (R^2)	The amount of pooled variance explained by a model i.e. how much the variance in the dependent variable can be explained by the pooled influence of the independent variables
Standard error of the estimate	A measure of how accurately the model predicts the dependent variable. Generally, the smaller the number the more precise the model is
Durbin-Watson	A measure of how auto-correlated predictor variables are autocorrelated. A value > 1.5 and < 2.5 indicates a lack of auto correlation
ANOVA	Overarching assessment of whether a model is possible with the predictor variables. The results Is presented as the F statistic
F-test	As part of the ANOVA analysis, the F statistic tests the null hypothesis that the variance in the dependent variable cannot be explained by the model. A significant result: less than 0.05 means the null hypothesis is rejected and that a model is possible
B	A coefficient indicating how each independent variable is influencing the model. The coefficient is linked to the unit of measurement of the variable meaning coefficients cannot be compared directly
Beta	Standardises the coefficients allowing comparison of the influence of each independent variable
Tolerance	A measure of co-linearity between predictor variables. A tolerance <0.1 indicates a problem with the model
ViF	Another measure of co-linearity between predictor variables. A VIF > 10 indicates a problem with the model

Abbreviations: ANOVA = Analysis of Variance, ViF = Variance Inflation Factor

4.4.6 Linear model assumptions

When a multiple linear regression analysis is carried out certain statistical assumptions are tested (Table 4-2) to check the results of the predictive model are valid.

Table 4-2: Linear model assumptions (adapted from Field 2018)

Assumption	Explanation	Statistical test
Linearity	The outcome variable must have a linear relationship to the predictor variables	Q-Q plot
Lack of autocorrelation	Assurance that predictor values are not correlated with one another	Durbin-Watson
Homoscedasticity	Variance of residuals for predictor values should be constant	Analysis of residuals
Normal distribution of errors	Residuals in the model should be normally distributed. This means that the difference between the observed values in a sample and the predicted values from the model should be zero, or as close to zero as possible	Histogram of residuals
Lack of multiple co-linearity	There should not be a strong correlation between two or more of the predictor variables. This provides assurance that predictors are accounting for different variance within the model	Tolerance and Variance inflation Factor (ViF)

Abbreviations: ViF = Variance Inflation Factor

4.4.7 Multiple Correspondence Analysis

As a lot of the data from the PiR system is categorical it was decided to investigate the relationships between variables using multiple correspondence analysis (MCA). MCA is a statistical method used to identify and explore the associations between categorical data, representing relationships in a multi-dimensional way (Johnson & Wichern, 2007). MCA is an exploratory analysis; this is appropriate for this research which aims to understands the complexities and outcomes of DMRs.

Within the PiR system the variables linked to referral reason, the problem and recommendation for intervention type consisted of 111 individual codes. When these codes were examined, it was noticed that there were commonalities in the types of codes used. It was decided the codes should be consolidated to permit further investigation. Although the 111 codes provide an in-depth picture of the issues commonly encountered during a DMR, they have a strong pharmaceutical focus. The aim of reassigning each original code into broader clusters of codes was to enable a more real world understanding of the underlying issues discovered during DMRs.

Nine cluster variables were decided upon. Definitions (Table 4-3) were assigned to ensure consistency of recoding. Codes were applied to all referral reasons, problems and interventions.

Table 4-3: Definitions of consolidated codes for Multiple Correspondence Analysis

Consolidated code	Definition
Supply	There is an issue with the supply of at least one medication or an action is required to resolve an issue related to medication supply e.g. an individual has run out of an essential medication or there are excess medications in the home
Medication expertise	An issue requires the medication expertise of the DMR professional to resolve e.g. recommending a formulation change for swallowing difficulties
Compliance	There appears to be a discrepancy between prescribed medications and the medication taking behaviours of an individual e.g. an individual intentionally takes a lower dose or an individual cannot use a medication device correctly
Safety/ disposal	There are concerns that the medication management in a domiciliary setting is not safe or action is required to improve the safety of a situation e.g. removing excess meds
Domestic	A domestic situation is impacting on medication management e.g. an individual is housebound
Involve others	Formal carers/ other healthcare professionals or informal carers such as family members are involved with medication management or are asked to become involved to resolve a situation
Dosing/ administration	There is an issue with the dosing and/ or administration of at least one medication or actions is needed to address an issue with dosing and/ or administration

Consolidated code	Definition
Unmet health need	An unmet health need which affects the DMR or is uncovered at the DMR e.g. an individual is found to have low mood, or they have missed hospital appointments
Preventative health	There is a risk to the health of an individual e.g. they have an inappropriate diet for a condition, or they agree to accept smoking cessation help
Abbreviations: DMR = Domiciliary Medication Review	

For MCA each case could only have one code for each variable to be included in the analysis. Where a case had more than one problem identified within an intervention type, the original data from the PiR system was reviewed, and the code that was deemed to represent most of the work for the DMR was included in the analysis.

For the MCA numerical data sets (number of medicines, total number of interventions and total time spent conducting the DMR) included in the earlier multiple linear regression analysis were transformed into categorical data. This was carried out to further explore the relationship between variables. Although earlier correlation analysis showed that multiple scale data variables were associated with others this did not mean that the associations would be the same when variables were converted to categorical codes. Categories were chosen by reviewing histograms of data distribution. Each section of data within the histogram that appeared to have an approximately normal distribution became a category.

Discrimination measures describe the variance of a variable along a dimension in the model. If a variable has a high discrimination measure this indicates that a variable has been discriminated substantially by the dimension (Di Franco, 2016). Discrimination measures were interrogated, variables that did not load significantly with any dimension (defined as a discrimination measure less than 0.1) were removed, and the MCA analysis was re-run with the reduced number of variables.

For the subsequent MCA rounds categories were removed based on a visual inspection of the discrimination measure plots. Variables that did not appear to be loading significantly with either dimension were removed. All decisions to remove variables from the MCA analysis were checked and validated by the research supervisor (IB). Analysis of the relationships between variables and dimensions were used to identify the dimensions (Le Roux & Rouanet, 2010). A final iteration of the MCA model was used to determine the identity of dimensions 1 and 2.

4.4.8 Cluster analysis

Cluster analysis aims to place cases into relative groups (clusters) where there is homogeneity within data sets (Aldenderfer & Blashfield, 1984) . This analysis investigated whether the clusters shared any demographic attributes. Examining whether there were any commonalities between cases in the dataset before DMRs took place added a deeper layer of investigation and understanding of the data.

Grouping of cases was determined by inputting object scores (the position of variable in the low dimensional space) from the MCA. A k-means method was used to determine whether cases could be organised into groups. A 3-cluster solution was identified, cross tabulation and one-way analysis of variance (ANOVA) analysis was used to identify the shared demographic attributes (age, gender, number of medications and referral reasons) that define the clustering.

4.5 Results

The results for each analysis technique are described in the following sections.

4.5.1 Summary of descriptive statistics

During the study periods and a total of 251 participants received a DMR (Table 4-4). A total of 309 visits took place. The mean number of visits was 1.2 (SD: 0.5). Most participants had single DMR visits (n=203) and others (n=48) had multiple; 40 participants received two visits, six participants received three visits and two participants receive four visits. The mean age of DMR participants was 77.4 years (SD: 11.9). The mean number of medications taken by participants was 10.2 (SD: 4.6). . The mean length of the first DMR visit was 46 minutes (SD: 19.7). A total of 1373 interventions were made by the DMR pharmacist. Clinical interventions were the most common (43.9%, n= 603), followed by compliance interventions (63.3%, n=498) and other interventions (12.7%, n=174). Access interventions were the least common type of intervention (7.1%, n=98). The mean number of interventions, regardless of type was 5.5 interventions (SD: 2.9) per participant.

Table 4-4: Summary of descriptive statistics for PiR data

	Pilot (23.11.15 – 18.12.15)	2015 (January – December) *Includes pilot data*	2016 (January – December)	2017 (January – June)	Cumulative summary
No. patients visited	10	95	110	46	251
Mean age persons visited	71.8 (SD: 12.9)	77.4 (SD: 10.55)	77.6 (SD: 12.7)	76.93 (SD: 12.91)	77.4 (SD: 11.9)
Median age persons visited	76.5	78.0	81.0	79.5	80
Gender persons visited	6 male (60%) 4 female (405)	41 male (43.2%) 54 female (56.8%)	43 male (39.1%) 67 female (60.9%)	18 male (39.1%) 28 female (60.9%)	102 male (40.6%) 149 female (59.4%)
No. visits	14	116	137	56	309
Mean no. visits	1.3 (SD: 0.5)	1.2 (SD: 0.5)	1.3 (SD: 0.5)	1.2 (SD: 0.6)	1.2 visits (SD: 0.5)
Median no. visits	1.0	1.0	1.0	1.0	1.0 visits
Mean length total visits	45.0 mins (SD: 13.47)	50.2 mins (SD: 25.2)	54.7 mins (SD: 24.7)	71.2 mins (SD: 36.2)	56.1 mins (SD: 28.3)
Median length total visits	45.0 mins	45.0 mins	60.0 mins	60 minutes	60 mins
Mean length first visit	34.5 mins (SD: 15.0)	42.5 mins (SD: 15.8)	45.7 mins (SD: 19.4)	56.9 mins (SD: 23.0)	46.0 mins (SD: 19.7)
Median length first visit	30 mins	40.0 mins	45.0 mins	60.0 mins	45 mins
Mean no. medicines	8.2 items (SD: 2.6)	10.4 items (SD: 5.2)	10.2 items (SD: 4.0)	10.0 items (SD: 4.6)	10.2 items (SD: 4.6)
Median no. medicines	8.0 items	10.0 items	10.0 items	9.0	10 items

	Pilot (23.11.15 – 18.12.15)	2015 (January – December) *Includes pilot data*	2016 (January – December)	2017 (January – June)	Cumulative summary
No. access interventions (mean)	4 (0.4 SD: 0.7)	44 (0.46 SD: 0.67)	43 (0.4 SD: 0.6)	13 (0.3 SD: 0.8)	98 (0.4 SD: 0.7)
No. access interventions (median)	4 (0.0)	44 (0.0)	43 (0.0)	13 (0.0)	98 (0.0)
No. compliance interventions (mean)	26 (2.6 SD: 1.5)	214 (2.3 SD: 1.3)	200 (1.8 SD: 1.5)	84 (1.8 SD: 1.3)	498 (2.0 SD: 1.4)
No. compliance interventions (median)	26 (2.0)	214 (2.0)	200 (1.0)	84 (2.0)	498 (2.0)
No. clinical interventions (mean)	39 (3.9 SD: 2.2)	268 (2.8 SD: 2.6)	252 (2.3 SD: 1.7)	83 (1.9 SD: 2.2)	603 (2.4 SD: 1.4)
No. clinical interventions (median)	39 (4.5)	268 (2.0)	252 (2.0)	83 (1.0)	603 (2.0)
No. other interventions (mean)	2 (0.2 SD: 0.632)	29 (0.3 SD: 0.7)	87 (0.8 SD: 1.0)	58 (1.3 SD: 1.1)	174 (0.7 SD: 1.0)
No. other interventions (median)	*2 (0.0)	29 (0.0)	87 (1.0)	58 (1.0)	174 (0.0)
No. total interventions (mean)	72 (7.2 SD: 1.81)	555 (5.9 SD: 3.3)	582 (5.3 SD: 2.5)	238 (5.2 SD: 2.7)	1373 (5.5 SD: 2.9)
No. total interventions (median)	77 (7.0)	555 (5.0)	582 (5.0)	238 (5.0)	1373 (5.0)

Abbreviations: No. = Number, SD = Standard deviation,

The postcode of the GP surgery was used to determine the socio-economic status of cases (Table 4-5**)**. This information was available for 246 participants. Decile 1 represents the 10% most deprived neighbourhoods in England and decile 10 represents the 10% least deprived neighbourhoods in England (Ministry of Housing Community and Local Government, 2019). The DMR participants are more deprived on average than the rest of England with the lowest score for the Income Deprivation Affecting Older People Index (IDAOPI).

Table 4-5: Descriptive statistics of socio-economic deciles for cases

	Decile			
Deprivation Index	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Health and Disability	2	10	4.19	1.715
Income	1	10	3.20	1.618
IDAOPI	1	10	1.87	1.280
Multiple deprivation	1	9	3.47	1.320

Abbreviations: IDAOPI = Income Deprivation Affecting Older People Index

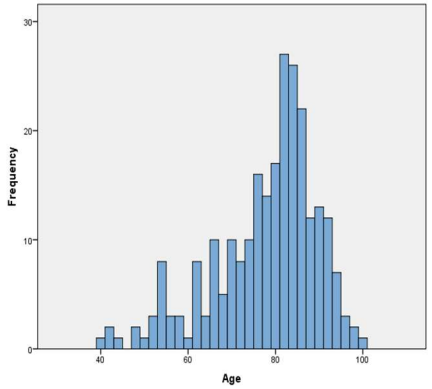
4.5.2 Normality of data

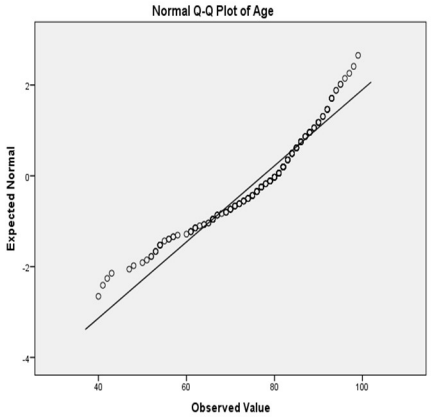
An initial visual inspection of histograms (Figure 6) indicated that the variables obtained from PiR data were both normally and uniformly distributed, which did not give a clear indication as to whether parametric or non-parametric tests should be employed. However, it is accepted that when sample sizes are larger than 30-40, parametric tests can be employed even if a visual inspection indicates that some variables may consist of uniform data (Pallant, 2010).

The final check of comparing means and medians for all variables (Table 4-4) showed that all variables shared a comparatively similar central tendency. For all variables the mean and median were within one integer of each other. For both access and other intervention categories the median was zero, this is because for both

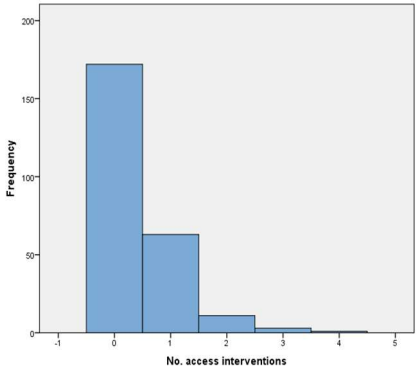
categories more participants did not have an intervention in one of these categories than the number of participants who did. It is known that the median can be affected by the most common data point. For both variables zero was the most common and lowest data point. Based on these checks it was decided that for the non-categorical data from PiR that parametric tests could be employed.

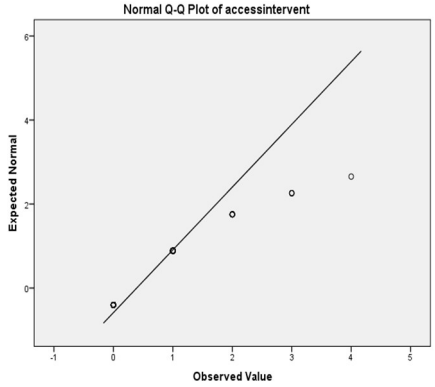
Age



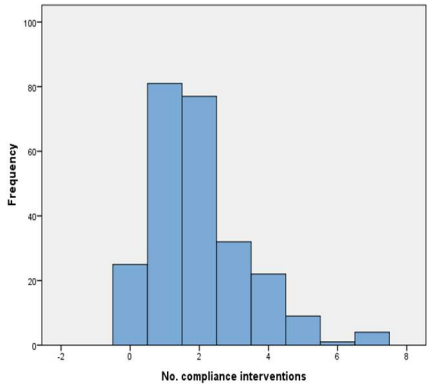


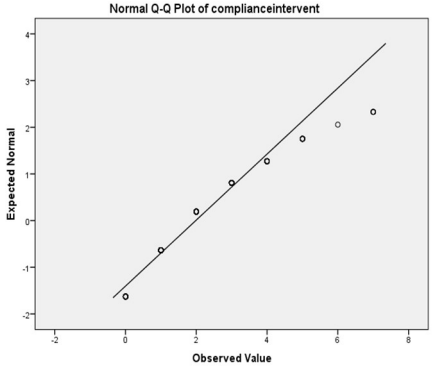
Number of access interventions



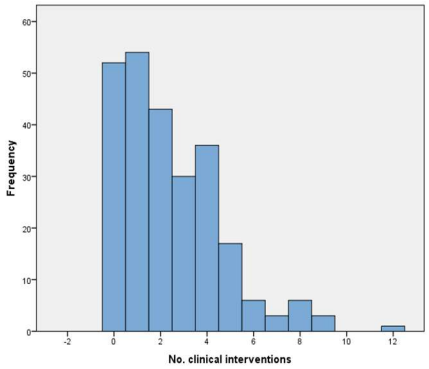


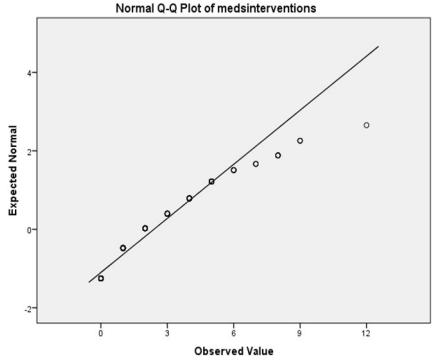
Number of compliance interventions



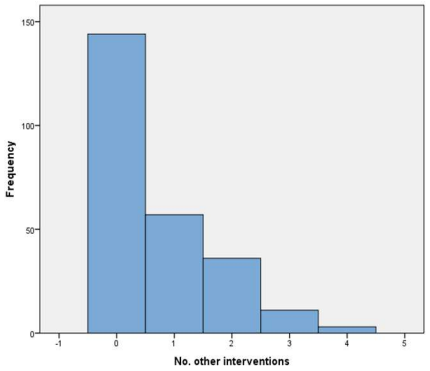


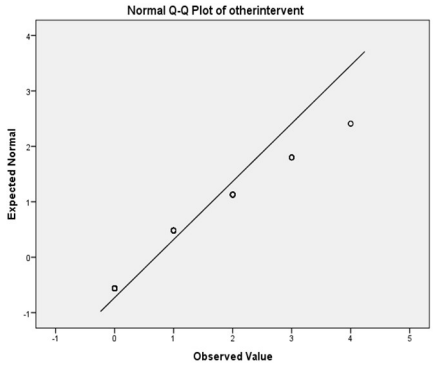
Number of clinical interventions



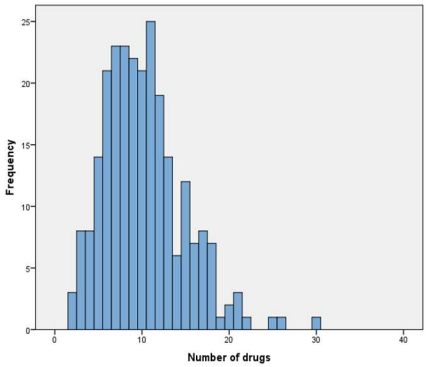


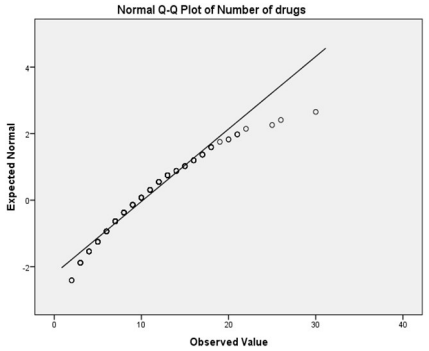
Number of other interventions



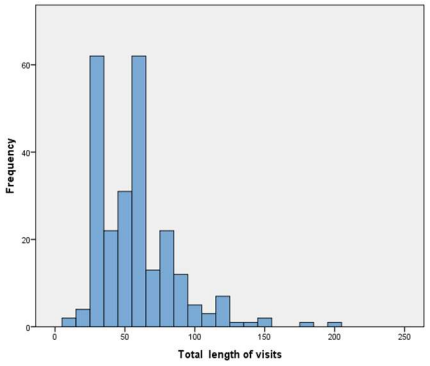


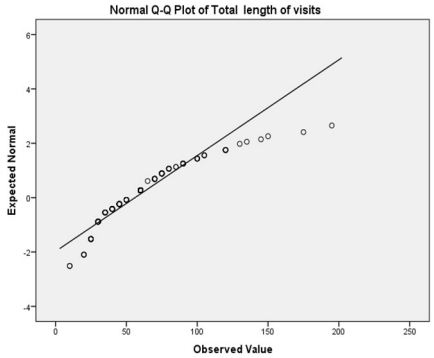
Number of medicines taken



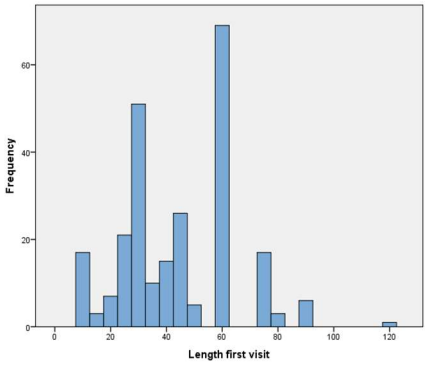


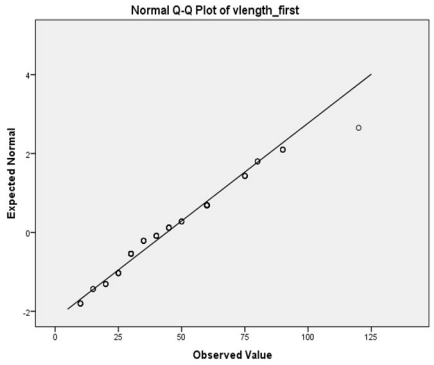
Total length of visit





Length of first visit





Total number of interventions **Total number of visits**

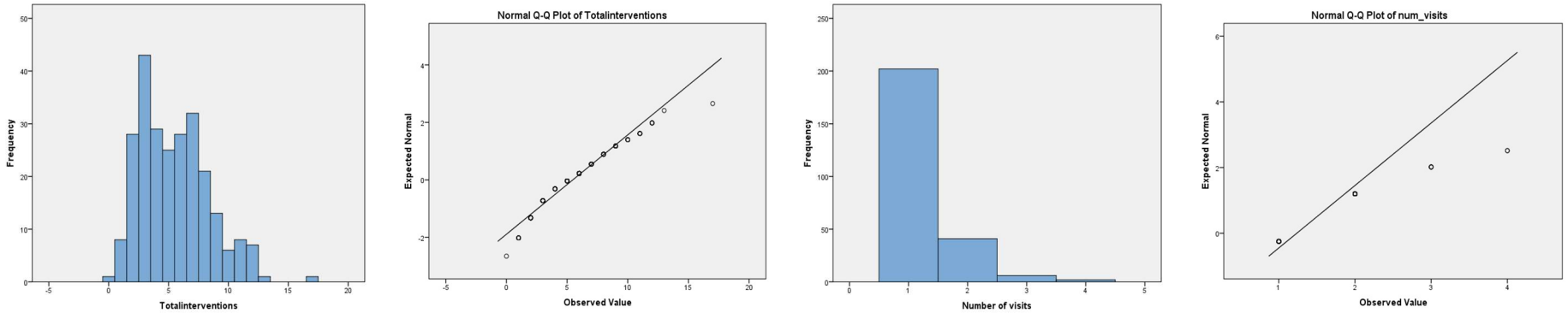


Figure 6: Histograms and Q-Q plots of variables included in the correlation analysis

4.5.3 Correlation analysis

Statistically significant correlations are highlighted in yellow (Table 4-6). The number of cases included in the analysis for all variables was 251. Definitions of a small correlation (r: .10 to .29), medium correlation (r: .30 to .49) and a large correlation (r: .50 to 1.0) were taken from Cohen (1988).

Gender and clinical interventions had no statistically significant correlations with any other variable included in the analysis.

Age had small statistically significant negative correlations with number of medicines (*r = -0.160, p=0.11),* number of access interventions (*r = -0.135, p=0.032),* the length of first visit (*r = -0.234, p=0.07)* and the total length of visits: *small correlation (r = -0.169*, p=0.00).

Number of medicines had small positive correlations the number of compliance interventions (*r = 0.186, p=0.003),* the number of other interventions (*r = 0.167, p=0.008)* and the length of first visit (r = 0.287, p=0.00). Number of medicines had medium positive correlations with the number of clinical interventions (*r = 0.337, p = 0.00), the* total number of interventions (*r = 0.410, p=0.00)* and the total length of visits (*r = 0.314, p = 0.00).*

Access interventions had small positive correlations with the total length of visit (*r = 0.144, p = 0.023)* and the number of visits (*r = 0.164, p = 0.090).*

Compliance interventions had small positive correlations with the length of the first visit (*r = 0.194, p = 0.002)* and the number of visits (*r = 0.164, p =0.009).* Compliance interventions also had a medium positive correlation with the total length of visits (*r = 0.410, p = 0.00).*

Other interventions had a small positive correlation with the length of the first visit (r =0.258, p = 0.00) and the number of visits (0.166. p = 0.008). Other interventions

also had a medium positive correlation with the total length of visits (r = 0.326, p = 0.00).

The total number of interventions had a small positive correlation with the length of the first visit (r = 0.237, p = 0.00) and the number of visits (r = 0.274. p = 0.00). The total number of interventions also had a medium positive correlation with the total length of visits (r = 0425, p = 0.00).

The total length of visits had a large positive correlation with the number of visits (r = 0.676, p = 0.00)

Statistically significant correlations were noted between access, compliance, clinical and other interventions with the total number of interventions. This was expected correlation as the individual intervention types are composite variables of the total number of interventions variables. A statistically significant correlation was also found between length of first visit and total length of visits. Again, this is an expected finding as they are composite variables. These composite correlations were not explored any further. Correlations between composite variables are highlighted in blue.

The next section presents correlation analysis results when the data is divided into two age groups and examines commonalties and differences in results to the overarching correlation analysis.

Table 4-6: Summary of correlation matrix results

		Age	Gender	Number of medicines	Access interventions	Compliance interventions	Clinical interventions	Other interventions	Total interventions	Length of first visit	Total length of visits	Number of visits
Age	Pearson Correlation	1										
	Sig. (2-tailed)											
Gender	Pearson Correlation	.100	1									
	Sig. (2-tailed)	.116										
Number of medicines	Pearson Correlation	-.160*	.097	1								
	Sig. (2-tailed)	.011	.124									
Access interventions	Pearson Correlation	-.135*	-.014	.044	1							
	Sig. (2-tailed)	.032	.822	.486								
Compliance interventions	Pearson Correlation	-.058	.019	.186**	.066	1						
	Sig. (2-tailed)	.361	.759	.003	.298							
Clinical interventions	Pearson Correlation	-.014	.004	.337**	.070	.072	1					
	Sig. (2-tailed)	.830	.951	.000	.267	.253						
Other interventions	Pearson Correlation	-.082	.006	.167**	-.006	-.048	-.083	1				
	Sig. (2-tailed)	.193	.924	.008	.926	.447	.190					
Total interventions	Pearson Correlation	-.097	.011	.410**	.314**	.542**	.776**	.242**	1			
	Sig. (2-tailed)	.126	.861	.000	.000	.000	.000	.000				
Length of first visit	Pearson Correlation	-.169**	-.005	.287**	-.080	.194**	.102	.258**	.237**	1		

		Age	Gender	Number of medicines	Access interventions	Compliance interventions	Clinical interventions	Other interventions	Total interventions	Length of first visit	Total length of visits	Number of visits
	Sig. (2-tailed)	.007	.941	.000	.204	.002	.108	.000	.000			
Total length of visits	Pearson Correlation	-.234**	.023	.314**	.144*	.410**	.111	.326**	.425**	.580**	1	
	Sig. (2-tailed)	.000	.718	.000	.023	.000	.079	.000	.000	.000		
Number of visits	Pearson Correlation	-.099	.009	.123	.164**	.340**	.020	.166**	.274**	.004	.676**	1
	Sig. (2-tailed)	.117	.889	.052	.009	.000	.754	.008	.000	.946	.000	

*Correlation is significant at the 0.05 level (2-tailed)

**Correlation is significant at the 0.01 level (2 tailed)

4.5.3.1 Sub analysis of age distributions: descriptive statistics

Although, there is a clear difference in sample size between age groups there does appear to be differences in the reasons for referral (Table 4-7). The younger age group were most frequently referred for medication expertise and the older population were most frequently referred because of concerns round compliance.

Table 4-7: Referral reasons for the two age distributions

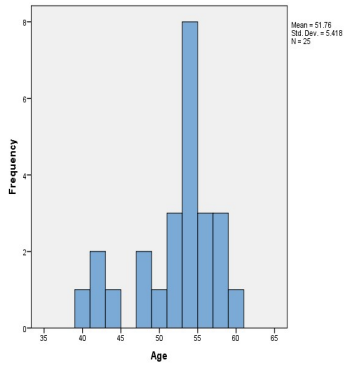
	Up to 60 years old		More than 60 years old	
Referral Reason	Frequency	Percent	Frequency	Percent
Supply	3	12.5	14	6.2
Medication expertise	13	54.2	81	35.8
Compliance	9	33.3	132	58.0
Total	25	100.0	226	100.0

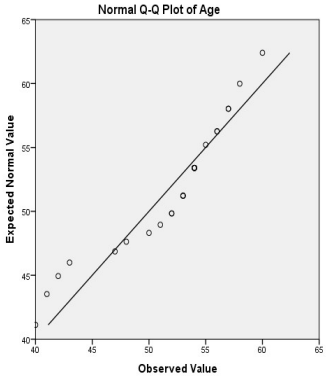
The mean number of medications the younger population was prescribed (11.4 SD: 3.65) at the time of the DMRs was more than the number the older population were prescribed (10.1 SD: 4.67). However, when the two means are compared via an independent samples t-test there was no statistical difference noted between the two means (t= 0.61, p = 0.11, equal variances not assumed).

4.5.3.2 Sub analysis of age distributions: normality of data

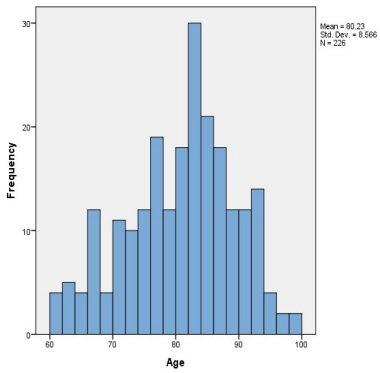
Review of histograms and Q-Q plots for the two groups showed data appeared to follow normal distribution (Figure 7). It was decided that a Pearson's Correlation would be an appropriate test for this data.

Up to 60 years old





Over 60 years old



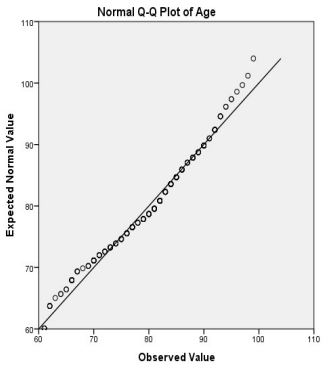


Figure 7: Histograms and Q-Q plots for the bi-modal age distributions

4.5.3.3 Sub analysis of age distributions: Correlation analysis

A Pearson's correlation was run for the two age populations (Table 4-8). The younger age group did not show any statistically significant correlations between variables. Although the small sample size is likely affected ability to detect correlation between variables.

Table 4-8: Correlation analysis results for age distributions

		Age	Gender	Number of medicines	Access interventions	Compliance interventions	Clinical interventions	Other interventions	Total interventions	Length of first visit	Total length of visits	Number of visits
Up to 60 years	Pearson Correlation	1	-.062	.000	-.114	.162	.086	.057	.123	.179	-.016	.113
	Sig. (2-tailed)		.768	.999	.588	.439	.684	.787	.559	.393	.939	.590
	N	25	25	25	25	25	25	25	25	25	25	25
Over 60 years	Pearson Correlation	1	.073	-.150*	-.089	-.145*	.000	-.045	-.105	-.176**	-.133*	-.078
	Sig. (2-tailed)		.273	.024	.184	.029	.995	.498	.116	.008	.046	.242
	N	226	226	226	226	226	226	226	226	226	226	226

*Correlation is significant at the 0.05 level (2-tailed)

**Correlation is significant at the 0.01 level (2 tailed)

When the two age groups were considered separately the small statistically significant negative correlations between age and number of medicines (r = -0.150, p = 0.024), length of first visit (r = -0.176, p = 0.08) and total length of visit (r = -0.133, p = 0.46) remained for the over 60 age group. The small negative relationship between age and access interventions also remained but statistical significance was lost (r = -0.89, p = 0.184). A new small negative correlation between age and compliance interventions (r = -0.145, p = 0.029) appeared.

Conversely, in the younger age group there was no relationship between age and number of medicines (r = 0.00, p = 0.99) and the relationship between age and length of first visit (r = 0.179, p = 0.939) becomes positive. As mentioned above none of these correlations from the younger age group were statistically significant.

The correlation analysis started to paint a picture of the relationships between demographics and interventions. It suggested that further analysis using different analytical tests was warranted. The next step in the statistical analysis was the multiple linear regression analysis.

4.5.4 MLR: Total interventions

Data from the 251 cases who received a DMR were used for the regression model with total intervention as the dependent variable and five independent variables: age, gender, number of medicines taken, total length of visits and number of visits.

An R^2 value of 0.27 shows that at least 27% of the total interventions that occurred after a DMR can be explained by the model (Table 4-9). A low standard error of the estimate indicated a precise model, a significant F statistic indicated that a model is possible from the predictor variables and the Durbin-Watson result between 1.5-2.5 indicates the assumption of lack of autocorrelation between predictor variables is met.

Table 4-9: Multiple linear regression model for total interventions

			ANOVA		
R^2	**Adjusted R^2**	**Std error of the estimate**	**F**	**Sig**	**Durbin-Watson**
0.27	0.25	2.50	17.85	0.00	1.862

Abbreviations: Std = ANOVA = Analysis of Variance, Standard, Sig = Significance

When the total number of interventions was predicted it was found that number of medicines (Beta = 0.315, $p < 0.01$) and total length of visits (Beta = 0.318, $p < 0.01$) were significant predictors. Age (Beta = 0.033, n.s.), gender (Beta = -0.30, n.s.) and number of visits (Beta = 0.23, n.s.) were not significant predictors (Table 4-10).

Table 4-10: Beta values for total interventions model

	Unstandardized Coefficients		Standardized Coefficients
	B	**Std. Error**	**Beta**
(Constant)	1.120	1.303	
Age	.008	.014	.033
Gender	-.178	.325	-.030
Number of medicines	.199	.037	.315*
Total length of visits	.033	.008	.318*
Number of visits	.129	.415	.023

**p<0.05*

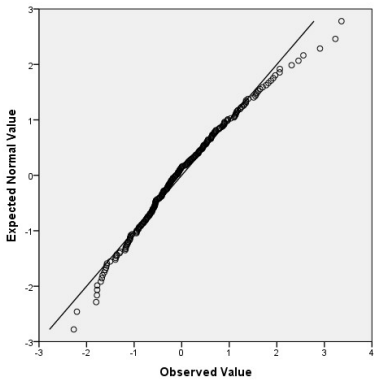
The relationship between the variables within the model can be represented by the following equation:

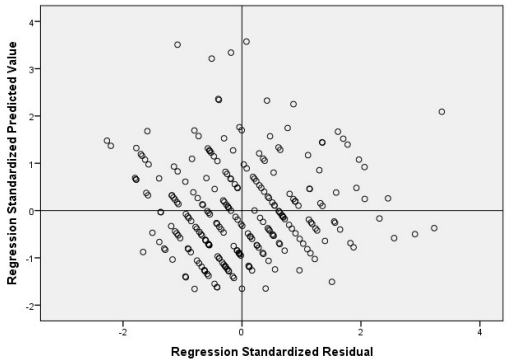
Total number of interventions = 1.120 + (0.37 x number of medicines) + (0.08 x total length of visits)

Standardised coefficients are used in the equation as the units of variables vary.

All the assumptions of the linear model were met. The Q-Q plot of standardised residuals (Figure 7) demonstrated an approximately linear relationship between predictor variables. The scatter plot of standardised residuals; demonstrated a random distribution of variables to meet the assumption of homoscedasticity and the histogram of standardised residuals; demonstrated an approximately normal distribution, meeting the assumption of normal distribution of errors (Figure 8).

Q-Q plot of standardised residuals	Scatterplot of standardised residuals





Histogram of standardised residuals

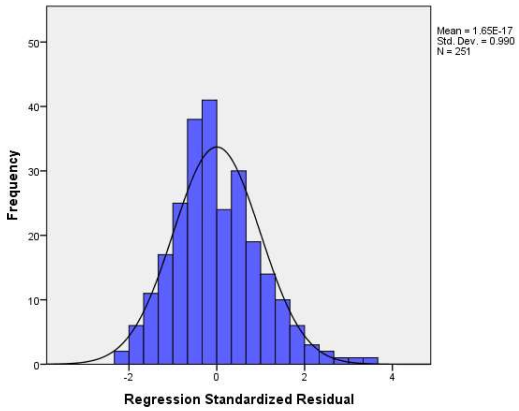


Figure 8: Plots demonstrating assumptions of the linear model for total interventions

All variables had a tolerance more than 0.1 and VIF results less than 10 meeting the assumption of a lack of co-linearity between variables (Table 4-11).

Table 4-11: Co-linearity variables for total interventions model

Variable	Tolerance	VIF
Age	0.92	1.09
Gender	0.98	1.02
Number of medicines	0.87	1.15
Total length of visits	0.47	2.13
Number of visits	0.53	1.89

Abbreviations: ViF = Variance Inflation Factor

4.5.5 MLR: Total length of visits

Data from the 251 cases who received a DMR were used for the regression model with total length of visits as the dependent variable and five independent variables: age, gender, number of medicines taken, number of visits and total interventions.

An R^2 value of 0.56 shows that at least 56% of the total time spent conducting a DMR can be explained by the model (Table 4-12). The standard error of the estimate was higher for this model indicating a larger standard deviation of residuals and perhaps a less precise model. This was investigated further through examination of a scatter plot of residuals. A significant F statistic indicated that a model is possible from the predictor variables and Durbin-Watson result slightly less than 1.5-2.5 indicated that variables may be more autocorrelated for this model. However, the result is close to 1.5 and not a cause for large concern. Interpretation of the model can proceed.

Table 4-12: Multiple linear regression model for total time spent

R^2	Adjusted R^2	Std error of the estimate	F	Sig	Durbin-Watson
0.56	0.55	18.99	62.05	0.00	1.46

Abbreviations: Std = ANOVA = Analysis of Variance, Standard, Sig = Significance

When the total number of interventions was predicted it was found that age (Beta = -0.136, $p < 0.01$), number of medicines (Beta = 0.140, $p < 0.01$), number of visits (Beta = 0.59, $p < 0.01$) and number of interventions (Beta = 0.192, $p < 0.01$) were significant predictors. Gender (Beta = 0.150, n.s.) was not a significant predictor (Table 4-13).

Table 4-13: Beta values (coeficients) for total time spent model

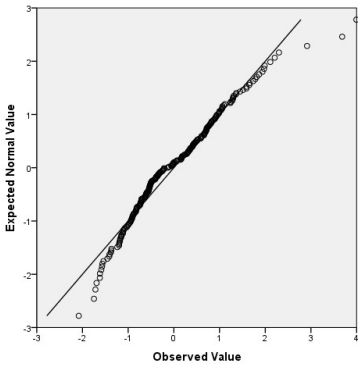
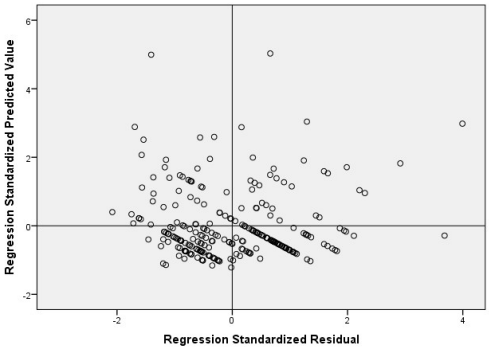
	Unstandardized Coefficients		Standardized Coefficients
	B	**Std. Error**	**Beta**
(Constant)	21.151	9.82	
Age	-0.32	0.10	-0.14*
Gender	0.89	2.47	0.015
Number of medicines	0.86	0.29	0.14*
Number of visits	32.06	2.39	0.59*
Total interventions	1.88	0.47	0.19*

$p<0.05$

The relationship between the variables within the model can be represented by the following equation:

Total time spent = 21.15 + (0.10 x age) + (0.29 x number of medicines) + (2.39 x number of visits) + (0.47 x total interventions)

All the assumptions of the linear model are also met for this model (Figure 9). The assumption of linearity from a Q-Q plot of standardised residuals, the assumption of homoscedasticity from a scatter plot of standardised residuals and the assumption of normal distribution of errors from a histogram of standardised residuals.

Q-Q plot of standardised residuals	Scatterplot of standardised residuals
	

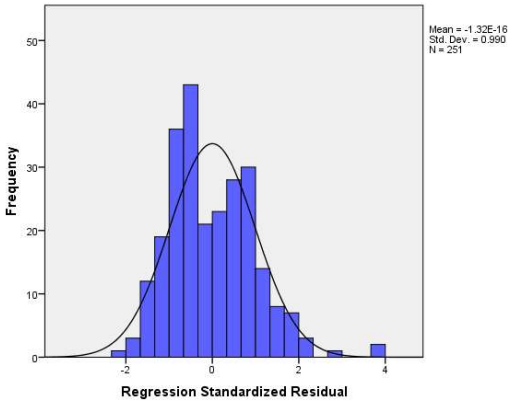
Histogram of standardised residuals


Figure 9: Plots demonstrating assumptions of the linear model for total time spent

Again, all variables had a tolerance result more than 0.1 and a VIF results less than 10 meeting the assumption of a lack of co-linearity between variables (Table 4-14).

Table 4-14: Co-linearity variables for total time spent mode

Variable	Tolerance	VIF
Age	0.96	1.05
Gender	0.98	1.03
Number of medicines	0.81	1.24
Number of visits	0.92	1.09
Total interventions	0.78	1.28

Abbreviations: ViF = Variance Inflation Factor

4.5.5.1 Total length of visits: linear regression results for two age distributions

Data from the 25 cases of participants up to 60 years of age and the 226 participants aged over 60 years who received a DMR was used for the regression model with total length of visits as the dependent variable and five independent variables: age, gender, number of medicines taken, total length of visits and total interventions.

Around 60% of the total time spent conducting a DMR with the younger population and 55% of the time spent with the older population can be explained by the model (Table 4-15). The standard error of the estimate was higher for younger population than the older population, indicating a larger standard deviation of residuals and a less precise model. This was investigated further through examination of a scatter plot of residuals. A significant F statistic indicated that a model was possible from the predictor variables for both age populations. For the less than 60 years model a Durbin-Watson result slightly less than 1.5-2.5 indicated that variables may be more autocorrelated for this model. This was not observed in the 60 years and over model as a Durbin-Watson result of 1.52 was observed.

Table 4-15: Age distributions multiple linear regression model for total time spent

	R^2	Adjusted R^2	Std error of the estimate	F	Sig	Durbin-Watson
Up to 60 years	0.59	0.49	24.76	5.55	0.003	1.43
60 years and over	0.54	0.54	18.44	52.79	0.00	1.52

Abbreviations: Std = ANOVA = Analysis of Variance, Standard, Sig = Significance

For participants up to 60 years of age only the total number of visits (Beta = 0.718, P <0.01) was found to be a significant predictor of the total time spent with a participant. No other predictor variable contributed significantly to the model. For the younger sample, although age does not make a statistically significant contribution to the model, it had to a positive relationship (Beta = 0.07) with the independent variable; total time spent. This was a change from a negative relationship observed in the overarching regression model.

For participants over 60 years old age (Beta = -0.09, p=0.05), number of medicines (Beta = 0.146, p=0.05), number of visits (Beta = 0.57, p <0.01) and total number of interventions (Beta = 0.22, p < 0.05) were found to be significant predictors of the model. Gender was not a significant predictor (Table 4-16).

Table 4-16: Beta values for total time spent model by age distribution

	Up to 60 years			60 years and over		
	Unstandardized Coefficients	Standardized Coefficients		Unstandardized Coefficients	Standardized Coefficients	
	B	**Std. Error**	**Beta**	**B**	**Std. Error**	**Beta**
(Constant)	5.07	54.44		15.70	13.19	
Age	0.46	0.95	0.72	-0.29	0.15	-0.09**
Gender	-11.08	10.44	-0.16	2.29	2.55	0.041
Number of	0.57	1.45	0.61	0.84	0.30	0.146*
medicines	35.65	7.40	0.78*	31.5	2.61	0.57*
Number of visits	0.76	1.93	0.61	2.01	0.48	0.22*
Total interventions						

**p<0.05* **p = 0.05

Model assumptions

All the assumptions of the linear model were met for both age distributions (Table 4-17 and Figure 10). Between the two age samples the assumptions are more strongly demonstrated for the over 60 years group. For the up to 60 years group the model assumptions were not as clearly met; there appears to be some deviation from normality. The small sample size was likely having an effect. However, the modelling appears to be functioning well in spite of this.

Table 4-17: Co-linearity variables for total time spent model by age distribution

	Up to 60 years old		60 years old and over	
Variable	**Tolerance**	**VIF**	**Tolerance**	**VIF**
Age	0.96	1.04	0.96	1.04
Gender	0.90	1.11	0.97	1.03
Number of medicines	0.92	1.09	0.79	1.27
Number of visits	0.81	1.23	0.92	1.09
Total interventions	0.89	1.12	0.77	1.30

Abbreviations: ViF = Variance Inflation Factor

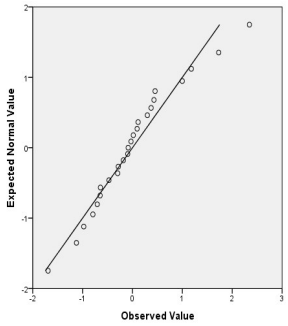
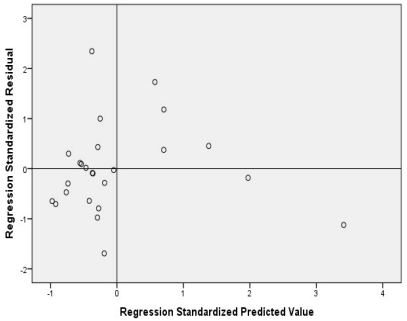
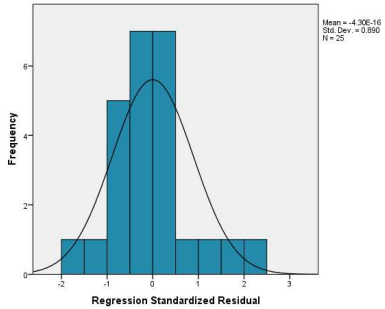
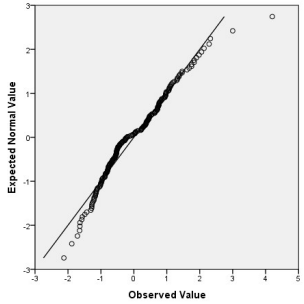
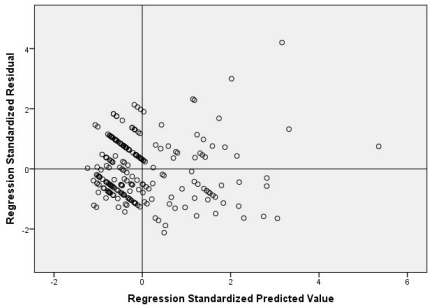
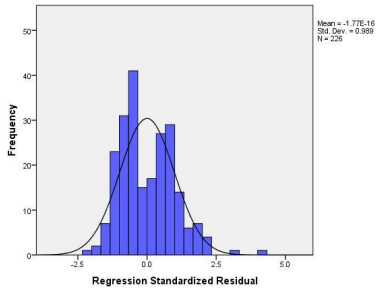
Up to 60 years old		
Q-Q plot of standardised residuals	**Scatterplot of standardised residuals**	**Histogram of standardised residuals**
		
60 years old and over		
Q-Q plot of standardised residuals	**Scatterplot of standardised residuals**	**Histogram of standardised residuals**
		

Figure 10: Plots demonstrating assumptions of the linear model for total time spent by age distribution

4.5.6 Multiple correspondence analysis

The MCA analysis was conducted with three derived dimensions (Table 4-18) , then two derived dimensions (Table 4-19).

Table 4-18: Discrimination measures for a 3-dimension model

Variable	Dimension		
	1	2	3
Gender	.040	.096	.067
Access problem	.147	.060	.273
Access recommendation	.148	.024	.149
Compliance problem	.008	.034	.047
Compliance recommendation	.263	.229	.275
Clinical problem	.050	.453	.428
Clinical recommendation	.138	.337	.267
Other problem	.287	.201	.168
Other recommendation	.143	.242	.171
Referral reason	.261	.403	.192
Total interventions	.536	.136	.017
Number medicines	.197	.041	.005
Total length of visit(s)	.308	.198	.248

When discrimination measure values were examined for the 3-dimensional model only one variable; access problems, differentiated with dimension 3 over dimension 1 and 2. As no other variable clearly differentiated with dimension 3 over dimensions 1 and 2, it was decided to proceed with the analysis using the two-dimensional model.

The model summary for the first version of the 2-dimensional solution was as follows for dimension 1 and 2 respectively; eigenvalue: 2.527 and 2.454, inertia 0.194 and 0.189 and Cronbach's alpha 0.655 and 0.642.

Table 4-19: Discrimination measures for the first iteration of the two-dimensional model

Variable	Dimension	
	1	2
Gender	.042	.099
Access problem	.141	.059
Access recommendation	.144	.025
Compliance problem	.008	.035
Compliance recommendation	.267	.233
Clinical problem	.049	.455
Clinical recommendation	.140	.339
Other problem	.284	.195
Other recommendation	.143	.238
Referral reason	.258	.409
Total interventions	.539	.135
Number medicines	.196	.041
Total length of visit(s)	.317	.190

Gender and access problems did not appear to associate strongly with either dimension. As they had discrimination measures less than 0.1 for both dimensions the analysis was re-run without these variables.

After review of the discrimination plot (Figure 11) of the subsequent model access problems, access recommendations and the number of medicines were also removed from the analysis.

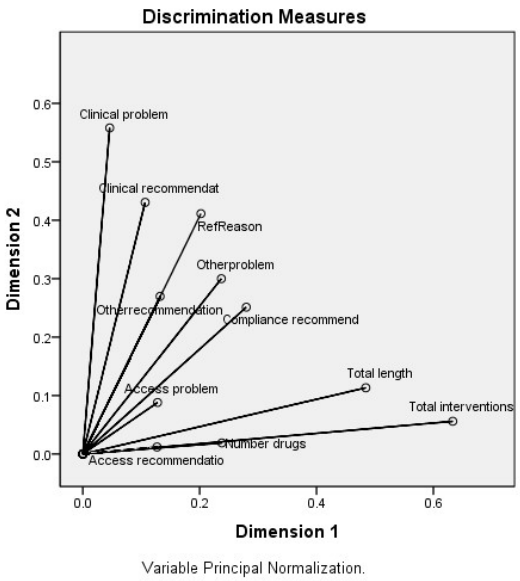


Figure 11: Discrimination plot for the first iteration of the two-dimensional model

The model summary for the final version of the 2-dimensional solution was as follows for dimension 1 and 2 respectively; eigenvalue: 2.264 and 2.182, inertia 0.283 and 0.273 and Cronbach's alpha 0.638 and 0.619. The accepted lower level for Cronbach's alpha is 0.7. However, in exploratory research, such as the work described in this thesis, lower limits have been accepted (Johnson & Wichern, 2007).

A final iteration of the model with discrimination measures (Table 4-20) and discrimination plots (Figure 12) were obtained.

Table 4-20: Discrimination measures for the second iteration of the two-dimensional model

Variable	Dimension	
	1	2
Compliance recommendation	.337	.144
Clinical problem	.133	.484
Clinical recommendation	.183	.353
Other problem	.235	.223
Other recommendation	.112	.239
Referral reason	.177	.348
Total interventions	.538	.129
Total length of visit(s)	.549	.262

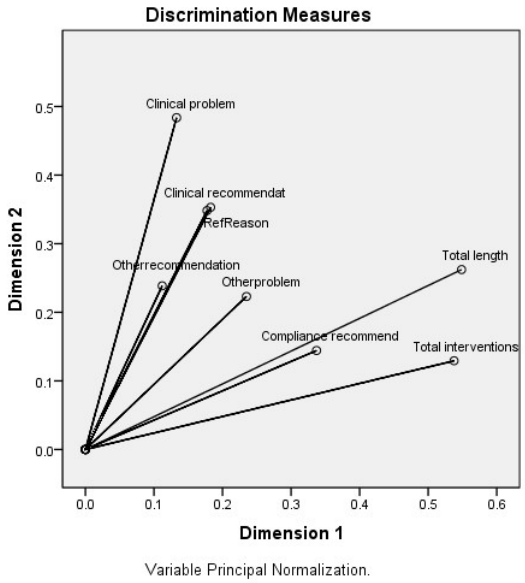


Figure 12: Discrimination plot for the second iteration of the two-dimensional model

The most discriminant measure for dimension 1 was the total length of time spent conducting the DMR. Compliance recommendations and total interventions also associated more strongly with dimension 1 than 2. The most discriminant measure for dimension 2 was the clinical problems categories. Clinical recommendations, referral reason and other recommendations also associated with dimension 2 more than dimension 1. Other problems appeared to associate equally with each dimension.

Considering the associations it is suggested that the identity of dimension 1 is interpreted as the complexity of medication therapy and dimension 2 to the complexity of the individual.

A joint plot of category points was obtained (Figure 13). Visual examination of the points revealed that certain categories associated together, suggesting they have similar characteristics. Categories plotted close to each other in 3 main collections. Safety/ disposal (other recommendation), compliance (clinical recommendation), compliance (clinical problem) and domestic (other recommendation) do not associate with other categories.

The lowest (up to 5), middle (5-10) and highest (more than 10) number of interventions were plotted close to the lowest (up to 40 minutes), middle (40-100 minutes) and highest (more than 100 minutes) visit length respectively, suggesting the categories have much in common. The shortest visits also associated with referral reason linked to the need for medication expertise, clinical problems, clinical recommendations and compliance recommendations.

Medium length reviews associated with referral reasons linked to supply and compliance. However, there was only one compliance recommendation category within this graphical area: safety/ disposal. Within this area there was one clinical problem and clinical recommendation linked to dosing/ administration. The three remaining categories were other problems (unmet health need and safety disposal) and other recommendation (involve others).

The longest reviews were not associated with any referral reason. Other problems and recommendations are the closest plotted categories. There were commonalities between a larger number of medications, a longer DMR and other issues.

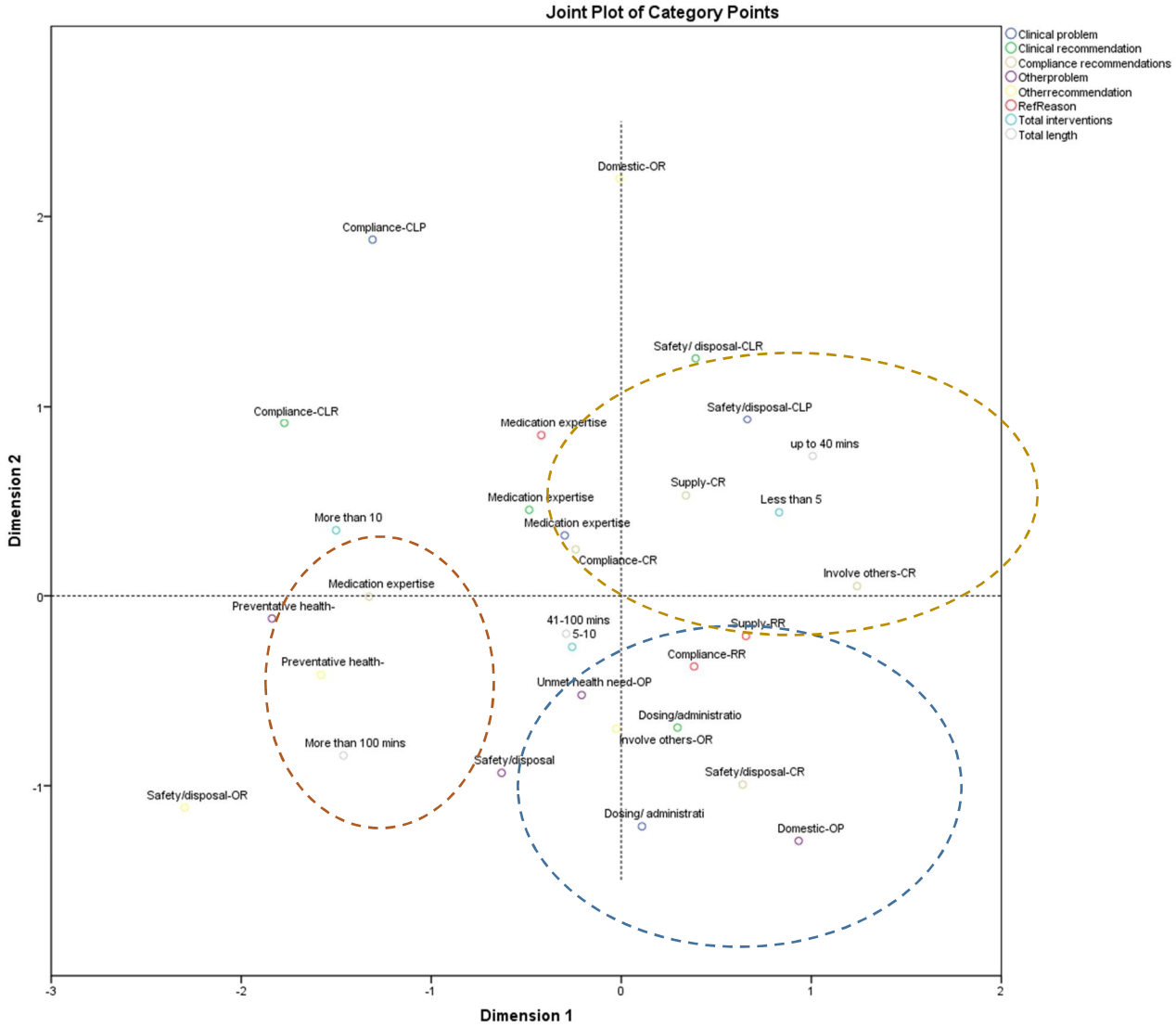


Figure 13: Joint Category of Plots for the final model

4.5.7 Cluster analysis

The cluster analysis suggested the presence of the three clusters, made up of a membership of demographic variables (Table 4-21).

Table 4-21: Cluster membership of demographic variables

Variable	Cluster 1	Cluster 2	Cluster 3
Gender	Male (n=31, 30.4%) Female (n=50, 33.6%)	Male (n=39, 38.2%) Female (n=44, 29.5%)	Male (n=32, 31.4%) Female (n=55, 36.9%)
Age*	Oldest: 79.7 years (n=81)	77.8 years (n=83)	Youngest: 74.9 years (n=87)
Number of medications*	Least meds: 8.4	10.3	Most meds: 11.8
Referral reason*	Supply (n=7, 41.2%) Compliance (n=49, 30.5%) Medication expertise (n=25, 26.6%)	Supply (n=6, 35.3%) Compliance (n=67, 47.9%) Medication expertise (n=10, 10.6%)	Supply (n=4 23.5%) Compliance (n=24, 17.1%) Medication expertise (n=59, 62.8%)

*Denotes a statistically significant result p <0.05

Males and females associated with all clusters. However, no association was statistically significant. Male participants were most likely to associate with cluster 2 (38.2%) and females with cluster 3 (36.9%).

There was a statistically significant association between age and the clusters (p= 0.03). Using mean values to discriminate data the oldest participants in the sample associated with cluster 1 and the youngest with cluster 3. Post-hoc tests suggested a statistically different age membership between cluster 1 and cluster 3 (p=0.026).

There was a statistically significant association between number of medications and the clusters (p= 0.00). Post-hoc analysis showed that cluster 1 is statistically different

to both clusters 2 (p=0.013) and 3 (p=0.00) in terms of the number of medications taken by cases and that there was no statistical difference between cluster 2 and 3.

There was a statistically significant association between referral reason and cluster association (p = 0.00). The strongest association was between cluster 3 and a referral for medication expertise; 62.8% of cases referred for this reason associating with cluster 3. Cases referred for a compliance reason most strongly associated with cluster 2 and supply with cluster 1.

There were too many variables for GP surgery (n=44) to permit an examination between of cluster associations.

There was almost a statistically significant association between aggregated postcode (n=245) and cluster membership (p=0.081). When those postcodes with less than 5 cases were removed (N22, WC1N, EC1A, N8) were removed (n=239) this became a significant association (p=0.03). Relationships between aggregated postcode and cluster membership was further examined via cross-tabs analysis (Table 4-22).

Table 4-22: Crosstabulation analysis of cluster membership and aggregated postcode

			Cluster membership			
			1	2	3	Total
	EC1R	Count	3	1	2	6
		% within Postcode	50.0%	16.7%	33.3%	100.0%
	N1	Count	25	22	34	81
		% within Postcode	30.9%	27.2%	42.0%	100.0%
	N7	Count	24	20	22	66
		% within Postcode	36.4%	30.3%	33.3%	100.0%
	N16	Count	1	4	3	8
		% within Postcode	12.5%	50.0%	37.5%	100.0%
	WC1X	Count	1	4	2	7
		% within Postcode	14.3%	57.1%	28.6%	100.0%
	N4	Count	3	4	5	12
		% within Postcode	25.0%	33.3%	41.7%	100.0%
	EC1V	Count	4	1	0	5
		% within Postcode	80.0%	20.0%	0.0%	100.0%
	N19	Count	12	13	6	31
		% within Postcode	38.7%	41.9%	19.4%	100.0%
	NW5	Count	2	6	0	8
		% within Postcode	25.0%	75.0%	0.0%	100.0%
	N5	Count	0	7	8	15
		% within Postcode	0.0%	46.7%	53.3%	100.0%
Total		Count	75	82	82	239
		% within Postcode	31.4%	34.3%	34.3%	100.0%

When observed counts and expected counts were compared there were differences detected suggesting dependency between variables and cluster membership. The biggest difference was noted for the N1 aggregated postcode; cluster 2 contained 6 fewer cases than expected and cluster 3 contained 6 more.

There were no statistically significant associations between Primary Care Network (PCN), Health and Disability decile, Income decile, Income Deprivation affecting Older People decile and the Index of Multiple Deprivation decile. However, when plots are examined there was a suggestion of patterns of associations with cluster membership, albeit with overlap i.e. no distinct variable associated with only one cluster (Figure 14, Figure 15 and Figure 16).

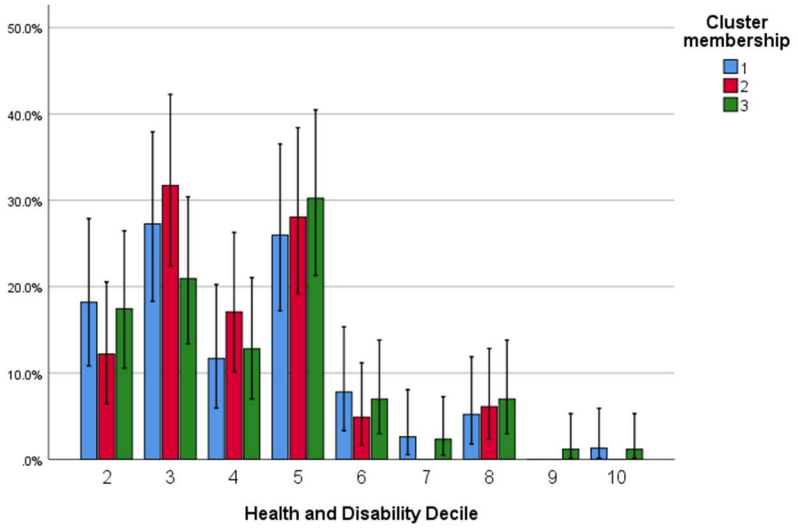


Figure 14: Plot of cluster membership for Health and Disability Decile

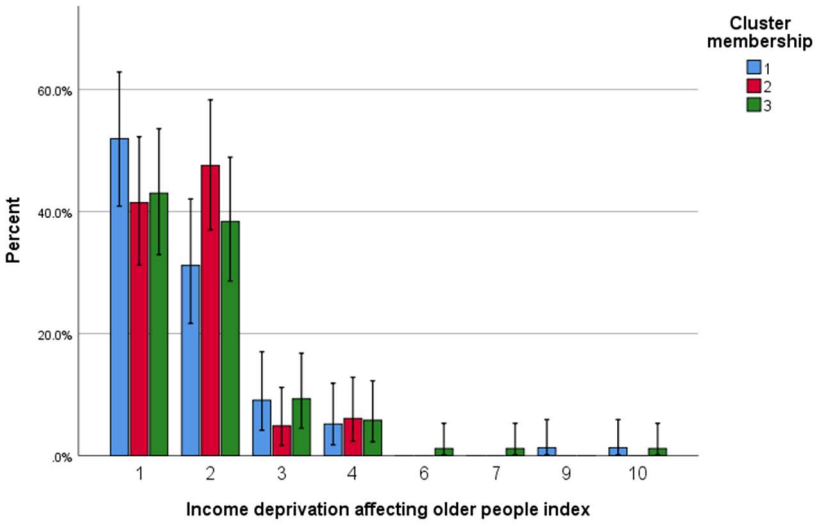


Figure 15: Plot of cluster membership for Income Deprivation Affecting Older People Index decile

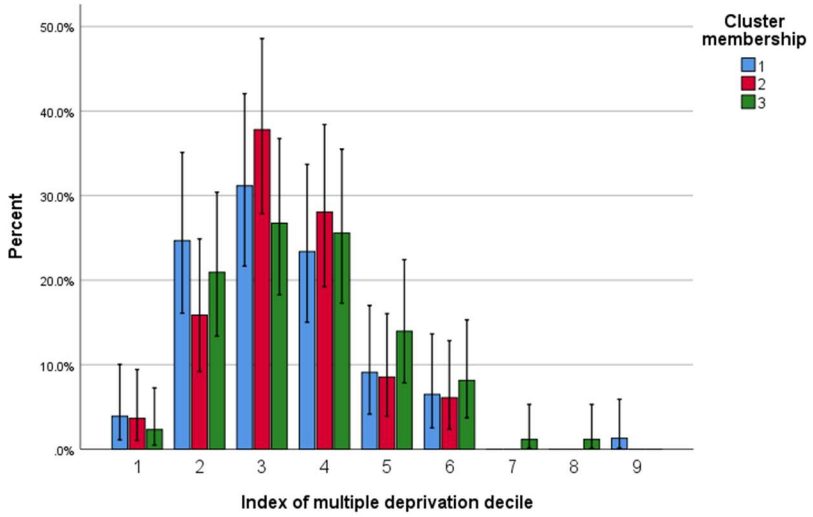


Figure 16: Plot of cluster membership for Index of multiple deprivation decile

4.6 Discussion

In this section the results of each data analysis step are discussed, then overarching conclusions are drawn.

4.6.1 Patient demographics

All available data collected during service provision of the Islington Reablement Service was included in the analysis. However, in a complex topic such as medicines optimisation in the domiciliary setting there are additional patient demographics that would have been interesting to explore within data analysis. These include, but are not limited to information on co-morbidities, the types of drugs being taken and the level of medication support a patient had in place before the DMR.

There are known links between multiple-morbidity and polypharmacy (National Institute for Clinical Excellence (NICE), 2015; Nobili et al., 2011; Valderas et al., 2009). Data linked to co-morbidity could be used to explore whether there is a relationship between overall level of co-morbidity, or the diagnoses of particular disease types, and therefore, the medication related needs of patients who receive a DMR. The data analysis described in this chapter used the number of medications as a variable. Information on the type of drugs taken and the conditions that are driving polypharmacy could help services provide targeted interventions to optimise medicines and reduce medication related risk (Gao et al., 2018)

Information on the level of medication support already in place at the time of the DMR, such as delivery or automatic re-ordering of medications, compliance aids and the presence of formal or informal carer support with taking medications would also be useful to explore. Access and compliance interventions were less common than clinical interventions in the Islington DMR study population. Understanding whether this was because these needs had already been met prior to the DMR, or whether individuals did not have these needs would provide constructive insights for service provision.

It is recognised that compliance aids such as blister packs may be overused and that they may not address the underlying medication needs of patient (Counter et al., 2017; The Royal Pharmaceutical Society, 2013). It is also recognised that informal carers who provide support with medications commonly play a role in supporting the wider medication related needs of their family member (Manias et al., 2019). Capturing information on level of medication support would enable investigation of this these phenomena in the DMR population, and whether there are any statistical relationships between the type of medication support and the wider needs of individuals.

4.6.2 Correlation analysis

Some of the relationships, and lack of relationships between variables revealed by the correlation analysis were surprising.

A small statistically significant negative correlation was noted between age and number of medicines. It is accepted that increased age is a risk factor for polypharmacy (Department of Health and Social Care, 2021; Rochon et al., 2021). Results from the Cognitive Function Studies I and II showed that the number of medications taken by older people (defined as over 65 years) in the United Kingdom had increased during the 20-year study period (1991-2011). The studies also showed that those aged 75 years and over tended to be prescribed more medications that those aged 65-74years (Gao et al., 2018). The correlation analysis indicates that as age increases the number of medicines an individual takes decrease. Although this is a small correlation. This raises the question of whether the results for the study sample go against this accepted belief.

The definition of polypharmacy varies. A recent narrative review examining polypharmacy in older adults found one hundred and forty-three definitions of polypharmacy (Pazan & Wehling, 2021). The majority of which contained a numerical

value for the number of medicines to be classified as polypharmacy e.g. more than 5 medicines. More recently it is recognised that defining polypharmacy as a number is an oversimplification and healthcare professionals should be exploring whether polypharmacy is appropriate or inappropriate (NICE, 2015; Payne & Duerden, 2015). For the data extracted from PiR it is not possible to explore the appropriateness of polypharmacy. In the context of DMRs both variables, age and number of medicines are independent i.e. the age of the participant and the number of medicines prescribed cannot be affected by the professional conducting the review. The negative correlation is an interesting finding which merits further investigation.

A lot of the published literature around DMRs discusses medication related problems as an outcome. For PiR data, number and type of interventions were taken as proxy measures for medication related problems. Age had a small statistically significant negative correlation with access interventions. No other intervention type had a statistically significant correlation with age. As most of the published literature around DMRs also seems to focus on the older population it is reasonable to assume that there would be a relationship between medication related problems (intervention variables) and increasing age. Again, the negative correlation between age and the intervention variables suggests that further investigation of the PiR data was warranted to gain a greater understanding of the relationships between variables in DMR populations.

Age had a small statistically significant correlation with the total length of time spent with an individual. This was also an unexpected finding in the context of the general population, given the belief that older adults tend to take more medications and have more medication related problems. It would be reasonable to assume that professionals would need to spend more time with older adults to conduct the DMR. However, it is a finding that follows the patterns of this data sample, as age also had a negative relationship with number and medicines and intervention types. Again, further investigation was warranted.

Number of medicines showed a positive, statistically significant, small correlation with both the number of compliance and other interventions. There was also a statistically significant medium correlation with the number of clinical interventions and the total number of interventions. This suggests that as the number of medications a person is prescribed increases so too does the tendency for compliance, other and clinical interventions during a DMR. It has been shown that polypharmacy is linked to increased prevalence of non-compliance and an increased risk of adverse drug reactions (Duerden et al., 2013). The results from the Pearson's correlation appear to reflect the literature.

The positive correlation between number of medications and the number of interventions categorised as other is interesting. Other interventions are not directly related to medications. There is a suggestion that polypharmacy and multi-morbidity (if number of medicines are considered a proxy measure) are indicators of an overall patient with complex needs who require input beyond medication expertise. If the DMR had not taken place would the non-medication related problems that individuals face have been detected? There is a suggestion that the impact of DMRs can be felt beyond medication management and that general medication related complexity is linked to other needs being unmet.

Interestingly, as no statistically significant relationship was found between number of medicines and access interventions there is a suggestion that polypharmacy is not correlated to access related problems requiring intervention. Other variables not measured or included in the analysis could be affecting individuals' access to medication. As the access interventions was the least common intervention type, sample size could also be limiting the ability to detect a correlation relationship.

Number of medicines, access interventions, compliance interventions, other interventions and total interventions all showed a positive relationship with total time spent conducting the DMR. The relationship between clinical interventions and total time spent was not statistically significant. It appears that spending more time conducting a DMR permits the identification and action planning for an increased

number of interventions. Time spent seems to be an important part of the DMR process. There is a suggestion that number of medicines could act as a proxy measure for multi-morbidity and patient complexity.

The initial exploratory correlation analysis suggested relationships amongst variables, but also revealed a lack of relationship between other variables where a relationship was expected. The analysis also suggested the sample cannot be treated as a homogenous group and that there are distinctions between groups in the sample, linked to age as well as medication and wider health needs. There is a younger sample of patients who are distinct from the sample distribution profile. This raises the question of what characteristics and attributes do this younger group have that mean they end up being recipients of a DMR service? There are also the questions as to whether the larger older participant group share other characteristics and medication related needs, or whether further investigation would reveal heterogeneity.

Correlation analysis gives an indication of whether a relationship exists between variables. There is definite interplay between multiple variables included in the correlation analysis. However, a statistically significant relationship does not necessarily represent an important relationship. Further, the results of a correlation analysis cannot demonstrate cause and effect. As the correlation analysis provided both expected and unexpected results based on the published literature further exploration of the interplay between variables for the DMR sample through regression analysis was warranted.

4.6.3 Multiple linear regression

Multiple linear regression analysis was carried out to further investigate and understand the relationships between data variables that were suggested in the correlation analysis. Two dependent variables were chosen; total number of

interventions and total time spent. Findings from both models could have implications for DMR service planning and delivery.

When trying to predict the total number of interventions; age, gender and number of visits were less important than the number of medicines and the length of a DMR visit e.g. a 50-year-old could be taking the same number of medications as an 80-year-old and this would be unlikely to affect the total number of interventions arising from a DMR for both individuals.

If interventions are considered to be a proxy measure for medication related problems this result is insightful. The causative factors behind medication related problems and health are complex. There are multiple factors that could play a part that have not been measured within this regression model. These factors are numerous and include (not exhaustively); behavioural factors, disease burden, memory and mental health status, the environment, socioeconomic status (World Health Organization, n.d.). Considering the complexities of health and the crudeness of the variables that have been input to the model being able to explain 27% of the variance is considerable.

Service providers cannot know in advance how much time it will take to resolve any problems discovered during a DMR but they may know how much time they have available to spend with an individual. Providers knowing that the number of medicines an individual takes, and an estimate of the amount of time they have available to spend with an individual conducting a DMR could predict the number of interventions an individual is likely to have, is new knowledge in this area. Although the results are taken from cases in the Islington Reablement service there is potential they could be generalisable to other DMR services if they involve individuals with similar demographics.

As discussed in the literature review (chapter 1) authors frequently use number of medication related problems and/ or related interventions to demonstrate the impact of their DMR. Understanding which cases are likely to need the most

interventions or being able to case find individuals with a higher probability of interventions will be invaluable for these DMR services. When DMR services are under high demand and there is not enough resource within services to review everyone, the model could be used as a starting point for identifying those likely to require intervention. Further, if a high number of interventions is important to a DMR service carrying out this analysis could provide a predictive model for DMR services to use resource as effectively as possible to obtain the greatest value.

The multiple determinants of health discussed earlier will also be at play when the total length of visit is the dependent variable. Considering this, having a model that explains 56% of the variance in the dependent variable is an important result. The limitations of the generalisability of the results from the first linear regression model also apply to this model. However, again, there is great potential for other services to predict how much time they may spend with an individual if their baseline demographics are similar to those seen in this data set.

The results from this model show that age has a negative relationship with the dependent variable; total length of time spent conducting DMRs. This mirrors the negative relationship highlighted in the correlation analysis. Both were unexpected results given the It is generally accepted that as age increases the disease burden and the likelihood of them experiencing polypharmacy increases (NICE, 2015; Nobili et al., 2011; Valderas et al., 2009). Over twenty years ago the National Framework for Older People (Department of Health, 2001) mandated that those over 65 years should have regular medication reviews to reduce their risk of medication related harm. The recommendation for comprehensive medications reviews in older people is still being repeated today (Department of Health and Social Care, 2021; National Institute for Clinical Excellence (NICE), 2015).

The results of the regression models for the two age distributions reinforced that there are differences between the groups which affect the DMR experience for the groups. For the up to 60 years of age group the only predictor variable that reached statistical significance for contribution to the overall model was the total number of

visits. This raises the question; what is the reason behind the younger population needing more DMR visits? It was highlighted in the results section above that the main reason for referral for the younger group was medication expertise. Additionally, from the regression model it appears that the younger DMR population have specific health needs that they would like addressed.

The younger sample has a more 'typical' relationship between age and time spent, i.e. the older someone gets (up to the age of 60) the more time is spent with them conducting the DMR. The model for the older sample (60 years and over) indicated a negative relationship between age and time spent. This finding reinforces the suggestion from the correlation analysis about that less time is spent with older participants when conducting DMRs. Previous work in the primary care setting between GPs and patients has suggested that the desire for medication related information decreases with age (Duggan & Bates, 2008b). If spending less time with older participants is interpreted as a proxy measure for the volume of information provided to participants as they age, could this phenomenon also be true for DMR services? This work was published in 2008 and data collection was completed in the two years before. In the intervening 10 years has progress been made with the older population to involve them more with their health-related decisions despite national and local drivers? This raises a hypothesis; that there is a cultural issue in the older age group whereby older people tend to have a more orthodox view of the clinician patient relationship. Rather than having in-depth joint decision-making conversations older DMR participants may defer to the knowledge and opinion of the professional. This idea will be explored further in the analysis of the interviews with individuals who have experienced a DMR.

The 60 years and over model mimics the overall model, with all predictors except gender reaching a statistically significant level of contribution to predicting the total time that will be spent conducting a DMR with this group.

The linear regression models demonstrated that there is interplay between variables associated with DMRs, that some of the independent variables can predict the total

interventions that will result from a DMR and the time taken to conduct a DMR, the latter in particular.

The MLR models also proposes that users of DMR services cannot be treated as homogenous groups. Although the regression models include crude measures and a small sample size it does suggest that there are distinct characteristics and desires amongst DMR services users which should be explored further in a bid to understand the value of these services.

Future work could test the generalisability of the results. The results of the regression modelling provide a starting point for all services to carry out service requirement modelling.

4.6.4 Multiple correspondence analysis

Although it was decided to use the two-dimensional model for analysis, the 3-dimensional model did highlight that other (non-medication related) interventions should not be an afterthought in the DMR process. It highlights that professionals conducting DMRs cannot solely focus on medications during reviews. The holistic nature of DMRs is important. The possibility of a third dimensions highlights the complexity of DMRs.

The identity of the two dimensions; complexity of the medication therapy and complexity of the individual reinforces the supposition that DMRs do not focus solely on the medications the individual is taking. Both the complexity of medication therapy and the individual can be the foci of reviews. A review of an individual's medications should be done within the context of the wider needs of the individual.

Commonalities between the number of interventions and length of DMR echo earlier correlation and multiple linear regression findings that time spent and the number of interventions are inter-linked.

The lack of association between the shortest visits and other problems and recommendations suggests that prolonged interaction between the individual and the professional conducting the review is needed to uncover the wider needs to individuals.

The association of categories of medium length visits suggest that if a referral reason for a DMR is linked to compliance, other; wider ranging issues are likely to be picked up. Perceived compliance issues could be an indicator of a more complex situation, which pharmacists conducting DMRs are attempting to tackle.

In the third group the longest reviews and the most medications taken were associated with other problems and recommendations. The skill set of the DMR professional is important in these situations; they need to be able to recognise the wider needs of the individual, not just medication related compliance and clinical issues. Currently, In professional guides on medication reviews there is no mention of the needs of an individual beyond the medications they are taking (NHS Scotland, n.d.; Royal Pharmaceutical Society, n.d.-a)

The relationships between variables highlighted by the MCA analysis demonstrated the complexity of a situation a DMR might reveal. Medication expertise and the ability to resolve compliance and clinical problems are important in a DMR. However, medication related problems cannot be the sole focus of DMRs. It is known that health and wellbeing is complex and determined by multiple factors, this should not be forgotten in the context of DMRs. The professional conducting the DMR needs to be able to acknowledge and address the wider needs of the individual as well as their medication related needs. While medication expertise is important it is also presumed in a pharmacist role. Further work in this area could explore whether DMR professionals have the equally important ability to engage individuals in conversation to address their wider needs.

4.6.5 Cluster analysis

The data suggests that trying to put individuals into groups based on their demographic data may be artificial. However, it does suggest there are certain demographic variables that are more likely to determine cluster membership than others. Age, number of medications, referral reason and aggregated GP postcode reveals something about membership of the three clusters within the data set. However, socioeconomic variables do not. It appears that socioeconomic demographics can paint a picture of the people who use DMR services but not their overarching needs. Although, socioeconomic demographics may have better predictive value in a larger sample.

Using postcode and/ or geographical location to predict health needs is not a new idea. Historically, small area analysis techniques have been used to predict population needs and allocate resources (Carr-Hill et al., 1994; Hopton et al., 1992; Twigg et al., 2000). However, it has not been done for the DMR recipient population. The development of Primary Care Networks will see the return of commissioning for local needs (NHS England, 2019b). Understanding the needs of a population based on geographical locations is an important avenue to explore. To our knowledge this is the first-time research has been carried out using demographic and socioeconomic variables in the context of DMRs.

Given the results of the cluster analysis suggest associations with demographic variables future research should explore these phenomena further, on a larger scale, to determine which demographic may be able to predict the medication relation needs of DMR users and even those who may benefit from a DMR.

4.7 Limitations

There are immediate arguments to the limits to the generalisability of the data extracted from PiR as it will be specific to the DMR sample under investigation during the study period. However, when the cumulative demographics are compared to the demographics of reablement users in 2011/2012 there are similarities; the majority of service users (83%) were over 65 years old and 58% were female (Windross, 2012). In the study data collection period the mean age of persons who received a domiciliary medication review was 77.4 years, with 86% being 65 years or older and 59% were female.

It could also be argued that sample size is a limitation. However, it represents real word data that was collected over more than 2 years. In the initial correlation analysis the sample size is less important as the aim was to uncover potential relationships between variables and direct the next statistical tests that should be done. For the other analytical tests trends and patterns were searched for, the aim was not to prove a hypothesis.

It has also been argued that for MCA relationships should not be over-interpreted as the mathematics underpinning the analysis does not permit this (Garson, 2012). This was not done in this analysis. Associations between variables were examined and links back to the 'real-world' data were drawn. It has also been argued that interpretation of MCA graphs is subjective (Garson, 2012). The impact of subjective assumptions was mitigated by looking at the data through multiple lenses, using multiple statistical techniques to try and get a true understanding of what the data is telling us.

The data analysis described in this chapter represents a more in-depth exploration of DMR data than has previously been published. However, the exploration of further patient demographics such as those outlined in the discussion may have enabled a richer understanding of the needs of DMR patients and the value the service provides. To ensure the results of any one analysis described in this thesis were not

over interpreted, the results of each were compared and contrasted before discussion in the final chapter to build a layered and triangulated understanding of where the value of DMR services might lie.

4.8 Conclusion

This study set out to gain a greater understanding the value of domiciliary medication reviews through the statistical interrogation of data. Each test had a different purpose (Figure 4) which resulted in a layered interpretation and understanding of DMR data.

From this analysis there is a suggestion that although medication expertise is important (demonstrated by the large number of interventions) individuals also have other needs that need to be addressed. These needs appear to be linked to the wider health and social needs of individuals. DMR pharmacists are already detecting and addressing these issues (evidenced by the other intervention types recorded) during the DMR process. Time spent also appears to be important, and to date there has been limited literature examining whether the benefit of time for medication reviews results in improved outcomes for patients.

Through the analysis a greater understanding of the demographics of DMR service users was also obtained. There is heterogeneity amongst DMR service users and an indication that a one size fits all approach to DMR service delivery will not work.

The analysis also set out to understand the interventions that occur during a DMR. Results showed that a variety of interventions took place, not restricted solely to the medication needs of individuals.

Finally an understanding of the relationship between demographics and individuals' needs was obtained. It appears that individuals have complex needs which necessitates a holistic and comprehensive approach from DMRs pharmacists. The

demographics of an individual, particularly age, demonstrate that the users of DMRs have differing needs. It is rare that the interventions that occur in a DMR are solely linked to the reason for referral.

The statistical interrogation described in this chapter describes a more in-depth analysis of DMR data than has previously been published. To date published papers have simply focused on presenting process measures and outcomes. The published literature has not sought to understand the relationships between variables or how data might paint a picture of where the value of DMR services lies.

Despite producing suggestions of where value might lie this statistical analysis continued with the clinical and professional-centric view point of DMR that is published in the literature. There has been no input from the individuals who use the service, so there is no assurance that the right data is being captured or that the conclusions drawn from the data demonstrate that value of services to patients.

The research question has not yet been fully answered. To fully understand the value of DMR services the views and opinions of DMR stakeholders, with a focus on the users of DMRs (patients) needs to be sought. This will be explored in chapters 6,7 and 8.

Chapter 5 Patient perspectives on the value of domiciliary medication reviews

5.1 Introduction

The previous chapter described an in-depth exploration of demographic and service level data for the domiciliary medication review service provided by the Islington Reablement team. Multiple statistical tests were applied to the data with the aim of understanding the value of the service. It was also hoped that an in-depth exploration of the data would be useful for service planning purposes. The over-arching findings of the analysis were that there are differences in the demographics of the people who use the service, problems uncovered during the review and the actions taken. The data suggests that there are complexities to service users and their wider health needs. A one size fits all approach will not work for DMR service provision. Despite the extensive data interrogation, it was felt that the value of DMRs was still not fully understood. To enrich understanding, it was decided that the research question should be evaluated using multiple methods. The next step of the research was to investigate the value of DMRs from the point of view of stakeholders. This chapter describes the investigation of an important stakeholder group - the recipients of the DMR.

5.2 Aim and objectives

The aim of this part of the study was to:

Determine the value of domiciliary medication reviews to service users (patients).

Within this aim there were four objectives:

- To determine service user expectations of DMRs
- To determine service user experience of DMRs
- To determine impact of DMRs on recipients lives
- To determine the preferred setting for medication review

5.3 Methodology

The constructivism ideal with elements of pragmatism described in Chapter 2 underpinned the methods described in this chapter.

5.3.1 Reflexivity

For this study the PhD student had to ensure they were fulfilling their role as a researcher and not taking on a DMR pharmacist role. Interviews had to be focused on the experience of DMRs, and not the underlying medication and wider needs of patients, unless this was something that a participant volunteered. Ethically it was also important to be open to outcomes outside pre-conceived expectations around the value of DMRs, specifically that patients valued DMR services. To ensure that all patients could voice any opinion, even negative opinions which could have limited the potential of DMR services time was taken to develop a topic guide with open questions. The presence of a PhD supervisor during the first interview, and the transcription of audio files as soon as possible after interview completion aided reflection on interview technique and avoided inadvertent influencing of results.

For the qualitative methods it was particularly important that the PhD student considered the influence that they could have on the research to ensure trustworthiness. Actions to address specific trustworthiness criteria (Guba & Lincoln, 1989) are highlighted in the results and discussion of this chapter.

5.4 Method

This study was sponsored by University College London (17/0784). It required ethical (18/NI/0049) and Health Research Authority (17/0784) approval. The research was given local approval by NOCLOR.

To take part in the study participants had to meet the following inclusion criteria:

- >18 years old
- Recipient of a DMR
- Capacity to consent to participate in research
- Able to understand and communicate in English or has a family member/ carer that -can translate for them

Potential research participants were identified from DMR services provided by Whittington Health. As the research was unfunded, this was a convenience decision. Participants were recruited from a geographical location that the PhD student was able to travel to. At the time of study Whittington Health had six pharmacists working across five services that provided DMRs. All services were invited to participate in the hope that this would increase the breadth of individuals and DMR experiences that would be discussed in the interviews. Pharmacists within the DMR services were asked to make an initial introduction of the research to their service users. Service providers introduced the research to potential participants who met the inclusion criteria, gave them an information leaflet and obtained their permission for their contact details to be passed to the PhD student. A target sample size of 10-15 participants, or until data saturation was reached was aimed for.

The PhD student telephoned potential participants, answered any questions they had, and if they were happy to participate in the research, arranged a convenient time for the interview. Formal consent for participation in the research was collected before the interviews began and was recorded on consent forms. Interviews were conducted using a topic guide (Appendix 5). Interviews were recorded to aid data analysis. Notes were taken during the interviews to help the PhD student probe

relevant points further and to remember the context of key points that participants raised when analysis was carried out.

A second researcher (PhD supervisor - BC) was present during the first interview to give feedback on interview technique. The check on interview technique was carried out for the confirmability criterion of trustworthiness, whereby a researcher needs to have a degree of neutrality in the research process (Guba & Lincoln, 1989). The purpose of the second researcher's presence was explained to relevant participants.

Audio files were transcribed into anonymised transcripts. Transcripts were checked against audio files to ensure transcription accuracy. The Braun and Clarke (2006) methodology for thematic analysis was followed. Analysis of data began through immersion in interview data; the PhD student read and re-read all transcripts ensuring they were familiar with the data. Each transcript was then coded. Codes were used to construct overarching themes from the data. Codes and themes were re-visited to ensure no duplication or ambiguity in meanings. Codes evolved during the analysis period. The PhD supervisor read and coded 3 transcripts independently. Codes were compared and a consensus on categorisation was reached through discussion. For all other transcripts the PhD supervisor validated the codes and themes that the PhD student had elucidated. Codes were excluded from the final analysis if they did not represent a recurring theme within the data and/ or the quotes were not a strong opinion of the participants(s). This involved re-coding of quotes to a theme or sub-theme they better fitted within. All decisions on inclusion and exclusion of codes were decided through discussion and consensus.

The PhD supervisor had an overview of the PhD work and understood DMR services, this ensured participant views had been represented correctly by the PhD student, in line with credibility criteria set out by Guba and Lincoln (1989).

After the interviews were completed service providers were asked to provide information on; the number of medications, age, number of interventions recommended, and number of interventions accepted after as result of the DMR for

each participant. This data was collected in case there was a need to check for relationships between themes from interviews and participant demographics.

5.5 Results

Quantitative (demographics) and qualitative (themes) data were derived from this study.

5.5.1 Demographics summary

12 interviews with service users and informal carers/ family members took place between April 2018 and September 2018. 11 interviews involved one service user and one interview involved two: a husband and wife (participants 010 and 011). Three interviews also had an informal carer present (participant 001, 010 and participants 011, and 012).

Post interview demographic data was returned for 10 out of the 13 participants (Table 5-1). Seven (54%) out of the 13 participants were female and six (46%) were male. For the ten participants for whom data was returned the average age was 84.4 years and the median 85.5 years. The average number of medications taken (n=9) was 14.3 and the median 14.

Table 5-1: Summary of demographics of interview participants

Participant	Age at time of interview	Gender	Medication at time of interview
001	86	Female	5
002	88	Female	11
003	87	Male	26
004	85	Female	14
005	93	Male	9
006	$$	Male	$$
007	70	Male	15
008	90	Female	12
009	73	Male	15
010	82	Male	$$
011	79	Female	22
012	$$	Female	SS
013	$$	Female	$$

$$ Denotes missing data

Data was also requested on the number of interventions the professionals made because of the DMR, and how many interventions were accepted by the GP and/ or other relevant healthcare professional (Table 5-2). Data was not returned for all participants.

Table 5-2: Summary of DMR intervention data for interview participants

Participant	No. access interventions	No. compliance interventions	No. clinical interventions	No. other interventions	Total no. interventions
001	1	3	3	3	10
002	3	3	4	6	16
003	0	2	5	7	14
004	1	1	2	1	5
005	$$	1	1	1	3
006	$$	$$	$$	$$	$$
007	0	0	4	3	7
008	5	2	2	$$	9
009	$$	4	4	1	9
010	$$	1	3	1	5
011	1	4	20	4	29
012	$$	$$	$$	$$	$$
013	$$	$$	$$	$$	$$
Total	11	21	48	27	107

*$$ denotes missing data

Abbreviations: No. = Number

The number of interventions related to an individual ranged from five to twenty nine, and the number known to have been accepted from three to twenty seven (Table 5-3).

Table 5-3: Summary of total number of DMR interventions and number accepted

Participant	Total no. interventions	No. interventions accepted
001	10	5
002	16	12
003	14	$$
004	5	5
005	3	3
006	$$	$$
007	7	3
008	9	8
009	9	8
010	5	4
011	29	27
012	$$	$$
013	$$	$$
Total	107	75

$$ Denotes missing data

Abbreviations: No. = Number

5.5.2 Coding summary

Analysis of the semi-structured interviews revealed five key themes (Figure 17). Themes were constructed from sub-theme codes. Illustrative quotes are used to demonstrate the themes and sub-themes within transcripts.

Sub-themes are presented within the theme they most fitted. However, there was also links between themes and sub-themes. Links are highlighted by a dashed two-way arrow.

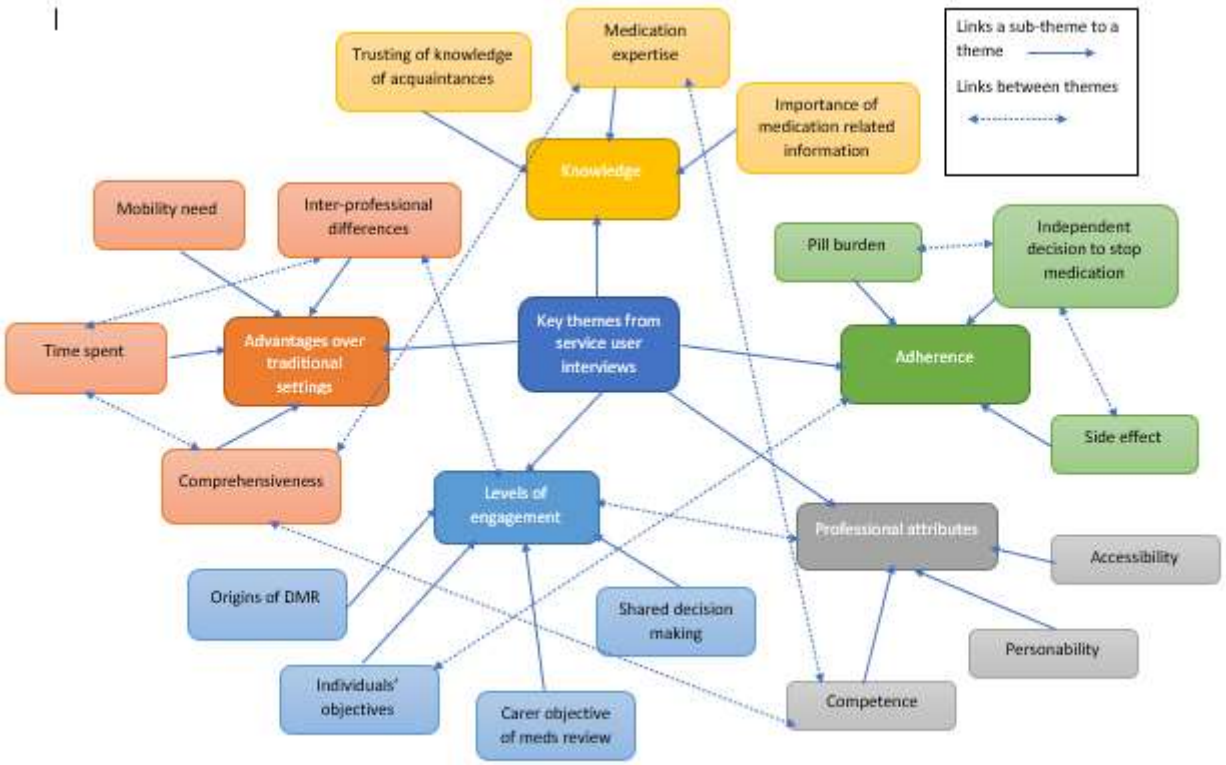


Figure 17: Summary of themes and sub-themes from patient interviews

5.5.3 Theme 1: Advantages over traditional settings

Participants were asked their opinion on the domiciliary setting to explore whether it presented any benefits or drawbacks over traditional healthcare settings.

A positive Impact was felt in four key areas; the avoidance of encountering mobility issues, the amount of time the DMR professional spent with participants, the comprehensiveness of reviews and the differences in experience between the DMR and more traditional healthcare professional and patient interactions. No interviewee expressed a negative opinion of participating in a domiciliary medication review.

5.5.3.1 Mobility need

A recurring sub-theme across the interviews was that a domiciliary medication review was felt to be positive because it avoided the need for interviewees to travel to a traditional care setting, such as a GP surgery. Mobility issues caused a physical barrier to accessing traditional healthcare settings, which were not encountered if a professional visited an interviewee in their home.

> *He told me it was a new thing, for the GP surgery, which is very good, I think, because you don't have to go through the GP. That's good, because it always takes a long time. it takes me... it's difficult for me to get down to the surgery now [participant 004)*

> *No I prefer it… I don't like travelling over [participant 005]*

> *I think for them, because in terms of mobility, both of them, things are different, it works out really well. [Carer for participants 010 and 011]*

No. She would rather they come so she doesn't have the hassle of going out [carer of participant 012]

If I go to the surgery, I have to walk up that hill and wait there for a while. [participant 013]

5.5.3.2 Time spent

Many interviewees recognised that the domiciliary setting enabled the professional to spend more time with them. On occasion this was presented in contrast to the time spent with other healthcare professionals. Spending more time with a DMR professional meant participants felt listened to, and their issues were resolved, which corresponded to satisfaction with the service.

I was glad to spend quite some time going through it all. I haven't had a problem with professionals coming in [participant 003]

And [Name of service] I was impressed, very very impressed. I felt they were giving me their time, I felt they were listening to me. When I go to places like [GP practice], I'm just a number that they've got to click off in ten minutes… [participant 007]

Is you go to the doctors, you have got 10 to 15 mins, they ain't going to give you an hour, they ain't going to sit there for an hour to talk, they are going to give you 10 to 15minutes, as less as they can…

[Pharmacist name] has sorted it out. She was here for 1hr and a half sorting it out. She wasn't going to come in here for 2-3 minutes. She was here for 1hr and a half, 2hrs and she sorted it all out. [participant 009]

5.5.3.3 Comprehensiveness

The thoroughness and comprehensive nature of the DMR was highlighted on multiple occasions. The comprehensiveness of reviews was also linked to time spent (5.5.3.2) The strongest recognition of the comprehensiveness came from informal carers. For the informal carer of participant 001, the feeling of comprehensiveness was linked to the actions of the whole service the DMR pharmacist worked within.

> *We've been dealing with the (names service) looking at what we can do in terms of peripatetic support, in terms of mum's healthcare but also in terms of mum's medication as well and so it was (doctors name) who first came round and worked with mum's GP at the end of the road. Together they have been putting in some medication care plans for mum going forward [Informal carer of 001]*

> *I think it's a good idea quite frankly because the thing is you can see perhaps what is wrong. I mean if you didn't come here and somehow we'd forgotten to tell you we had stairs. I can't use them so... [participant 001]*

For the informal carer of 010 and 011 the comprehensiveness came from the individual pharmacist.

> *And looked at each… [participant went off to retrieve medications] This was much much fuller than what is was, the box. Looked at each one, each medication mum was on, how long, if it's helpful or not, any benefits and just kind of real thorough discussion about each one of them and if mum had noticed any possible side effects that she thought she might be experiencing from each one of them. [informal carer of participants 010 and 011]*

For the informal carer of participant 012 the comprehensiveness was illustrated by the pharmacist looking into a non-medication related need of the participant.

She recommended somebody, she'll said she'll look into it, I don't know it was someone in particular, it was to do with mum's bath rails. We ended up buying them, but they put mum on the waiting list but it takes ages and ages. And she needs things done in the toilet and the bathroom. So I asked her, she said I don't know she'll look into it to see if there's somebody who can come to fix it, a handyman or something like that [Informal carer of 012]

For some participants the comprehensiveness was demonstrated through the review of every medication they were taking. The comprehensiveness demonstrated was linked to the medication expertise (5.5.7.2) that DMR pharmacists displayed and their overall competence (5.5.4.2).

I was worried I was taking too many; I was worried that some of the tablets might be clashing. I've got so many things wrong. I've got about 14 different conditions. And I wanted to know if the pills were right and I wanted a review. Cos what happens is piecemeal, and I don't blame the doctor, they treat you for each different situation. Without reviewing the whole picture. It's holistic and they don't do it as such. [participant 007]

She went through systematically each one and she said right we can cut that in half, we can do this and we can do that (-) she changed them [participant 009]

5.5.3.4 Inter-professional differences

Throughout the interviews the experience of a DMR was presented in contrast to participants' previous experiences and interactions with other health care professionals. Participants expressed frustration at not being able to contact a General Practitioner (GP).

Mind you I'm naughty (reads label) do not stop taking without talking to your doctor but the thing is you can never get an appointment with your doctor to talk to them about it (-) I don't take things willy nilly [participant 002]

it's always me that's got to do all the phoning, they never do the phoning, phone here phone there, phone everywhere. I say ain't that your job, they said no, it's your job. If I didn't have a phone, they'd have to phone. It makes you mad sometimes, when they could help you in some way, can't you phone them for a change, no no we're not allowed to, you've got to do that [participant 008]

When they do access a GP, appointments are time limited, participants can feel they are not listened to, and that a standard response is to prescribe another medication.

But, what it is, you walk in, I walk in to the doctors right, what is the first thing they do? You tell me what they do first. Now I come in, I've already told them exactly what's the matter with me, I'm being sick, or whatever and then they ask me what I want. And then it's 4 or 5 minutes on the computer looking back three hundred years ago what happened to me when I fell over… you know…by the time they do all that, they go oh, we'll give you another two more pills. Because you know, you're going to yourself, 5 minutes, you've only got 5 minutes to sort out what it is, and you might as well have not come. But they don't understand that. They're not doing that. They give you a treatment, here you are, now p--- off, and shut the door on the way out. And what happens is, you feel like getting the pills that they give you and throwing them into the bin, because you don't know if they work they just giving it and bunging it on to you [participant 009]

She was just being given more and more stuff so things were being added without kind of (-) and I guess they don't have the time it's just a case of right you're in pain, here you go and GPs don't either and they wouldn't have necessarily (-)I think one thing I realised is they're, I guess they don't have, either the skills or the knowledge. [carer of participant 010 and 011]

There are several examples within the transcripts of professionals 'imposing' interventions on participants without discussion. An example included the initiation of blister packs, which resulted in confusion for the interviewee.

I was alright with my boxes. They decided to give me this [gestures to blister pack]. I think they thought occasionally I was forgetting. That's what they thought but I wasn't. When they did come with them they came with three of these. This is the last. One of them had already been started on as I thought because I didn't understand it but if they had explained in the first place that these were never filled up [gesturing to empty slots within blister pack] Course I didn't look to release one was lunchtime and teatime and I thought maybe they had forgotten to put them in
[Participant 002]

..for 15 years I've been taking stuff out of boxes, and all of a sudden, they come up with a flat pack and it doesn't mean a thing to me [Participant 003]

There were also examples of medication changes that were not explained by healthcare professionals to patients, which also caused confusion.

I've been having quite a few falls, and I went into [hospital name]. They didn't say a word, they just changed, I knew course. I was up queer street as they say. I hadn't got a clue what I was taking. [Participant 003]

…what you'd find was the next blister pack would come and they'd be two different ones in there. [Participant 009]

Other examples of lack of communication involved community pharmacists, linked to the stopping or starting of medications.

Yes but it was still in the blister pack, 6 weeks later [Participant 009] (referring to a medication that the participant had decided to stop)

Then they removed it for a while and then it was reintroduced. she's not taking it. [Informal carer of participant 012]

5.5.4 Theme 2: Attributes of the professional

Three main areas linked to the professional's attributes were highlighted and discussed repeatedly during the interviews: the personability of the DMR professional, their professional competence, and their accessibility.

5.5.4.1 Personability

Several participants reported how "nice" the professional carrying out the DMR was. Or they recalled interactions with other professionals who they thought were nice. The niceness of a professional seemed to resonate more than knowledge or capability.

They were nice people [participant 001]

She's very nice (pharmacist's name) very nice. [participant 002]

I was glad to see him. He's a nice boy [participant 005]

she's a nice girl, I got on well with her, very nice person [participant 008]

…it's a bit of company actually. At least I'm talking to someone and not looking at the floorboards all the time. I don't get a lot of visitors. [Participant 008]

And they all seem to be very nice people at the [hospital name], like yourself, and [Pharmacist name] [participant 009]

5.5.4.2 Competence

The perceived competence or professional expertise of the DMR professional was highlighted by two out of the three informal carers who participated in the interviews and two out of the 13 service users.

(Name of service) have been brilliant, absolutely brilliant and please if you can be doing more of that that would be really really good [Carer of participant 001]

He was very good, he looked through everything I got, chucked out a lot of it. and said you need this this and that… he's very good [participant 004]

Well a review, well certainly a tablet review, she did it so much better than anyone else had one [participant 007]

She was amazing, in every sense. Very supportive, very professional, knew her stuff back to front, I've never known a professional know so much about medication, and kind of really really thinking about. If we put this recipe together, is it

going to work, is it not going to work [carer of participants 010 and 011]

5.5.4.3 Accessibility

The opportunity to have a conversation with a health care professional was repeatedly highlighted. Service users felt heard and felt they could express their opinion. This accessibility was occasionally presented in contrast to other professional encounters.

Yes I could speak to (pharmacist name) normal like I am speaking to you. Some people are not like that. [participant 002]

Well when you're round there you are one of many. When they come to your home it's you [participant 002]

No. No one. The impression I got from [Pharmacist name] Even if I saw a different doctor or something like that, they always wanted to shove more tablets inside me. [Pharmacist name] didn't... [participant 003]

I've been phoning him since, he's very very good [participant 004]

She spoke to me on the phone, asking how was it going about the Gabapentin and stuff. I think that was about it really. I feel that I can always call her though that's the nice thing [Participant 007]

You know some people, you can talk to, and you can talk all day to and some people you can look at (-) doctors, you know how they are and they've got this air about them and you don't feel comfortable, all you want to do is get up and get out. Well, [Pharmacist name] you can sit and talk to for a week. [participant 009]

Yes, she was brilliant. And then kind of each visit she was here emailed me, this is what we discussed, this is what we agreed, here is the plan, sent a copy to the GP. We were kept in the loop [daughter of participant 010 and 011]

5.5.5 Theme 3: Compliance

There were two issues that affected medication compliance in the interview participants: the pill burden and side effects.

5.5.5.1 Pill burden

Pill burden was mentioned in several interviews, usually in a negative context, and linked to non-compliance because of the number of medications participants were prescribed. Only one interviewee [008] mentioned the number of medications they take in a neutral way stating: *'I just take them automatically'.*

Yes you then realise what others have to do [take medications everyday]. It can get you down I mean this did get me down at first but I've got used to it. [participant 002]

I now have the. I don't know what they're called. I have quite a lot of them. I take the cancer tablets, I take the COPD, orange ones, I don't know what they are, I also have high blood pressure, so I take irbesartan. and pain killers. Always drugged at the moment. [Participant 004]

The pills that (-) they kept just giving me more. Instead of saying oh look, we'll cut this one day to say 10% instead of 20%. But all they kept doing was giving me another two, or another one. And then they gave me another two boxes on top [Participant 009]

And also, we're talking about the tablets as well, being many because mum doesn't take her afternoon medication, the evening ones; she said she's not taking them. She takes the morning medication [Informal carer of participant 012]

A few? There's a lot. I feel sorry for her as well, I understand when she says there's too much, there's too much. [Informal carer of participant 012]

5.5.5.2 Side effects

Side effects are a frequent reason why participants were not taking their medications. Reasons included constipation, how they made the person feel e.g., not themselves or not in control, excessive sleepiness, weight gain and gastrointestinal problems.

They say 'Are you in pain?' and you wake up in the morning and say 'not only am I in pain I feel like I have gone crackers overnight. I can't focus properly'. That's why I said I would go on paracetamol for pain only [participant 001]

The mirtazapine I don't take anymore. It's an antidepressant and it was alright to get me to sleep at night I suppose but I was falling asleep of a day. I didn't want to fall asleep in the day time so I stopped it and I take a glass of hot milk instead [Participant 002]

The other trouble with Gabapentin is one of the side effects is put on weight. And I had got my weight really down, and suddenly without knowing it, I was 3-4 kgs heavier again. It was very frustrating. [Participant 007]

So for night-time I'd get up, go to the toilet and I'd be in the toilet for 2-3 hours. We didn't know what it was, obviously. But we worked it out it was, I'd said to her; just let me have one of the Metformins. And then I had that for a couple of days and it never happened and then we threw one away. But we told them, we didn't just throw it away [Participant 009]

5.5.5.3 Independent decision to stop taking medication

Within the interviews there were examples of participants deciding not to take a medication they had been prescribed as they felt they did not need the medication, or they reported they did not have the condition the medication was prescribed to treat. There were links between both pill burden and side effects which contributed to individual decisions to stop taking a medication.

Yes they stopped that and I have the ranitidine now which is alright be me and they described it. It's a yellow round one but sometimes I don't take that. Let me see where I am. That [gestures to pill] not always. Now this morning I took the lot but sometimes I think I haven't got my reflux or anything so to keep taking pills that you don't have reason for so I don't take it. I leave it. sometimes. I mean I don't. I do use common sense about it. [Participant 002]

And I don't take tramadol. And of course, the chemist sees me subscribing and subscribing, no, prescribing, and me medication was getting out of hand, all the quantities. [Participant 003]

But you tend to use these things blindly, I didn't take most of them religiously [Participant 006]

I had a fall they gave me some morphine but I didn't take them, I just stuck to my paracetamols. [Participant 008]

I never used it [inhaler] so I'll have to take it back. [Participant 013]

5.5.6 Theme 4: Levels of engagement

Throughout the interviews there were differences in how DMRs came about and how involved participants and/ or carers wanted to be with the DMR process. There were links between inter-professional differences (5.5.3.4) and the level of engagement in a DMR. Examples of previous breakdowns in communication between the participant and other professionals were highlighted which contrasted to the DMR. In addition, professional attributes (5.5.4) also contributed to levels of engagements in a DMR.

5.5.6.1 Origins of DMR

11 out of 13 participants did not request their DMR. Of the DMRs that were requested, the first was by the participant's (009) wife because of worries about polypharmacy. The second was opportunistic; the participant (011) requested the review while the DMR pharmacist was in his home to review his wife's (010) medications. When the remaining 11 participants were made aware of the DMR, five participants (001, 002, 004, 005 and 008) reported that they did not then have any issues to raise while six participants reported that they did have something to raise.

No. No. No. I was alright with my boxes. They decided to give me this [gestures to blister pack]. I think they thought occasionally I was forgetting. That's what they thought but I wasn't. [Participant 002]

5.5.6.2 Individual objectives

Although most reviews were not requested by individuals six participants wanted to discuss a medication related issue when they became aware of the DMR; participant 003 wanted the excess medications in their home to be removed.

> *You know, I was happy for her to come, and I said there is medication here, which you know, I would like taken away, if you could take it away.*

Participant 006 and 007 both wanted to know whether their medications were beneficial. Participant 007 did not request the DMR but they did actively approach their GP to discuss their medication related worries. The GP then arranged the DMR.

> *I was worried I was taking too many; I was worried that some of the tablets might be clashing. I've got so many things wrong, I've got about 14 different conditions. And I wanted to know if the pills were right and I wanted a review. [Participant 007]*

Participant 010 wanted a medication review before treatment options from a memory clinic were considered. Participant 012 wanted a general review and participant 013 wanted a bigger tablet box and to discuss one of her inhalers.

In one instance the individual did not engage with the DMR process because she was prioritising the needs of her husband, she did not recognise that she might gave medication related needs.

I suppose I was more interested in what was playing out for my husband…It wasn't really worrying me. I was taking medication and getting around and looking after my husband. It wasn't really a priority thing at the time and so I didn't think too much about it [participant 001]

5.5.6.3 Carer objectives

The informal carers of participants wanted general reviews of their parents' medication, so that they could be assured what their parents were being asked to take was appropriate. They also wanted to increase their understanding around medication indications. Medication related information (5.5.7.3) was important to informal carers.

It was just making sure that the interplay of the medication that she was having. You know, she wasn't taking one thing to the detriment of something else. That was another really important reason for having that reviewed. [Informal carer of participant 001]

She started with the questions and then she looked at the pack and every one of them and what they were for. Because that's what we really wanted, clarity. [Informal carer of participant 012]

5.5.6.4 Shared decision making

When DMRs took place there were examples of participants wanting to be involved in the decisions around their medications:

They cut it in half. I suggested that. See sometimes you can suggest it [participant 002]

But we cut them down. I said listen, I can't not go without them. But I don't need one in the morning and one at night. I

only need one. That's what we were trying to do [participant 009]

I'm speaking on their behalf because they've spoken about it, to come in, really listen, to really unpick what they're on, how long, why, just (to) really really have a thorough understanding of their needs and what's working and what's not and how can we make it better. And really review. And asking them [carer of participants 010 and 011

5.5.7 Theme 5: knowledge

Knowledge is a key theme from the interviews, particularly who provides the knowledge. Interviewees accepted knowledge from professionals and acquaintances. No individual presented themselves as the definitive source of knowledge. Once medication related knowledge was acquired, it was of importance to the individual.

5.5.7.1 Trusting of the knowledge of acquaintances

Participant 001 took the advice of an acquaintance and stopped taking a medication because of a potential side effect. She chose to remain in pain rather than following the advice of a healthcare professional.

The only thing I found out about today or yesterday rather that someone else who has had a similar sort of thing, is that codeine give you constipation…. It just that she (visitor) said I've noticed it since taking them and I thought oh that's funny. I've felt like that for. I don't know. A week I suppose I have been taking them

5.5.7.2 Medication expertise

Throughout the interviews there were examples of participants taking on the advice and information provided the DMR pharmacist:

> *There was a conversation about the importance of actually taking paracetamol and codeine together to have effective pain relief [carer of participant 001]*
>
> *We also spoke about not taking too much codeine and the initial dose was limited to 15mg and two paracetamols because of the possible effects of codeine leading to falls as well. [informal carer of participant 001]*
>
> *She discussed how this you know tells you the description of the pills [participant 002]*
>
> *I think there was a query I had, and I phoned, and he phoned me back, answered the query. Sorted [participant 005]*

In one of the interviews a participant recalled their GP stating they were not a medication expert, suggesting that not every professional can provide medication expertise.

> *Well my doctor really. And I've got a lot of time for him. And he said "look [interviewee name], I'm not qualified to do this, I'm a GP, not an expert on tablets. You're probably right but I don't know which ones might clash and which ones are wrong. And yes, I do do it piecemeal but that's the only way I can do it". [participant 007]*

5.5.7.3 Importance of medication related information

When medication information was given to participants by the DMR pharmacist there were references to it making a difference to the individual or resulting in a change of medication taking behaviours. There were also suggestions that without this information and awareness it would have resulted in non-compliance.

The candesartan didn't have a description and also one to be taken each day which I didn't really grasp I thought it was the same as the bisoprolol one morning and one night but instead of that it's just each day and I take it at breakfast time. [participant 002]

Until this came [refers to medication reminder chart], I hadn't got a clue [participant 003]

5.6 Discussion

The implications from the five key themes are discussed in the following section. Each theme is discussed in turn in line with thematic analysis methods (Braun & Clarke, 2006). Finally, conclusions are drawn linked to the objectives of the study, based on the inter-related themes and sub-themes.

5.6.1 Demographics

The interview sample is older (mean age 84.4 years vs 77.4 years) and takes more medications (mean 14.3 meds vs 10.2 meds) than the sample that underwent statistical interrogation in section 5. For this interview cohort clinical interventions were the most common intervention type. This supports the literature review findings that focus on clinical problems by DMR professionals (McCormick et al., 2020). Other interventions were the second most common intervention type, highlighting that medication related problems do not exist in isolation.

It was hoped that collecting post interview metrics would permit investigation of trends between outcomes of the DMR. However, it is difficult to draw conclusions from quantitative data returned for this small sample size. It is also difficult to do this because of the complexity and variety themes that emerged from the interviews.

5.6.2 Theme 1: Advantages over traditional settings

Removing the need to travel to a traditional care setting was a strong positive for participants for whom leaving the house is a challenge. Professionals visiting a person in their home removes obstacles to receiving a service. Providing services in the domiciliary environment is in line with the Five Year Forward View; bringing care closer to home (NHS England et al., 2014). The value of a DMR is partially recognised in its convenience.

The domiciliary setting permitted in-depth conversations between the participants and healthcare professional which lasted longer than other interactions in traditional settings. Individuals valued being the focus of the professional without time constraints. They felt heard and important.

Being an informal carer can put an enormous amount of psychological strain on the carer, and they can feel they are operating without support (Chipchase et al., 2001; Donnelly et al., 2008). A comprehensive DMR removed confusion and stress around appropriateness of medication therapies. The ability to pick up on and help resolve non-medication related issues was appreciated. Valuing a systematic and comprehensive approach was also echoed by participants who were unsure why they were taking medications.

Inter-professional differences were highlighted in the context of lack of time, particularly for GPs. Participants did not feel listened to and time constraints meant their problems could not be unpicked. Descriptions of these interactions left individuals feeling frustrated and undervalued. It is widely known that GP services are under strain and the feeling of frustration is echoed by GPs themselves as they worry about the quality of care they can provide (Fischer et al., 2020). If an in-depth consultation around medications, which requires time, can be carried out by a professional with expertise in the area this could avoid negative patient-professional interactions, which could have an adverse effect on the likely success of future patient-professional interactions. Inter-professional differences were also

highlighted through descriptions of blister packs being imposed on a participant when they did not feel they needed one. Inappropriate blister pack use has been highlighted as problematic by the Royal Pharmaceutical Society (RPS) (2013). Blister packs have been recommended and by a range of professionals as a one size fits all approach to compliance which does not address the underlying issues. Memories of decisions that participants did not agree with or consent to, that were imposed on them, stayed with the participants. These experiences are presented in contrast to the DMR encounters, where there is an attempt to involve individuals in decision making processes and are generally view positively by participants.

5.6.3 Theme 2: Professional attributes

The personability of the DMR professional was valued by participants, more than their perceived professional competence. The personability of a professional, particularly their 'niceness' is not an attribute that is commonly highlighted as being key to a DMRs success. The authors of the HOMER trial (Holland et al., 2006) looked at the attributes of the pharmacists conducting DMRs to see if this made a difference to outcomes, but the focus was on professional attributes and experience level not the 'softer' attributes that interviewees highlighted as important. Service managers should be looking for professionals that can strike a rapport with individuals, and be examining ways to skill professionals, enabling them to engage individuals in conversations about their medications and wider needs. The personability of the professional correlated to individuals feeling the professional was accessible, either during their conversations or physically contactable. Giving participants a way to raise further questions was appreciated.

The perceived competence of the professional was mostly valued by the informal carers. This linked to the discussion points around comprehensiveness of DMRs in section 5.6.2.

5.6.4 Theme 3: Compliance

Medication compliance is a widely discussed topic. Pill burden and side effects are known reasons that individuals become fatigued with taking their medications (Pasina et al., 2014). DMR interventions that address pill burden and medication related side effects are important to individuals, and therefore the value they see in the DMR service.

If an individual has taken an independent decision to stop a medication, the DMR presents an opportunity to discuss this decision. Without the DMR the non-compliance may not have been picked up another professional. DMRs also overcome the barriers individuals face when they want to discuss their concerns; access to the relevant healthcare professional and lack of time allocated to consultations when they do access one.

Not every interviewee expressed discontent over their pill burden. Of note participant 11 was taking the most medications at the time of the interviews but they did not mention their feelings around pill burden during the interview. In this instance it could be because the informal carer did most of the talking during the interview, or it could be because for participant 11 other issues are of more importance. Given the known effects on wellbeing that pill burden could cause this is a topic that all professionals should try to probe into during a DMR. Then, based on the individual's response decide whether this is something that needs addressed.

5.6.5 Theme 4: Levels of engagement

Most of the participants did not request a DMR; it was suggested by a healthcare professional. There appears to be a mismatch between the patient centeredness claim of DMRs, and professionals rather than the individuals taking the decision that a medication review is needed. Despite not requesting the review no participants described themselves as unhappy that the DMR took place. DMR professionals

should be trained in ensuring they are having two-way conversations with individuals. They should explain their intentions fully and be able to detect when a person does not consent to the DMR or agree with the intervention being proposed and respond appropriately.

The interviews revealed instances of individuals wanting to be involved with decisions about their medications. However, there were no examples described of true shared decision making. Shared decision making is a national priority (NHS England et al., 2014), but it may not be a priority for the individual. Previous work examining the information needs of hospital patients proposed that 'a desire for information is not the same as shared decision making' (Duggan & Bates, 2008a). A systematic review conducted by Willeboardse et al. (2014) concluded that research evidence of health care professional and patient interactions rarely go beyond information exchange. If this is a phenomenon that is also observed within DMRs, there needs to be an examination of why. Shared decision making did not come across as a strong desire for participants so what is its role within DMRs? Should professionals conducting DMRs ascertain how much individuals would like to be involved in decisions linked to their medication and health? Do they have the skills to have these conversations?

The burden of having worries for others and/or other priorities correlated to less participation in DMRs by interviewees. To build trust and rapport professionals will need to be able to acknowledge and empathise with the wide-ranging worries of DMR recipients. Informal carers expressed a desire to understand the medication their relatives were being asked to take and looked for reassurance that the medications were appropriate. The objectives of the informal carers were more aligned to the traditional skill sets of pharmacists i.e. providers of medication expertise. Given the on-occasion mismatch between individual and informal carers objectives there appears to be value in ensuring informal carers are part of the DMR process. Particularly when individuals appear to have abdicated responsibility for their health decisions to informal carers.

5.6.6 Theme 5: Knowledge

Patients can obtain knowledge from a range of professional and supplemental sources (Cutilli, 2009). In this DMR cohort there were examples of the DMR pharmacist providing information to the individual having an impact on medication taking behaviours. There is a suggestion that the provision of medication information had an impact and therefore added value. The one example of a GP presenting themselves as not an expert in medications raises and interesting discussion point around which professionals should be conducting in-depth, complex medication reviews.

One of the participants trusted the knowledge of an acquaintance enough to alter their medication taking behaviour without consulting a professional. Having an awareness of the sources of information DMR participants use could help DMR professionals think about how they structure and approach reviews. They need to have the skills to assess the validity of the information that individuals have taken on, and perhaps challenge it while maintaining trust so that the individual recognises and accepts their expertise.

5.7 Limitations

A potential limitation of the study was the small sample size. However, in qualitative thematic analysis a large sample size is not a pre-requisite for reliable data (Bowling, 2014). Interviews were continued until it was felt data saturation was reached to ensure a breadth of feedback.

It has also been argued that projection; when researchers can force their views or theories on a topic into their interpretations of the data, is a limitation of thematic analysis (Boyatzis, 1998). This was minimised by having codes with explicit definitions and a second researcher independently reviewing the sections of data allocated to a code. Any disagreements were discussed and settled by consensus. Although, the

PhD candidate had worked as a domiciliary pharmacist previously, this was viewed as a strength. Their professional experience meant they understood the context of the discussion. This allowed presentation of nuanced results which may not have been understood by a researcher with less direct experience. The PhD student was not working as a DMR pharmacist at the time of this research and was not directly involved in the care of any of the participants, and so had no professional pressure to influence the results of the interviews and present the value of DMRs in a particular way.

Another potential limitation is selection bias. Participants were initially recruited by the pharmacist who conducted the DMR. There is potential that they selected patients who they felt would report favourable outcomes from the DMRs. This was countered by asking a range of questions to capture views on multiple aspects of the DMR.

There is also potential that a recall bias affected the interviews. Although, interviews had quite a broad focus there were some questions which asked participants to recall what happened during their review. If a prolonged period had elapsed recall bias could come into play. To reduce this effect, service providers were asked to refer participants for research that they had recently received a DMR.

The final potential limitation is that the participants all lived within two boroughs in north central London which could limit the generalisability of the results. Using sample size as an assessment of generalisability is a quantitative critique which has leaked into assessment of qualitative methods, the appropriateness of which is widely debated (Leung, 2015). For this exploratory research, generalisability was not a goal, the limitation should not be applied to this work. Health beliefs and behaviours may vary across geographical locations. Simple demographics were captured which may enable readers to map parallels to their local populations.

5.8 Conclusion

The study examined the expectations for DMRs and found that in general recipients did not have any at the outset. They did not request the DMR but were happy for it take place. On further probing individuals did have issues that they wanted the DMR professional to explore. Recurring hopes were that pill burden could be reduced and/ or their independent decision to stop a medication would be heard. Carers in contrast did have expectations of the DMR. They wanted to know that the medications their relative was taking were safe and appropriate.

The experience of the DMR was a positive one for those involved. Individuals enjoyed the interaction and connection with a health care professional. Carers also enjoyed the experience but tended to see it more as an exchange of professional expertise.

The impact of the DMR for individuals was that they felt heard and listened to. Carers felt reassured that someone had taken the time to review the individual medication needs of their relative.

The domiciliary setting was clearly preferred to traditional healthcare settings. At times this was due to mobility issues but for the majority it was because they were afforded more time with the DMR professional which meant they felt listened to, and comprehensive and holistic reviews ensued. Time spent was key to the value of DMRs, in the opinion of participants.

This is the first study exploring the value of DMRs by conducting in-depth interviews with service users. This study adds to the understanding of what participants value from DMRs, and the perceived benefits of DMRs. It provides suggestions of enhanced skills DMR practitioners should have for effective consultations. It also suggests a mismatch between the published literature which focuses on clinical outcomes and the more intangible outcomes that DMR participants value; time with a healthcare professional and feeling that they are being listened to. Instead of the traditional

outcomes chosen in the published literature it suggests that the value of DMRs should be measured through the time spent and which individual-identified goals have been met. For some it may be appropriate to focus on pill burden. Given the focus on the personability of the DMR professional and the impression that the DMR interaction was appreciated, measuring whether individuals felt they were able to input into the DMR interaction could be more useful than traditional satisfaction measures.

The work has provided an insight into the value of DMRs for those that have medication reviews. It adds to the findings of the statistical interrogation of DMR data. A picture of where the value DMRs lies is emerging. The next chapter continues with this exploratory research, it describes the findings of semi-structured focus groups and interviews with the professionals who provide DMR services.

Chapter 6 Pharmacist perspectives on the value of domiciliary medication reviews

6.1 Introduction

In the last chapter the views of service users relating to the value of DMRs were explored. The home setting was advantageous in the eyes of service users who preferred it to traditional health care settings such as hospitals and GP practices. DMRs were not subject to time constraints which resulted in comprehensive medication reviews where service users felt heard and listened to. Informal carers recognised the perceived professional competence of the DMR pharmacists and were reassured by an expert review of the medications their family members were taking. The attributes of the professional were important, positive views of DMRs were linked to service users finding the DMR professional personable, meaning they could interact with them on an accessible level. Service users (patients and informal carers) did not highlight the frequently reported outcomes in the literature as discussed in chapter 1 as representing the value of DMRs to them.

As this research sought to understand the value of domiciliary medication reviews from different perspectives this chapter presents an in-depth exploration of the value of domiciliary medication reviews to the professionals who provide these services. This was done via semi-structured focus groups, and semi-structured interviews.

6.2 Aim and objectives

The aim of the study was to:

Determine the value of DMRs to the professionals who provide the service.

Within this aim there were four main objectives:

- To determine service provider expectations of DMRs
- To determine service provider experience of DMRs
- To determine the impact service providers perceive DMRs have on recipients lives
- To determine the preferred setting for medication review

6.3 Methodology

The constructivism ideal with elements of pragmatism described in Chapter 2 underpinned the methods described in this chapter. The pragmatic approach that had to be taken in this study was the change of data collection described in method section 6.4.

6.3.1 Reflexivity

For this study the PhD student's previous experience of working as a DMR pharmacist was viewed as a positive. It was felt that this experience would enable the interpretation of results based on real-world experience rather than academic theory. The drawback of being an insider for this study was the risk that the PhD student would unintentionally impose their experience onto the that of the pharmacists who participated in the review. To avoid this risk time was taken to ensure a topic guide with open questions was developed. PhD supervisor feedback was sought to ensure that questions were not leading and did not contain preconceptions. The use of prompting and probing questions was important in this study to ensure that the opinions and perspectives of the pharmacists who participated in the study were drawn out.

For the qualitative methods it was particularly important that the PhD student considered the influence that they could have on the research to ensure trustworthiness (Guba & Lincoln, 1989).

6.4 Method

This study was sponsored by University College London (17/0784). It required ethical (18/NI/0049) and Health Research Authority (17/0784) approval. The research was given local approval by NOCLOR.

To identify potential participants emails that explained the research and asked for interested participants were disseminated to known DMR professionals and authors of DMR-related articles, identified during the literature search described in this thesis. A call for participation was also posted on two professional networks: the research forum of the Royal Pharmaceutical Society (RPS) website and the UKCPA website. A target sample size of 10-15 participants or data saturation was aimed for. Interested participants were offered their choice of time of planned focus groups.

It was intended that focus groups would be the means of data collection. However, at times getting participants to commit to a focus group proved difficult. It was therefore that interviews would also be carried to capture the views of professionals when they could not attend a focus group. Before any focus groups or interviews took place formal consent was obtained and recorded on consent forms. Focus groups and interviews were conducted using a topic guide (Appendix 6). As analysis of patient interview transcripts started during this study questions were added to the topic guide to explore emerging themes and sub-themes. These questions are highlighted in italicised font in the topic guide. Discussions were recorded to enable data analysis. Field notes were written to enable further probing of points of interest and to help remember the context key points that were raised.

Audio files were transcribed into anonymised transcripts. Transcripts were checked against audio files to ensure transcription accuracy. The Braun and Clarke (2006) methodology for thematic analysis was followed. Analysis of data began through immersion in interview data; the PhD student read and re-read all transcripts ensuring they were familiar with the data. Each transcript was then coded. Codes were used to construct overarching themes from the data. Initially the emerging

themes and sub-themes from the servicer user interviews Chapter 5 were considered as a codebook. However, where codes did not fit with the data they were excluded, and emergent codes were added. Inclusion of an indicative approach within methods was important to ensure all the opinions of the study participants (DMR pharmacists) were represented. Codes and themes were re-visited to ensure no duplication or ambiguity in meanings and evolved during the analysis period. The PhD supervisor read and coded 3 transcripts independently. Codes were compared and a consensus on categorisation was reached through discussion. For all other transcripts the PhD supervisor validated the codes and themes that the PhD student had elucidated. Codes were excluded from the final analysis if they did not represent a recurring theme within the data and/ or the quotes were not a strong opinion of the participants. This involved re-coding of quotes to a theme or sub-theme they better fitted within. All decisions on inclusion and exclusion of codes were decided through discussion and consensus.

As highlighted in Chapter 5 the PhD supervisor had an overview of the PhD work and understood DMR services, this ensured participant views had been represented correctly by the PhD student, in line with credibility criteria set out by Guba and Lincoln (1989).

6.5 Results

In total 15 professionals agreed to participate in the focus groups however, only 12 were interviewed. Three participants originally agreed to participate in a scheduled group then dropped out due to competing work commitments.

Three focus groups took place. One took place virtually via GoToMeeting (SP1 and SP2) and two took place face-to-face. The first involved three participants (SP3, SP4 and SP5) and the second involved two participants (SP6 and SP7). Five interviews took place via telephone for the remaining participants (SP8 – SP12).

6.5.1 Coding summary

Analysis of the data revealed six key themes and 23 sub-themes (Figure 18). Illustrative quotes are used to demonstrate the meaning within themes. Sub-themes are presented within the theme they most fitted. However, there was also links between themes and sub-themes. Links are highlighted by a dashed two-way arrow.

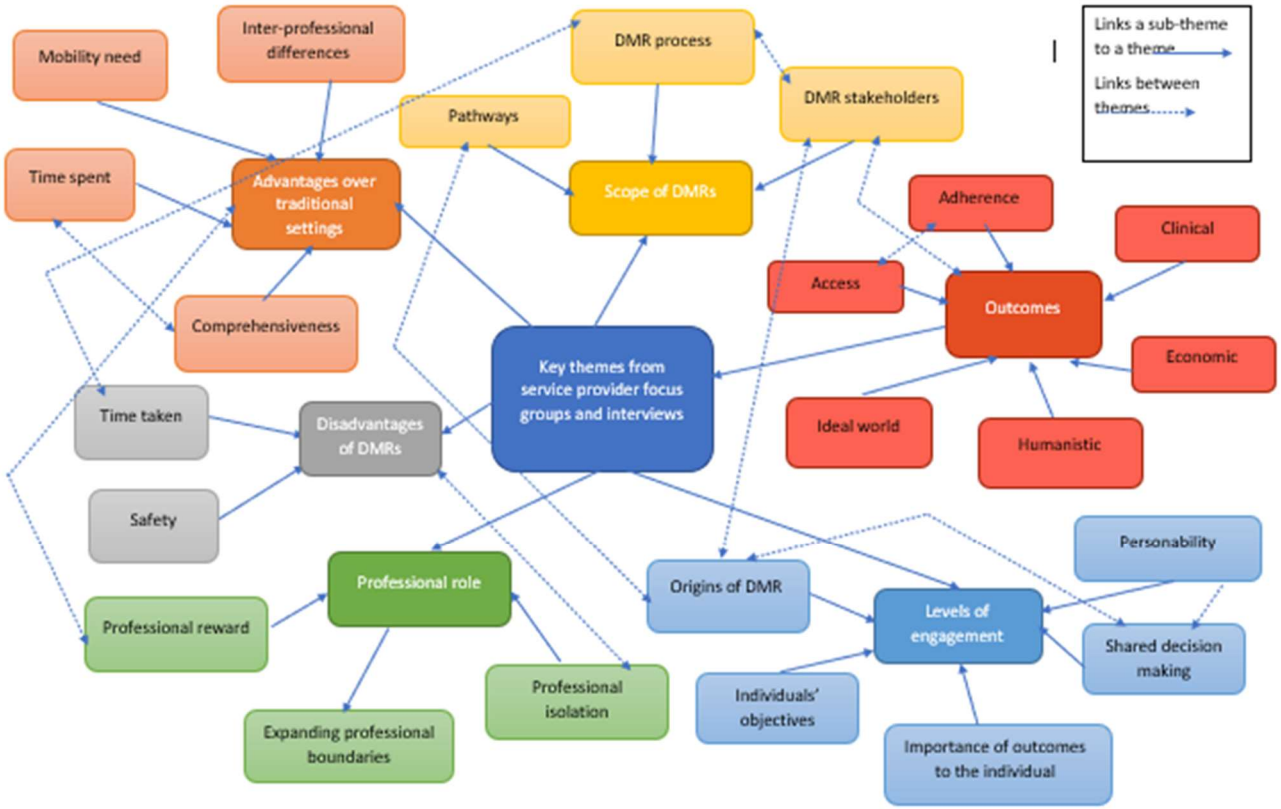


Figure 18: Summary of themes and sub-themes from pharmacist focus groups and interviews

6.5.2 Theme 1: The scope of the DMRs

Opening questions to DMR professionals set the conversation up to cover the genesis and operational aspects of their DMR services. In response professionals described the scope of their DMR services. The scope encompassed: what the service involved, who the service involved and where the DMR service sat in relation to other services.

6.5.2.1 DMR stakeholders

The professional stakeholders of DMRs included those that the DMR professional worked with directly, those that made the referrals to the service and those the DMR professional interacted with to attempt to resolve issues picked up during the DMR.

Most of the DMR professionals interviewed worked within larger multi-professional teams who have a remit to support patients to remain independent in their home.

> *My name is [Name] I work with the North Islington frailty team at the moment. It's a Pilot frailty team which proactively screens patients by telephone call and we carry out medication reviews at home if they're suitable. [Professional 005]*

> *My job is working for the re-enablement team and REACH which is a, how do I explain, it is like a longer-term outreach team that has goals around mobility, therapy, things like that. [Professional 004]*

> *I work for Haringey integrated locality team which is a multi-disciplinary team. Our remit is to keep people out of hospital and away from A&E, if possible. [Professional 003]*

> *There was an opportunity from some funding we had from some community hospital placements but working with, what we call a community response team which is pretty much a therapy led service, that looks after patients that have just stepped out from hospital, with the aim of having the rehab potential so we got physios and OTs there, but we'll support them to either hospital step down or maybe a bit more support and identify care, other teams so that's where I was based. [Professional 010]*

Regardless, of where the DMR professional 'sits' they usually had interactions with a range of stakeholders from health and social care teams while carrying out their role.

> *The nice thing about working with other Health Care Professionals, you can refer to them, because quite often the problem isn't just the pharmacy, it might be that it needs carers to prompt them with their meds because they keep forgetting or whatever. And the other nice things about it is that I don't need to make a separate referral to social services. [Professional 003]*

Most of the professionals needed to interact and communicate with GPs to discuss and resolve recommendations from the DMR. Interviewees highlighted that accessing GPs for these conversations was not easy, which presented a barrier in the DMR process.

> *We can theoretically contact a GP and there have been times when we've had to because we've been really worried about a patient and you can't always get through to them. [Professional 003]*

> *So how it works in our service, is if anyone is referred into the service, other than via the GP, we always contact the GP, for permission to see that patient. So we always pop them an email to say so and so referred your patient because of this issue, that issue or whatever, are you happy for us to see them and also are there any issues that you would like us to look into. [Professional 011]*

There were also links between the multi-disciplinary teams pharmacists worked within and the origins of DMRs (6.5.6.1).

6.5.2.2 Pathways

During the interviews DMR services were presented as novel services which were growing in number. Some services, which had slightly different remits considered how it could work best with an existing service to enhance effectiveness.

> *But what we are going to look at now, is how they impact on each other and very much looking at the case management model and ethos where you pick them up, make a plan, action the plan and maintain contact, so at what point along that case management timeline do you (-) is there an interchange between the specialisms, you know the adherence and the acute personal. So we're trying to map that out at the moment. [Professional 002]*

The same professional highlighted a community pharmacy pathway which was also in development but there did not appear to be consideration of impact on existing services.

> *But there is another, community pharmacy that is being developed to look at adherence as well. So, they will have their own pathways with managing these patients. [Professional 002]*

Other examples of interactions with health care professionals are presented in section 6.5.6.1 (Origins of DMRs).

6.5.2.3 DMR process

From the descriptions given it was clear that how DMRs were carried out across services was different. The DMR processes were linked to the stakeholders of services (6.5.2.1) Differences in processes included access to systems:

> *We write on RIO. I've learnt to write down everything I've done. I've got my own chart, that I write if I've done a review. [Professional 003]*

> *Our entries are on EMIS and they're actually on the GP's own EMIS. [Professional 005]*

Professional 005 also pointed out that they still have to proactively contact the GP to highlight a review has been done. Simply using the same system was not enough to resolve the issues they had raised.

> *Leaving the note by itself isn't enough, they won't see it. So I would always email as well or call or something. But yeah it's difficult. [Professional 005]*

All professionals interviewed conducted broad medication reviews, i.e. not disease or condition specific. The exception to this was professional 009 who focused on medication related issues linked to respiratory conditions.

> *And then anyone I see at home, I'll drop them onto EMIS and I'll just go and see them again, if they need any changes to their inhalers. For the most part, it is just the respiratory focus, I may look at their other medication as well, so as you probably know. [Professional 009]*

The need to complete some pre-review investigative work, to enable an effective review was highlighted.

> *Unfortunately, we don't have mobile working so we have to prepare some of our information for (-) before the visit, so what we tend to do is, we prepare a care plan with a drug*

history or however you want to call it, to focus it, so we've got something to do the reconciliation with, and also highlight things and bloods and stuff, so we can do level 3review. And when we get into the home that is very much then led by whatever you find there, which can vary. [Professional 001]

Professional 001 also highlighted that their team had originally produced a template for conducting reviews, with the aim of providing consistency. However, in reality it was not used as the pharmacists conducting the DMRs found the tool distracting and preferred to use their clinical experience to guide the reviews.

6.5.3 Theme 2: The professional role

Interviewees described their professional role when working as a DMR practitioner, how their professional boundaries had been stretched, the reward they got from the job, and at times, the isolation being a DMR professional brought about.

6.5.3.1 Expanding professional boundaries

Professionals frequently highlighted that they were completing tasks that are not traditionally considered 'pharmacist' roles. They had varying opinions on whether this was an appropriate use of their time or not.

Being on your own, you are covering all bases (-) you're not just pharmacy. There are things I'm not comfortable like checking people's skin. Most pharmacists wouldn't be checking rashes and things like that, but you do suspect it is there. [Professional 005]

I think it's quite hard. You can get a thermometer and you can get a blood pressure machine you could everything, like a fundascope. You can go round and do a full clinical examination but that isn't really your role. Sometimes you go

round and someone has got a cold and you say if I had my stethoscope I could diagnose whether you got pneumonia or whether it's fluid or something but it's not my role. [Professional 004]

It's good, I would say it's good but happens is, you find that you're doing other peoples' job and you're not doing your own job. Because my medication reviews are behind and no one can do my job. [Professional 003]

Examples of the DMR professionals reviewing non-medication related issues are also highlighted in section 6.5.4.3 (Comprehensiveness).

Only one pharmacist highlighted that they made the changes that they recommended themselves, without consulting another health care professional. This pharmacist was an independent prescriber.

I've got free reign now, so I stop something, I just stop it, I wouldn't mention it to anyone. [Professional 004]

6.5.3.2 Professional Reward

Professionals enjoyed conducting DMRs and felt a reward from carrying out interventions to meet individuals' medication related needs. The professional reward was viewed as an advantage of the DMR setting.

They've [DMR pharmacists] found the work very rewarding because they can see that change that they are making. (Professional 001)

There's a Parkinson's patient that immediately jumps to mind, where we've managed to get this chap really compliant with his Parkinson's medicines, with a medication reviews, stopping certain things, timings, and his Parkinson's has massively improved since the time we've spent with him, so it's nice to see a change from people. (Professional 010)

I found it certainly from a patient point of view, interaction with the patient, hugely rewarding and very informative. (Professional 008)

6.5.3.3 Professional isolation

Some professionals highlighted that conducting DMRs left them professionally isolated, as generally they were not conducting reviews with another professional, or as part of an MDT. In addition, whatever professionals discovered during a DMR they have to resolve, which caused stress. The latter point was mainly discussed in one focus group.

One drawback would be you're kind of on your own and every now and then you come across things that you don't feel comfortable to leave and it tends to be on a Friday afternoon and you're still there at 8pm at night. But that's part of the job I guess. (Professional 003)

For one pharmacist the isolation was felt through not having their professional identity recognised.

They always think you're a pharmacist, they don't always know (-) which shop do you work in, and where you've come from. But at the end of the day, provided they are happy to see you and you get the results that you need, I don't really care if they know who I am or where I've come from, as long as they get what they need. (Professional 001)

Professional isolation linked to the disadvantages of DMRs (6.5.5) highlighted by study participants.

6.5.4 Theme 3: Advantages over traditional settings

Interviewees felt that DMRs presented advantages to multiple stakeholders, but in particular the recipient of the DMR. The benefit of the DMR was felt in four key areas: mobility need, time spent, comprehensiveness and inter-professional differences.

6.5.4.1 Mobility need

One professional highlighted the advantages to those who might otherwise struggle to engage with a professional because of mobility need:

> *They don't want to get on a bus or struggle waiting in a waiting room or anything. They prefer it. (Professional 005)*

Another described that their service was set up for housebound participants:

> *an initial pilot service where we-the domiciliary arm-was to get referrals from many GPs are the health care professionals for housebound older patients who require a medication review who may not get to the pharmacy or GP very often or at all and may be sort of isolated. (Professional 006)*

6.5.4.2 Time spent

Many of the professionals recognised that they spent more time with individuals when conducting DMRs than they had in other professional roles and settings e.g. acute hospital setting. Professionals thought this this increased time meant that they were able to conduct more comprehensive reviews.

> *I guess it's a very patient tailored focus, which is probably something that I was able to do to some degree in hospital, but not to the full extent because of time limitations. Whereas here you are given the opportunity of time. So, you can look back through all the records and you can tailor it to the patient*

you can make sure it's safe especially with their age and risk factors. (Professional 007)

I agree [with professional 007] that the time factor really allows us to dig deep and check that everything is still appropriate and also check patient understanding. (Professional 006)

Some professionals highlighted that they felt that the recipients of the DMR were also appreciative of the time spent with them.

And I like to think the patients; most of them seem to appreciate someone spending more time with them, and think people are actually caring about their health. Not sure if it makes any difference in terms of their compliance but they seem very grateful that you can spend some time with them. (Professional 004)

Yes, there are lots benefits in terms of patient care, and because we can spend a bit more time at their home, my record is actually about 2 and a half hours. There's just no way you can spend that amount of time in a clinic and so it is a luxury. We have a patient survey as well, a questionnaire, and then most of the times the patients say this is the first time I've had someone to come in to talk to me about my medications for such a long time, to go through everything. (Professional 012)

6.5.4.3 Comprehensiveness

For DMR professionals the comprehensive nature of DMRs was highlighting through the fact they encounter and try and resolve issues that were not identified from the outset i.e. issues not linked to the referral reason, and which at times, were not linked to medication related needs. Professionals gave multiple examples of the comprehensiveness of reviews in different contexts.

We don't actually accept referrals, we screen them. And that means a large proportion ends up being not exactly pharmacy, because depending on the need, there's a lot of falls, mobility issues, financial issues, social issues, so a lot of it is signposting, social prescribing and things like that before we get to the pharmacy part. Like [Pharmacist 3] was saying, once you start looking for something, the more you dig you'll always find things to change (Professional 005)

And sometimes It's not only pharmacy issues that you tend to uncover, you might open up other issues (Professional 007)

Some professionals highlighted that they could get a better understanding of what was going on with an individual in their own home rather than another care setting:

If they're in a hospital gown, everyone looks the same. You can't tell. Whereas in their house if they are dressed funny, or the house is unkept or if there is a pot burning on a stove, it gives an idea of their cognitive function without even saying anything (-) People who tell you they don't smoke, but you can see ashtrays and empty boxes (Professional 005)

But I guess the advantage of doing it in the home setting, is that you truly see what it's like. And how they are coping with medicines so if you can just physically see a stack of blister packs dated a year back, you just know that they're not coping. And it's not something that you'd seen in hospital because the ambulance crew might just bring one blister pack from a pile of them. (Professional 006)

I think we talk about it in the communications, the patient can come across very well in hospital and polite and then it is not until you go to the settings. Some patients are quite good at hiding or not letting you see the full picture. (Professional 007)

And sometimes if it's adherence issues, we can suggest where they can put their medication or their dosage box so we can make it a bit obvious for them so they can see it to take the medication but in the clinic you are not aware of what the home is like. (Professional 012)

I had a very good case just yesterday, that I was just writing up when you phoned, and the fact it has been identified that the patient does have significant short term memory loss, and had not been taking the tablets but then when we came out there had been 6 weeks of mediboxes just sitting there (Professional 008)

Others stated that they reviewed complex patients and conducted in-depth reviews.

To look at holistically, the patient and do a comprehensive geriatric assessment and the medication review forms part of that. (Professional 006)

So we've got this in-depth assessment form which basically will get all the basic information about the patient and the medicines, and then looks at the three…we split it up into three main areas, basically questions about access, questions about the day to day medications management and then questions, most importantly about what their attitudes, pretty much looking at the intentional non adherence. (Professional 008)

I don't think I can generalise what they are really concerned about as such but what I would say is, you really can't tell what a patient is taking until you speak to them. You really really cant. You can prepare, well we do prepare before we go see the patients, but when you go there, it could be something completely different, because what they meant to be taking, they're not taking or you know, they're doing their own thing and tailoring their own doses. You just come across a whole array of things, to be honest I can't generalise. (Professional 011)

6.5.4.4 Inter-professional differences

Interviewees discussed how the home setting presented an opportunity for them to pick up on and resolve issues that other professionals had not picked up on. Various reasons were suggested for the limitations of other professionals. These included:

not having the correct medication expertise, not having access to patient information systems and not having sufficient time to uncover and/ or resolve the problems.

> *When I looked at his drugs, there wasn't a lot of pharmacy input as such… but I was able to reduce it to twice a day. Spoke to the pharmacist, then I found out he's also on a Patch which no one had even picked up on from my team. (Professional 003)*

> *You've maybe dealt with some problems that kind of fell through the net so where the GP wouldn't have had the time to maybe review all this person's medications or wouldn't have the incentive to do it... There is definitely a gap that you are filling, that no other professional is, the community pharmacy is a good link but they don't have access to the care records, the reviews they do will not be as comprehensive. It's definitely something that is not filled by anybody else. (Professional 005)*

> *At the start they [professionals referring for DMRs] would have just try to manage that themselves with the community pharmacy and there's been a huge drive on the back of that, where non-pharmacy professionals are seeing these patients, and making decisions, a huge drive towards MDS, so we're trying to really plug that gap, to get them all coming through the one channel and starting the process with the comprehensive review within the patient's own home. (Professional 002)*

> *I think they really appreciate the time we've spent with them. They say "oh we've never had this before" or "the GP, they never have time to really talk about this" obviously because they've got a set 10m minute clinic so that's the big thing. (Professional 006*)

There were examples of other health care professionals making recommendations to solve medication related problem that perhaps were not appropriate.

> *Yes, that's right and unfortunately, what I've found certainly is, a lot of AHPs that I deal with, that they see the medi boxes the answer to everything, so actually it was quite good yesterday for this Allied Health Care Professional, she's an OT and one of the main drivers of "can we get a medi box, can we get a medi box " it was actually quite interesting, to actually be in a home visit with her, because sometimes I do my initial visit with them, just as part of the team things and I would go back, it was interesting for her to see that the patient there did have a medibox, there's 6 sitting in the house and not a single medicine had been taken. It was actually quite a nice illustration because I can say look you know I have patients that store their mediboxes in the dishwasher, they don't take them, they're all lined up beautifully in the dishwasher, with not a single one taken. (Professional 008)*

One professional made a point of highlighting the reviews their team undertook were not driven by economics, unlike those their CCG colleagues carried out.

> *So we're not like optimisation team with the CCG, we are not there to go and look for cost savings, but if we feel as part of those reviews there are things that would improve that clinical care and be more cost effective then we will try and put those in place as well. (Pharmacist 002)*

6.5.5 Theme 4: Disadvantages of DMRs for the professional

Although disadvantages were not highlighted as much as the advantages of DMRs, it was apparent that the professionals providing DMRs also thought there were drawbacks. Interviewees highlighted two main drawbacks of DMRs, specific to them as DMR professionals: the time taken to conduct a DMR and their safety.

6.5.5.1 Time taken

Some professionals expressed frustration at how much time it could take to get problems identified resolved. At times this was because they relied on other professionals to action requests, who worked separately to the DMR professional. The whole DMR process (6.5.2.3) contributed to the time taken.

> *So it's full of real frustrations, which take ages to sort out. (Professional 003)*

> *Probably one of my main frustrations having been primarily involved in acute care throughout my career to date is the time it takes to get things changed, and the resistance sometimes for GPs to change things, so to stop things…things that have been going on for 10 years… there is great resistance and I'm never quite sure why, but I think that you have to accept that, you can't really win all the battles, it's the time taken, it's so easy when you work in a acute setting, just to go up to the doctor of the ward and say let's stop this or I would stop it myself, being an IP…(Professional 008)*

> *There can be quite lengthy reviews in that sense, but then it is a level 3 review, you're not going in any focussing on one thing, you're doing the whole thing. But that being said, sometimes it can be lengthy, whereas in hospital, you're not as relaxed, you're not in that home setting, you can push things a bit more, whereas sometimes in a home setting, it's about building that trust, because you want them to open up to you want them to be open about the issues that they're having, sometimes it can be a bit lengthy even though you do your best to direct the conversation and makes sure you get the main bit…I can't think of any disadvantages as such. Definitely there are lots of advantages. It is a time consuming service, definitely. (Professional 011)*

> *I think the drawback is, it's a luxury, because you have to spend so much time preparing and also not rushing patients, because elderly patients you sometimes have to talk very slowly, to make sure they understand and in [borough name] we have quite a lot of non…English is not their first language, so you really have to talk a bit slower, to these patients, making sure that they understand. And so I think that makes the process even longer. So it is a luxury because you can't see that many patients on the same day because you have to*

come back to write up the reports and we usually put the outcomes in the EMIS record, and that takes a bit of time and sometimes we have to send the GP a message to let them know our suggestions, and so everything takes a bit of time and so it is a luxury. (Professional 012)

DMR professionals were conscious of the time taken to conduct reviews which meant they worried about how much time they were spending with someone if the individual was not willing to work towards medication goals.

I think following things up is hard though, because how much time can you dedicate to one person when they're never going to change anyway. (Professional 004)

6.5.5.2 Safety

For a number of professionals, concerns around their personal safety or that of colleagues, when going into someone's home was a drawback to DMRs. Personal safety was not something they considered as much when they worked in other healthcare settings.

One interesting thing...It's more about the pharmacist going in, this is very much a new concept, certainly from the hospital? We've had to spend a lot of time thinking about the logistics and about the risk assessments, and the personal safety and you putting embedding systems that they feel safe and sure to go in the patient's own home and not feel vulnerable? That was something I had to spend a lot of time on which I probably didn't appreciate earlier on in the journey. (Professional 002)

it's taken me a long time to get used to that [going into someone's home] and I still dread it now 18 months down the line, Yes. It is a bit nerve wracking and I think the best, with having intermediate care team we have initial

assessments so I think they'll have a risk assessment they can pass on any issues, such as dogs... so it's risk assessed really well (Professional 010)

There is an element of… you don't know what you're going to get, when you get there. Which is a bit off putting in a way, but then most of the time. It's fine. (Professional 006)

I'm more new to the role. There's always a bit of nervousness because you're not sure what the setting is going to be like and I guess you are aware of your own safety as well. But you're right, the pharmacist don't tend to be the first visit and we do do a really thorough screen before we do send someone to the home setting just to make sure it is safe. If it's not safe to consider doing double ups. (Professional 007)

To be honest with you, because I've never done it before, I was actually quite scared when I first started it. Because you're going into a patients home I wasn't really familiar with the area that I was working in, so I was quite apprehensive within myself, I kept telling myself well, if you're scared imagine how they must be feeling. Because lot of the people I go see are elderly, and I just think well they don't know you either, you've got to be conscious of that as well, as time went by it was fine, touch wood, it's been fine so far I haven't had any issues. To be honest with you, when we first started this service, we used to do a lot of our visits as joint visits with the community Matron. And it was only after the first 6 months to a year, I can't remember exactly how many months that I started venturing out on my own. So initially, the majority of visits were joint visits. (Professional 011)

Once or twice I declined because I felt it might be a bit unsafe for me to go on my own. Occasionally we ask if the district nurse or the community matron could go with us. (Professional 012)

I don't like it too much. It does depend, I've been into some GP practices, sorry, some patient homes and it has been…awful. It just depends on the patient, I guess. I've kind of felt a little bit threatened going into patients' homes sometimes and just really uncomfortable. (Professional 009)

6.5.6 Theme 5: Levels of engagement

Professionals described how much individuals participated in the DMR process. There were three linked factors associated with the levels of engagement: individual objectives, shared decision making and their personability of the professional conducting the DMR. Throughout the focus groups and interviews there were differences between individual and professional objectives for DMRs and the levels of shared decision making.

6.5.6.1 Origins of DMRs

All the professionals who participated in the focus groups and interviews stated that DMRs came about after referral from another healthcare professional. Examples included:

> *It's a Pilot frailty team which proactively screens patients by telephone call and we carry out medication reviews at home if they're suitable (Pharmacist 005)*

> *Our adherence pharmacists are going to pick up referrals there, and again go in and do a comprehensive assessment in the patient's own home. It's going to be triggered from adherence needs, identified by the discharge team, the discharge social workers, there's several of these stakeholders that moves these patients out, who can effectively prompt the referral in. (Pharmacist 002)*

Despite this, the pharmacists reported that negative responses from individuals when they were contacted to arrange the reviews were rare.

> *No. Of the 300 patents that I've seen, there was only one that didn't want a review. I think it was just more offended that someone had said he's not managing his meds (Professional 010)*

Occasionally a few patients decline the appointment. And so in that case we just have to go back to the GP or the referral person to say the patient don't want us to see them. So that can happen as well. (Professional 012)

One professional reported that a referral without the individual having prior knowledge that they had been referred for a DMR could initially be a barrier.

Maybe at first they're a little bit dubious about what we're going to do, but then obviously on the first visit we have our information, patient information leaflet, and then we explain when we first go in and it's usually fine, but I think that's probably a barrier sometimes. (Professional 006)

There were a few instances of participants referring themselves, either because they had a review previously and were requesting another, or they met the DMR professional in another capacity and asked for a review.

If we've worked with patients or service users, we will always leave them a contact number, we have had some refer back to us, a self-referral back to us, which we accept for if things change or they develop issues. Sometimes if we've gone to see a person and their partner self-refer themselves as well. As long as they meet the criteria, we're happy to do that review. (Professional 001)

And others now I've seen them will ring me up and say can you come and visit me because this has changed, or this has changed. (Professional 004)

But taking a quick step back, we have had the odd referral from patients directly, I wouldn't say there is many at all but my colleague does training sessions for diabetes, some of the sheltered living and things like that and some patients there said oh I've got an issue with that and they request a medication review. (Professional 011)

6.5.6.2 Individual objectives

When a DMR was arranged individuals did not always have their own goals or issues to discuss. Despite individuals not requesting DMRs in the majority of cases, professionals reported that they were concerned with what is important to the individual. They viewed part of their role as helping to elicit individual goals. The goals identified, either by the individual or the professional were not always linked to medications.

> *The patients are very willing to set their own goals, what they want. They will tell you straight up… can you get rid of that horse tablet. You go in with an agenda on the warfarin and the warfarin has nothing...It's the laxative that pains them every day. (Professional 002)*

> *These patients are really happy for someone to come and look through the meds, from that point of view, they just want to be happy that their meds are OK or they want to know if they can change something or start something. (Professional 010)*

> *When I go into a patient home, it is very much driven by them, you know what is going on, what about your medicines, and then what they show you, sometimes it is horrifying, what they show you, the cupboards full of medicines, I've taken away bags and bags of medicines and sometimes that's a great relief for patients because they've obviously been building up and overwhelming them and they just don't know what to do with it because it's kind of got out of control so sometimes it's a great sigh of relief. (Professional 008)*

There was one example of an individual having reported an objective during an introductory call, and because the professional would not commit to meeting the objective the DMR was declined.

> *Oh could you increase my painkillers" and I said "Oh, I can't do anything until I come and assess you, and it would have to be the GP who would fundamentally make the changes". She just declined and said she would rather see the GP (Professional 007)*

Examples of goals linked to wider health and social care needs were given:

> *And also I find more and more now that I have to talk to them about diet. And they often ask us about the diet, especially for diabetic patients and so then they sometimes show you their fridge, what they've got, the foods, they will just bring all the cereal, porridge and they ask you whether it's OK, or the sauces whether it's OK, so it's not just about medication, it's actually about everything. Especially the diet which is very important. (Professional 012)*

> *Sometimes they have their own hidden agenda so they might play my game and are nice to me so that they can get what they want. It sounds very cynical and I don't mean it to be. (Professional 003)*

There are also instances where individuals did not have any objectives for the DMR, but the professional was not in agreement with the individual's views.

> *So this particular patient, she didn't really know. So I'd called her before and explained to her why I was coming, her GP had actually referred her to me, and then when I had gone over there, I did explain to her but she didn't have a clue, she was in her eighties? With lots of co-morbidities so I can kind understand why. (Professional 009)*

> *They say 'Oh I don't need a pharmacy review', but I look at their notes and we definitely do (Professional 003)*

6.5.6.3 Importance of outcomes to the individual

During interviews and focus groups when asked whether professionals thought recipients of DMRs would identify with the outcomes DMR professionals measured to demonstrate the impact of their service (6.5.7), there was agreement that they would not be important to the individual.

This list that is irrelevant to the patient. Yeah, the only real relevance to the patient and we're looking really hard at this, certainly around their health thermometer, how do they...does make a difference to how they see their world. We have some discussion around this, we really do need to see, well, the goal setting with the patient at the outset of the intervention, so we set the goal, how many of those goals did we achieve? Goals for the patient, to reduce the medicine, did we really achieve that? Yes or no? We really do (-) suppose everything that I've listed, it's probably higher level, it's irrelevant to the patient, if the list is appropriate or not. (Professional 002)

So it just helping the patients (-) empower the patients to look after the medication better and sorting out which ones they should have, because some of them are really confused. (Professional 012)

6.5.6.4 Shared decision making

There were examples of professionals trying to involve individuals in the DMR shared decision-making process. How much professionals were able to engage individuals (patients) and how much individuals wanted to be involved varied.

Yes, some people want to be left alone and I think if you approach slowly. I usually try to start at a problem. I get them to state their main problems and then sort of attach, I bring their medicines into it after that. It kind of gives them a chance to speak and they can start the conversation rather than you coming into them. I think that works. (Professional 005)

I think the best thing is to get them to engage, often they don't know what they're taking, don't really care. If you put some emphasis of education on it as well, I think they respond quite a lot. (Professional 004)

Coming on to the pain control as well. You've got to manage their expectations because there are some symptoms that you're not able to get rid of no matter what. So it's best to involve them, have them, manage their expectation, maybe you can reduce their pain enough so they can manage their daily routine or something like that and just be upfront with them and respect their wishes. (Professional 005)

I think the main thing is a patient centred approach. (Professional 006)

I don't drive my interview based on are they aware of what they perceive as the problem, but I very much want it to be, what does the patient think, where do they see the problems, so although I know what they think, I wouldn't ever kind of say well I understand your problems with access or I understand your problems with popping out, I just kind of come in and say right let's have a wee chat, this is all about what you think and you know so (Professional 008)

Professionals presented informal carers as having a role to play within a DMR.

They can also correct what the other person is saying "no, mum you don't do that. Tell the truth (Professional 004)

So I make a home visit with the patient or client out in their home, either with or without next of kin, carer, anybody who has any kind of input with medicines, so often I'll have family members there who assist with medicines (Professional 008)

There were also examples of individuals not willing to become involved and the impact that had on the DMR.

Sometimes they come round but otherwise it does affect what you're trying to achieve because you need their cooperation. Because it's really hard to advise on something when you don't know what they're actually doing. (Professional 003)

Some really want to know more, they want the best and some are more happy for you to give them the advice and tell them what they should be doing I think. (Professional 010)

6.5.6.5 Personability

Professionals highlighted their personability and presented themselves as being able to connect with DMR recipients to have meaningful conversations. This ability was presented as a driver for engagement in the DMR process.

> *Like anything, even in hospital, I think it's important to take a bit of time at the start to warm to them, introduce yourself, build a slight rapport (Professional 005)*

> *So you've always got to think about that but I think we've recently done communication training at the [hospital name] and that really made me realise that you are going to a patient's home, so you need to be…You need to respect their space and really make sure you do a good job of introducing yourself and ensuring they understand your role and just respect certain things really. (Professional 006)*

> *But I do think when you go to someone's house, you have to be respectful and you can build up bonds with them and most of the time they are quite willing. (Professional 003)*

One professional suggested that participants were more willing to open up to them during the DMR as they had a more informal relationship with the individual, than other professionals.

> *Yes, and as not being the prescriber of those medications, they see you as a little bit more neutral. And again, being in there...it's very hard for them to convince you that they are taking that calcios tablet, when there's 27 boxes behind them. (Professional 001)*

Other DMR pharmacists suggested that conducting a DMR and connecting with participants can help address social isolation.

> *I think sometimes they like to have a chat, loneliness is probably… [can't hear end of sentence] (Professional 004)*

Even with… I'm not saying that our interactions do this… but social things are one of the biggest indicators of mortality, it does make a difference even somebody taking some time, to their mood. You know that changes their incentive and sort of determination to keep on with their treatment and small things like that can help actually more than what about it looks at the time. So yes, it is not to be underestimated, definitely. (Professional 005)

6.5.7 Theme 6: Outcomes

Professionals were asked about the outcomes they routinely capture, or what they thought changed as a result of the DMR, and what they would like to capture in an ideal world to demonstrate the impact of DMRs. There were also discussions around who decided on the outcomes. Outcomes were suggested by a combination of stakeholders (6.5.2.1); CCGs, research bodies (regional innovation centres), and the professionals providing the service.

6.5.7.1 Access outcomes

Professionals highlighted a belief that their interventions had improved patients' access to medications.

I think their organisation and medication and if they're struggling, we can sort out the logistics between the liaising with the pharmacy and the GP, synchronisation of meds, that kind of thing. Or if they're doing the repeat drop in and if they're struggling to get about. Just sorting out their electronic prescribing side of things. (Professional 006)

Then I guess also when a patient is very frail and they've gone in and out of hospital, the medication accumulation that they have in their homes. And they don't have anyone to sort of look through the medications, and see that some of them were dated a year ago, 2 years ago, 3 years ago and community pharmacists will automatically deliver a stash. Also, it's trying to synchronise the most up to date medications so it is much safer for the patient. (Professional 007)

6.5.8 Compliance outcomes

Professionals also highlighted that they could have a positive impact on medication taking behaviours, increasing the likelihood that individuals would take their medications. Examples of how this was achieved included medication-related education and provision of aids to help compliance.

The patients get an explanation, of the medication, and they have some idea… well because some patients are not taking them at the right time, and so we… they probably never received advice or they just never remember, and so we provide that. That kind of advice, the proper time of taking the medication and how to just give them some ideas, how to improve the adherence. Of course if they're willing to improve their adherence. (Professional 012)

Compliance is a massive issue and if they're not complying with their inhalers, it is likely that they are not complying with their other medication either, so I may put things in place, to help them. I've done MAR charts for people and I've arranged dosette boxes for people, where I see it as necessary. (Professional 009)

Some professional also highlighted that tackling non-compliance was a pre-agreed aim of their service and/ or something they actively measured to demonstrate impact.

Better compliance, less risk of drug adverse events, reduced poly pharmacy. I guess all the classic things (Professional 004)

So, we have a couple of adherence targets where we looking into increasing adherence by around 25% from baseline in 30% of our patients and also to increase to 100% in sort of again x percentage of people. (Professional 001)

One professional highlighted the challenges they faced when trying to assess compliance during a DMR.

It may be from visiting you can assess their blister pack, you can see that in the last week, they've missed a number of doses, it maybe through tablet counts, in the initial visit we do tablet counts and then follow that up and look...because you don't want to delay intervention, when we go in to assess, and there is an adherence issue, we would put an intervention that we feel appropriate in straight away. For a lot of people, we can't record that because we are not going to wait and see how bad they are before we put in an intervention. (Professional 002)

6.5.8.1 Clinical outcomes

When asked about outcomes recorded, clinical outcomes were highlighted by every professional who participated in the focus groups and interviews. The interviewees described a multitude of clinical process measures and outcomes that they recorded within their services. These included: adjustments to medication taking directions, adverse drug reactions, healthcare utilisation, mortality rates, number of medications taken, measure of appropriate prescribing, frailty scores, number of interventions and the significance of interventions.

> *I'm just looking at the main metrics here, we are doing the usual, we're capturing every patient, seeing their demographics, age, gender, do they live alone, and we're also looking at the referral, where does it come from, when was it received, how quickly did we respond. Our baseline, we're looking at Healthcare resource usage so number of A&E visits, number of unplanned hospitals, number of GP callouts, length of stay. Then we're looking at... around medicines related outcomes, looking at poly, the number of medicines, the adherence needs that they currently have, the appropriateness of the list, so we are using MAI, which is a validated tool. Looking at also the clinical significance of any interventions made. (Professional 002)*

6.5.8.2 Economic outcomes

Although not reported as frequently as clinical outcomes some professionals measured economic outcomes i.e. whether the DMR had resulted in any monetary savings to the health system.

> *You've got the numbers side of things, that you can see reducing tablet burden, optimising medications. And that will all have some sort of financial aspect. (Professional 007)*

One professional specifically highlighted that they do not look at economic outcomes.

> *I tend not to go down the cost route, but maybe that's something I have look at, I tend to look at efficacy, safety and then if I feel it is significant, I might say to them a potential cost saving. (Professional 008)*

6.5.8.3 Humanistic outcomes

There were examples of professionals attempting to capture data or use narrative to try and demonstrate the difference and impact DMR interventions made to the recipients of DMRs. The following illustrative responses were given when

professionals were asked about the outcomes they measured and/ or what they thought changed as a result of the DMR.

> *I think the biggest impact had was the narratives of the patient stories (Professional 001)*

> *Patient understanding. Not always, but definitely most of the time. (Professional 006)*

> *there is a little bit at the end about patient feedback and service users, referrer feedback, I kind of feel the end of the day, that's what we are here, for, to see what do the patients feel. I think, or hope that we going to maybe formalise and do it as a patient feedback, I am aware that they did do that in the pilot project in 2015, that they got feedback from the referrers, they did this form that you get, this patient satisfaction survey. At the moment, it's very much just on our form. (Professional 008)*

> *Whether we've improved their quality of life, whether lung function has improved, etc. so I always keep a record. (Professional 009)*

6.5.8.4 Ideal world outcomes

When asked about ideal outcomes professionals expressed a wish to know which of their interventions had been accepted by GPs, how long an individual followed a recommendation for and the lasting impact of interventions.

> *One would be, which of your recommendations have been taken up. And impact of those recommendations so if you suggesting maybe increasing the dose of the hypertensive, what is the blood pressure after a couple of weeks, or something…The impact of your recommendation. And also, whether compliance is improved, and whether things like pain has improved, these sort of things. (Professional 003)*

Others reported they would like to record patient satisfaction or have a greater

understanding of what the changes mean to the individual receiving the DMR, something they had not found easy to do.

> *Sometimes it is difficult to really capture, I don't know essence is really the right word, when you're making an intervention, especially people who aren't adhering for whatever reason it may be, so you can put that as an intervention for adherence or whatever it may be, but it doesn't really bring home the significance of that intervention. Well I don't think so anyway. Some people, you can really hear their heart felt thank you and when you see them really engage with their medicine and you see that difference, it is really really nice and rewarding. (Professional 011)*

Although professional 006 was using a patient satisfaction questionnaire, they did not feel this adequately captured the impact the DMR service had on patients.

Professional 011 also highlighted that there were inadequacies in the tools that are currently being used to capture impact, not just for the impact on patients but the wider impact of the DMR service.

> *And also I think in general, correct me if I'm wrong, you may know more, just to find a tool that can actually quantify a significance of an intervention. You know when I was looking up how people report their cost savings and you know, the impact of the service, I just find it's a hit and miss whether people are willing to accept…I know quite a few people look at reducing hospital admissions, you can't… you know there's no definitive way to say, yes, this was definitely the service that reduced hospital admissions and yet people use that and some places will be like, oh that's great, that's fantastic, whereas other people will be sort of dubious about…well actually, does that really show the reduction of hospital admissions? (Professional 011*)

One pharmacist did not have any ideal world outcomes as they felt they already captured quite a lot of data, which caused data fatigue.

I think what we are recording now, we've covered…yes because we do the tracker, so I think we've covered it anyway. The problem is, we don't want to have so much paper work, and we spend all the time just doing the paperwork. I think the tracker we use is sufficient. (Professional 012)

6.6 Discussion

The implications from the six key themes are discussed in the following section. Each theme is discussed in turn in line with thematic analysis methods (Braun & Clarke, 2006). Finally, conclusions are drawn linked to the objectives of the study, based on the inter-related themes and sub-themes.

6.6.1 Scope of DMRs

There is heterogeneity within DMR services; how they are set up, how DMRs are carried out, how actions are recorded and how interventions are implemented. When setting up DMR services professionals are trying to learn and share best practice through professional and informal networks. There is no framework outlining how services should be run and how value should be captured. Although not explored in depth during focus groups and interviews, differences could be linked to how services are funded. It appears that needs are examined at local level, and solutions funded by different stakeholders e.g. social services, CCGs, integrated care organisations. Heterogeneity amongst services could make it difficult to understand the wider impact of these services. It is also contrary to the national approach that has been taken with Care Home Pharmacist and General Practice based Pharmacist roles in recent years. These roles are funded, at least initially, by NHS England, and standards for services and Key Performance Indicators (KPIs) are suggested (NHS England, 2020; Royal Pharmaceutical Society, n.d.-b). Could, or should DMRs be the next pharmacy enhanced service to be reviewed and commissioned on a larger scale?

From the interviews it is clear that to be most effective DMR pharmacists cannot work alone. Working with other professionals either directly as part of a multi-disciplinary team, or indirectly via communication or referrals to other professionals enable DMR pharmacists to resolve issues they identified during the DMR process. Earlier research examining medication reviews of different levels and depth, in traditional settings, also found that multi-professional input helped medication reviews be more effective (Blenkinsopp et al., 2012). Perhaps future assessments of the value of DMR services could review MDT links and interactions.

Without the means to prescribe interviewees highlighted that they were reliant on GPs who were often hard to communicate with. Within different services there was commonality that professionals had to spend time trying to contact GPs to ask them to review their plans. Given finite resource it is questionable whether this is the best use of time.

6.6.2 The professional role

Within the transcripts there are examples of DMR professionals expanding their professional boundaries and taking on the tasks traditionally conducted by other professionals. Provided this is appropriate and safe, DMRs could be an example of pharmacists taking on expanded and enhanced roles in line with the NHS long-term plan . The plan aims to develop practitioners who can provide holistic care to patients, to support them to live with their long-term conditions (NHS England, 2019a). The enhanced role DMR pharmacists have taken on could also be contributing to the professional reward highlighted by the pharmacists interviewed.

Only one pharmacist interviewed was able to make prescribing changes themselves and this was only in one part of their role. There are logistical challenges to being able to prescribe when carrying out DMRs including: access to prescribing systems and budgets when you are employed by another organisation. Most of the

prescribing changes recommended are enacted at a GP level. If pharmacists are accepted as medication experts and the most effective way for DMR services to run is for them to make the changes independently there needs to be a review of how some of these organisational barriers can be overcome to enable truly joined up working across health and social care.

Pharmacists conducting DMRs took professional reward from their role. The quality of the interaction enhanced the professional reward for pharmacists. Research has suggested that pharmacists are not motivated by renumeration but by other aspects of their role (Goodwin et al., 2010). The benefits of a DMR may not only be for the individual who is recipient of the review, they can also have a wider impact on the professionals involved.

At times pharmacists reported they felt isolated, either because they worked alone or because they felt a responsibility to resolve the issues they uncovered while conducting a DMR, even those that were not medication related. To avoid this isolation there is a need for DMR pharmacists to integrate with other professionals and services, either directly or indirectly, so that they do not feel like they are working alone. From a service planning point of view it is important that mangers are aware of the potential drawbacks to DMRs for professionals, so that they can be addressed and avoided.

6.6.3 Advantages over traditional settings

Overcoming mobility issues was not highlighted as an advantage as much as it was by the recipients of the DMR. This suggests that for the professionals interviewed, who they believe can benefit from a DMR is not linked to whether someone is housebound, but rather, more to do with the individual.

Being able to spend more time with individuals conducting reviews than in other settings was presented as an advantage by many of the professionals who felt they

were able to build up rapport with individuals and conduct in-depth reviews. The professionals also reported that they felt the individuals they reviewed valued the increased time and felt listened to. This matches the findings of service user interviews presented in chapter 6. From both the interviews and focus groups it appears that more time permits higher quality conversations. There is a suggestion that the value of DMRs be represented by an input (time spent) rather than solely by outputs (outcomes).

Comprehensiveness was also highlighted as an advantage, but it may something of a necessity given the complexity of the situations the DMR professionals find themselves within. Pharmacists have unique expertise and experience making them the best equipped professionals to conduct medication these reviews. However, they also need to be able to recognise and take action to resolve other issues uncovered linked to the wider determinants of health. DMR pharmacists gave multiple examples of times when they uncovered or implemented solutions for issues other professionals had missed. Reviewing someone in their home meant that pharmacists were able to provide tailored interventions.

6.6.4 Disadvantages of DMRs for the professional

Time spent with individuals was presented as a positive but the time taken to conduct a DMR as a negative. Understanding the time taken to conduct a DMR from start to finish, including any pre-review preparation and post-review actions is important. If DMR professionals feel the DMR process is arduous they will view it in a negative light. Earlier work in this thesis used multiple linear regression to try and to predict the amount of time a DMR might take. The idea being that if you know how long a DMR takes then you can estimate how many you can commit to completing. Presenting time taken in a negative light raises the possibility that DMR processes are not as efficient and/ or that services are not adequately resourced. If it is recognised that DMRs take time then perhaps number of reviews is not a good measure of the

value of DMRs. A focus on a process measure could push professionals to focus on quantity rather than quality. Research has been conducted in the inpatient setting to gauge workforce needs for clinical pharmacy services (Bednall, 2018). Further research into DMRs could look to explore something similar for home medication reviews.

Safety of professionals is of outmost importance and has been highlighted as a concern linked to DMRs by other literature (Flanagan & Barns, 2018). Taking measures to ensure the safety of DMR professionals should be a priority when services are set up. As working in the home environment is novel for some DMR pharmacists, every professional may not be reassured to the same degree. However, professionals will need to feel safe to effective in their roles. If they do not it is unlikely that they will feel comfortable spending increased amounts of time building rapport with individuals in their home. This is particularly important if some DMR professionals also feel professionally isolated.

6.6.5 Levels of engagement

Professionals reported that DMRs are rarely requested by individuals themselves. Despite this, professionals believe that understanding the individuals' objectives and trying to meet them is an important part of the DMR. The professionals also highlight the importance of shared decision making (SDM). Either they are trying to use SDM methods in their reviews or the individual and/or carer has shown a desire to be involved with decision making. It is important that when this happens professionals know how to facilitate involvement, failure to do so could result in individuals feeling like they have not been listened to and resentment as discussed in Chapter 6. Patient engagement, or lack thereof is a risk to chronic disease outcomes (Simmons et al., 2014). There is also evidence to suggest that medication reviews can increase patient engagement (Reeve & Wiese, 2014). Domiciliary medication reviews could start off a stepped approach from engagement to shared decision making.

Professionals recognise that they need to be able to connect with individuals in a way that the individual values, they present themselves as personable. In interviews with recipients of DMRs personability of the professional was also a strong theme, with individuals frequently commenting on how 'nice' the professional was. Being personable enables professionals to build relationships with individuals. This in turn could have an impact on how much an individual is willing to engage in a DMR, discuss their wider health needs and perhaps even lead to shared decision making (Michie et al., 2003).

During the focus groups it was clear that the objectives of professionals and individuals were not always aligned and how much recipients of DMRs are active participants varied. Currently, the reviews taking place are not true examples of shared decision making. If an individual does not agree with the reason for referral, or that they have medication-related issues the professional needs to be able to engage them in a discussion about their priorities, which may align with the professional's objectives after thoughtful conversation.

DMR professionals believe that the value of DMRs lies in resolving issues that are important to the individual, but they are not capturing this. There was a recognition by interviewees that the outcomes they measure or their DMR service may not be of importance or recognised by the recipients of DMRs. The use of non-patient centred outcomes presents in contrast to the suggested patient-centric nature of these services.

Some professionals highlighted that family members and/or informal carers like to be involved in the DMR. The role of carers was also shown to be important in the service user interviews in chapter 6. DMR professionals should ask whether there is anyone else an individual would like to be present for the review.

6.6.6 Outcomes

Clinical outcomes and compliance outcomes were the most commonly reported outcomes. This complements the findings of the systematic review in chapter 1. Although in the systematic review adherence outcomes were classified under an overarching clinical outcomes term.

Outcomes were a combination of mandated by CCGs and decided upon by individual services. There was also an element of learning from and adapting the outcomes of other services. Focus on clinical outcomes appears to be embedded into the psyche of pharmacy professionals. Even if clinical outcomes have not been mandated by a commissioner, professionals believe they are important to record. This is not wholly surprising given the clinical professional background of DMR professionals, they are recording and measuring what they know. A variety of validated and unvalidated tools were used by professionals to measure their clinical outcomes. There is a challenge around finding tools to fit the DMR process, one size does not fit all.

A lot of the professionals highlighted the holistic nature of DMRs but outcomes they are measuring do not support this. At times patient satisfaction is captured but nothing more on-depth. There is no check back with individuals to find out what matters to them. This is a point acknowledged by some of the professionals, they want to measure humanistic outcomes, but they do not.

During the focus group and interviews, nobody discussed patient reported outcome measures (PROMS). At their core PROMS are meant to focus on quality, safety and effectiveness, but from the point of view of the individual. They can be disease specific or generic (Black, 2013). Future research could look at whether PROMS can be identified and validated for measuring the value of DMRs.

6.7 Limitations

There is potential that the change of method from focus groups to interviews limited the richness of some of the views shared by interviewees. When the professionals were interviewed alone, they did not have other professionals to feed off and reply to. However, the change was necessary to capture the views of professionals when schedules could not be matched to enable a focus group. Any loss of richness was limited by the use of a topic guide with prompts and probes to drive conversations, that was used for all focus groups and interviewees. This ensured the main questions linked to the objectives of the study were posed to all participants, regardless of the qualitative method used.

The focus groups were advertised widely in a bid to capture as many views as possible of possible. Five out of twelve professionals were employed by the same organisation. It could be argued that having a number of professionals from the same organisation would limit the generalisability of results. However, the five professionals worked with three different services, and the two who worked within the same service had different levels of experience. All interviewees had different and personal views to share.

In addition, this argument cannot be applied to the work described in this chapter which is exploratory and not hypothesis generating. The analysis looked for commonalities and disagreements in the viewpoints expressed but did not assume they would be homogenous.

Similarly to the limitations discussed in chapter 6, sample size and projection from the researcher could be viewed as limitations in this research. This study involved 12 participants which is not a large number. However, in qualitative research it is the quality of the data, which is of importance, not the quantity. During analysis of the data it was felt that data saturation had been reached, which indicated an appropriate sample size. Again, projection, whereby a researcher inserts their opinions, or pre-existing theories into data interpretation was limited by the initial

independent coding of data into by the two researchers. Discussion of any mismatch of opinion on code interpretations and consensus agreement on final themes and sub-themes.

6.8 Conclusion

The study examined expectations of the DMR from the professional perspective. The professionals highlighted that there was no one size fits all approach with DMRs. However, they did enter with the aim of conducting in-depth reviews centred around the needs of the individual. Professionals highlighted that there were inconsistencies between the reason they were asked to conduct the medication review; the medication-related problem, usually suggested by another health or social care professional, and the problems uncovered when they conducted the DMR. Professionals recognised that the recipients did not always have their own medication-related issue(s) at the outset of a DMR. Despite the lack of objectives, professionals wanted to conduct the DMR and involve recipients in the process.

The experience of DMRs was generally positive for the professionals involved. Professionals felt they were able to have more in-depth conversations than they had previously been able to have with patients they cared for in other care settings. This meant they were able to address the wide-ranging needs of those they conducted DMRs for. However, the experience was not completely positive. Professionals found DMRs took a long time to complete, as the medication review itself is only part of the process. Time is needed to attempt to action and resolve any interventions. DMR professionals also worried for their safety when they carried out medication reviews in a person's home.

The impact of services was measured in various ways: professionals predominantly recorded clinical outcomes, and at times economic outcomes and patient satisfaction results. However, there is a lack of consensus on what outcomes to measure and

whether these outcomes actually capture the value of DMRs. The large list of 'ideal world' outcomes demonstrates that professionals feel that traditional, frequently clinical outcomes that they record do not always capture the value of DMRs. The continued use of traditional clinical and economic outcomes needs to be challenged, or at a minimum they should be presented as secondary outcomes, less important to those identified by an individual.

The relationship between the professional and the individual is also important. The connection is important to uncovering the objectives and needs of individuals. The value of DMRs could be measured through the level of engagement. There needs to be an acceptance that the 'softer' aspects of DMRs can also demonstrate the value of DMRs.

DMR professionals preferred the home setting to traditional healthcare settings. The domiciliary setting permitted longer and comprehensive reviews. Professionals and participants agree these are advantages to the DMR setting. When services are being put together there should be enough resource within DMR services to conduct quality reviews that stakeholders see benefit in rather than focusing on achieving a certain number of reviews. In an ideal world interaction would be permitted to last as long as there were still outcomes to achieve, which require DMR professionals' expertise and the possibility to achieve them.

This is the first in-depth study exploring the value of DMRs via semi-structured focus groups and interviews to the professionals who conduct the medication reviews. The advantages and disadvantages of DMRs highlighted present information which has service planning implications. Integration of professionals is important to address the wider needs of an individual. The importance of the personality of professionals, and their ability to engage individuals in the DMR setting highlights that training needs of DMR professionals should be reviewed and perhaps standards for competencies should be set. DMR professionals uncover problems that have not been identified by any other professional. Safety is a is a concern for DMR professionals and should not be an after-thought. Managers need to ensure

appropriate measures have been taken to ensure safety of DMR professionals so that they feel at ease when working in the home environment, and able to concentrate on the task at hand. Lack of access to GPs, and/or the systems they use slows down the DMR process. DMRs need to have access to GP prescribers to resolve issues uncovered in a timely manner. There should also be some exploration around how to expand DMR roles to make professionals more autonomous e.g. prescriber or advanced practitioner roles and whether this makes any difference to outcomes than traditional pathways.

In conclusion, this chapter explored the value of DMR services from the perspective of the pharmacists who carry out the reviews. Overall, DMR pharmacists felt these services provide a lot of benefit but they do not always feel the traditional outcomes they record captures the value of services. They would like to find a way of recording outcomes that describes the impact to the individual, as they believe the value of their services lies in the difference they have made to an individual.

The next chapter explores the value of DMR services from the view point of commissioners.

Chapter 7 Commissioner perspectives on the value of domiciliary medication reviews

7.1 Introduction

In the last chapter the value of domiciliary medication reviews was explored from the perspectives of pharmacists who provide DMR services. In the interviews and focus groups the complexities of DMRs and the need to focus on the wider needs of individuals were highlighted. The pharmacy professionals felt there was value in DMR services. Like the findings of the service user interviews, the domiciliary setting was felt to be an important aspect of the medication review. The home environment permitted longer, more in-depth consultations where professionals felt they were able to review the holistic needs of patients. Pharmacists routinely used traditional clinical outcome measures to demonstrate the outputs of their services. However, they felt these traditional outcomes did not demonstrate the impact or value that DMRs can have.

As this research sought to understand the value of domiciliary medication reviews from different perspectives, this chapter presents an exploration of the value of domiciliary medication reviews to the commissioners who fund these services. In England money is passed from NHS England to Clinical Commissioning Groups (CCGs) who are then responsible for commissioning services in locality to meet the needs of their local populations (NHS England, n.d.-a). With the knowledge that novel services within the locality were funded by CCGs, in was speculated that this might also be the case across the country.

To understand value of all stakeholders, CCGs were approached to establish why they commissioned DMR services and how these services had been evaluated. This exploration was done via structured questionnaires.

7.2 Aim and objectives

The aim of this study was to:

Determine the value of domiciliary medication reviews to commissioners.

Within this aim there were three main objectives:

- To determine reasons that DMR services are commissioned
- To determine commissioner experience of DMR impact
- To determine whether commissioners agree with the opinions expressed by service users and service providers in relation to impact of DMR

7.3 Method

This study was sponsored by University College London (17/0784). It required ethical (18/NI/0049) and Health Research Authority (17/0784) approval. The research was given local approval by NOCLOR.

Data collection was undertaken by an International MSc student enrolled at the UCL School of Pharmacy under the supervision of the PhD student, who guided the aims and objectives of the study.

A target sample size of 35 CCGs was aimed for. This was chosen based on an assumption that not every CCG (n=195) (Office for National Statistics, 2018) will commission or have previously commissioned a DMR service and traditional low response rate to questionnaires (Bowling, 2014). As this was exploratory research no sample size calculations were completed. There was no intention to have a sample size with sufficient power to test a hypothesis.

Initially the MSc student used the RAND program on Microsoft Excel to randomly generate a list of thirty-five CCGs. These CCGs were contacted by telephone and 9 agreed to complete the survey. Two further cycles of random generation were attempted of 20 and 40 CCGs. As response rate still did not reach the target it was

decided to email all the remaining CCGs to ask them to complete the questionnaire. In total 185 CCGs were contacted, and 43 responses (23%) were received.

Commissioners were contacted by the MSc student via email addresses or telephone numbers publicly available on CCG websites. Participants were either asked to complete the questionnaire on the telephone or were sent an electronic link or word document that they could complete at a time convenient to them, if security protocols did not permit clicking on survey links.

The questionnaire (Appendix 7) was put together based on the published literature described in the introduction chapter. It contained 12 questions exploring DMR commissioning history, reasons for commissioning or not commissioning DMR services and how DMRs had been evaluated. Participants were only required to answer the questions relevant to them. An introductory script explaining the purpose of the research for the MSc student to use was compiled. Data collection took place over a 4-week period in June – July 2018. Simple descriptive data analysis was conducted using SPSS.

Data analysis and coding was conducted by the PhD student to ensure that data had been coded and processed correctly. Where free-text options were recorded that fitted with the pre-populated answers these were coded and added to the data set. For example, in question seven, respondents were asked who provided the DMR service. On two occasions the 'other' option was selected and 'pharmacy technicians' was added as a free-text answer. As an option for pharmacy technicians already existed within the prepopulated answers, a frequency of two was recorded for that question. Any decision to move free text to data was verified by the PhD supervisor (BC).

7.4 Results

Of the 43 responses that were received, eight CCGs (19%) currently commissioned a DMR service. Three CCGs (7%) had commissioned DMR service in the past and 32 (74%) had never commissioned a DMR service.

7.4.1 Currently commissioned DMR services

One CCG who replied to confirm they commissioned a DMR service did not answer any further questions on the questionnaire. Full responses were available for seven out of the eight CCGs who commission DMRs. Respondents were permitted to select more than one answer. Improving clinical benefits, compliance and quality of life were the most common reasons for commissioning a DMR service. (**Table 6-1**).

Table 6-1: Reasons for commissioning DMR services

Reason for commissioning service	Number of CCGs
Reduce the medication risks	3
Improve clinical benefits	5
Improve the compliance of patients	5
Improve patient's quality of life	5
Reduce the medication cost	5
Other	3

Abbreviations: CCGs = Clinical Commissioning Groups

For 'other' reasons one CCG stated their service was commissioned to reduce hospital admissions. Two CCGs listed several reasons:

'Providing support for patients with long term conditions, dementia and mental health conditions. The provision of services to enable older people to live independently. Partnership working with social services, social care and community health care providers. Reducing unplanned hospital admissions. Reducing harm from

medication. Improving the safe and efficient management of medication across the primary/secondary care interface. Reducing prescribing costs due to waste.'

When asked about inclusion criteria for DMR services, one commissioner indicated that they had not clear inclusion criteria. The remaining six respondents selected a variety of inclusion criteria. The most common inclusion criteria for service use was the number of medications (**Table 6-2**).

Table 6-2: Inclusion criteria for accessing a DMR service

Inclusion criteria for accessing service	Number of CCGs
No clear inclusion criteria	1
Age	2
Number of medications	3
Recently discharged patient	2
Specific disease	1
Other	5

Abbreviations: CCGs = Clinical Commissioning Groups

For 'other' reasons three CCGs stated frailty scores two stated referral from GP, community services or partnership services.

DMR services were mainly provided by primary care pharmacists (n-4). Two CCGs employed pharmacy technicians and one DMR service was provided by a GP (**Table 6-3**)

Table 6-3: Professionals providing DMR

Professional providing DMR	Number of CCGs
Primary Care Pharmacists	4
Hospital Pharmacists	0
Community Pharmacists	0
Pharmacy technicians	2
General Practitioners	1
Medical specialists	0
Nurses	0
Other	1

Abbreviations: CCGs = Clinical Commissioning Groups

The CCG that selected 'other' used a community trust pharmacist to provide the service.

For the seven CCGs that provided this information, five services commissioned single visit services and two commissioned multiple visit services.

When asked about outcome measures the most commonly selected answer was 'other' (**Table 6-4**). Under 'other' two CCGS listed a reduction in medication waste, one CCG listed unplanned admission avoidance and one CCG stated they ranked interventions by level of risk managed.

Table 6-4: Outcomes measured by DMR service

Outcomes used to assess the quality of the service	Number of CCGs
Total number of interventions	3
Hospital readmission rates after service	3
Number of medicines stopped	1
Cost savings	3
Quality of life	0
Other	4

Abbreviations: CCGs = Clinical Commissioning Groups

Only six CCGs responded to the question of whether they had formally evaluated their service of which zero had.

7.4.2 Decommissioned DMR services

Three CCGs reported that they had previously commissioned a DMR service. When asked why the services were originally commissioned all three CCGs selected all of the available options, describing multiple reasons for commissioning services (**Table 6-5**). One CCG who selected 'other' and stated 'referral reason depended on the individual service'.

Table 6-5: Commissioning aims

Reason for commissioning service	Number of CCGs
Reduce the medication risks	3
Improve clinical benefits	3
Improve the compliance of patients	3
Improve patient's quality of life	3
Reduce the medication cost	3
Other	1

Abbreviations: CCGs = Clinical Commissioning Groups

Only two CCGs provided their reasons for decommissioning their services (**Table 6-6**). One CCG did not respond to this question. One CCG selected every option / multiple reasons. The 'other' reasons for stopping the DMR services were the service being put on hold for one year due to staffing and prioritisation of services at the time.

Table 6-6: Reasons for de-commissioning DMR service

Reason for decommissioning the DMR service	Number of CCGs
Not enough staff to provide the service	2
Not enough patients willing to use service	1
Cost factors	1
Failed to achieve expected results	1
Other	2

Abbreviations: CCGs = Clinical Commissioning Groups

For previously commissioned services, age was the most common inclusion criteria for accessing the decommissioned DMR services (**Table 6-7**). Under 'other' one CCG listed difficulty taking medications either for practical or clinical reasons and another listed a request from another health care professional.

Table 6-7: Inclusion criteria for de-commissioned services

Inclusion criteria for accessing service	Number of CCGs
No clear inclusion criteria	0
Age	2
Number of medications	1
Recently discharged patient	1
Specific disease	0
Other	2

Abbreviations: CCGs = Clinical Commissioning Groups

One of these CCGs used primary care pharmacists to deliver the DMR service, one CCG selected every option including other and added social care professionals. The third CCG did not answer this question

Cost savings were the most used outcomes that the decommissioned services used to demonstrate the quality of the service (**Table 6-8**).

Table 6-8: Outcomes of decommissioned services

Outcomes used to assess the quality of the service	Number of CCGs
Total number of interventions	2
Hospital readmission rates after service	3
Number of medicines stopped	1
Cost savings	3
Quality of life	2
Other	0

Abbreviations: CCGs = Clinical Commissioning Groups

The CCGs of decommissioned services were asked whether they had formally evaluated their service, one CCG had through a service evaluation. No further detail on what the service evaluation involved was given.

7.5 Discussion

In the following sections the motivations for commissioning a DMR service and how impact of services was measured are discussed for currently commissioned then de-commissioned services.

7.5.1 Currently commissioned DMR services

Economic, compliance, clinical and humanistic reasons for commissioning DMR services were all chosen by CCGs, suggesting there are multifactorial reasons for commissioning a DMR service, with clinical reasons being the most predominant driver. The referral criteria for using services were also clinically centric. From the data there is no indication the impact of DMRs on wider health and social needs of individuals were a factor in the decision to commission a DMR service. Pharmacy professionals are the main providers of DMR services which fits with their role of being a medication expert. The findings of this study suggest that commissioners recognise this expertise.

As five out of seven CCGs who responded only commissioned single visit services there is a suggestion that there was an expectation that one DMR visit would be enough to resolve any issues. However, there is also the possibility that CCGs are not making this assumption and there could also be funding or capacity reasons for only providing one visit. Without further context to the answers given these remain assumptions.

For this sample most CCGs measured the quality of their service using clinical outcomes. This aligns with the literature search findings in chapter 1. None of the

CCGs who responded had formally evaluated their DMR service. From the available data it is not possible to tell how the value of the DMR services commissioned by CCGs was measured.

7.5.2 De-commissioned DMR services

Again, economic, compliance, clinical and humanistic reasons were all chosen by all the CCGs (n=3) who had commissioned a DMR service in the past. All three indicated that there were multiple reasons for commissioning a DMR service.

Like currently commissioned services the inclusion criteria reflected the spectrum of options. For the professional providing the service question one CCG selected all options. There is potential that this question was misinterpreted as who is involved with the domiciliary service, reflecting a common MDT approach rather than who specifically conducts the medication review.

One DMR service was stopped as it had less of a priority for other services commissioned by the CCG. Further information on which services were given a higher priority would help with understanding what value the DMR service appeared to lack. If only one CCG had completed a formal evaluation it remains unclear what criteria are being used to determine whether to continue funding.

7.6 Limitations

It was hoped that this study would give an indication of the prevalence of DMR services across the country. However, the response rate was too low to get a clear understanding of the national picture. The results cannot be extrapolated as the population needs and demands on CCG resource will be heterogenous across the country.

Cold calling of CCGs may have contributed to the low response rate. At attempt was made to try and mitigate a potential aversion to take part in an unplanned call by preparing an explanatory text, outlining why this research was taking place, which the MSc student was asked to deliver at the start of every call.

When a telephone call was placed the MSc student asked to speak to a member of the pharmacy team in the CCG. When an email invite was sent this was generally sent to a generic CCG email which was publicly available on the CCGs website. Specific emails for pharmacy teams were not readily available and the student struggled to complete follow-up calls to check emails had been received in the data collection period. If this research was repeated, more time should be allocated to permit follow-up communication to ensure questionnaires have been received by target participants.

Given the overlap between pre-populated and free-text answers the data collection tool could be modified to make the pre-populated answers clearer.

7.7 Conclusion

It is likely that the results of this questionnaire study do not accurately reflect the number of DMR services commissioned at the time. The Pharmaceutical Service Negotiating Committee (PSNC) website lists more than seven domiciliary medication related services (Pharmaceutical Service Negotiating Committee, 2018). From the data there is an indication that those CCGs that fund DMR services favour clinical outcomes. This finding corresponds with the literature search presented in chapter 1, which describes that within the published literature DMR services favour clinical measures and outcomes for demonstrating the impact of their service.

The results of this work suggest that the mismatch between what where patients who participate in a DMR feel the value of the service lies, and the use of

professional-centric clinical outcomes may originate when services are commissioned. However, the limitations of this piece of work mean definitive conclusions cannot be drawn from this piece of work. Future research should examine the motivation of CCGs for funding DMR services and choosing clinical outcomes metrics. The findings in this thesis around where service users and the providers of DMRs feel the value of the service lies could be used to structure the future questioning guide. This would permit a robust comparison of the similarities and differences of the values of the three stakeholder groups.

Chapter 8 Discussion and Conclusions

8.1 Context

Domiciliary medication review (DMR) services involve the in-depth review of a person's medication by a healthcare professional, usually a pharmacist, in the home setting (Sorensen et al., 2004). In March 2012 a pilot was set up by Whittington Health to embed a pharmacist within the Islington Reablement Service. The Pharmacist's role was to conduct medication reviews in the home setting for service users who needed medication related support. The service was felt to be of value. Collection of activity data and the results of a satisfaction survey resulted in the permanent funding of the service (Mccormick, 2015).

At the same time as the creation of the Reablement Pharmacist role at Whittington Health, DMR services were becoming more prevalent nationally and internationally (Loh et al., 2016). The literature linked to DMRs was also increasing. It was felt that DMRs were beneficial (Abbott et al., 2020; Fadaleh et al., 2021; McCormick et al., 2020). Studies frequently focused on clinical outcomes such as: medication related problems identified during the review process. However, there was heterogeneity in the outcomes chosen to demonstrate effect, and the impact of DMRs on the outcomes chosen.

Given the growing interest in DMRs it was felt important to critically examine the value of these services. It was hoped that this would reveal how the impact of the services should be captured, and also ensure the appropriate use of DMR resource.

This thesis set out to analyse the value of domiciliary medication reviews using a mixed-method approach. The quantitative and qualitative methods used aimed to explore the research question through multiple lenses and perspectives, to gain a rich understanding of the true value of DMRs.

In this chapter the research journey is summarised, the findings from the studies are discussed, limitations are considered and final conclusions are drawn.

8.2 The literature review

The literature review that was conducted for this research provided a greater in-depth understanding of the limitations of DMR outcomes. Clinical outcomes were the most commonly reported, followed by economic outcomes, and finally humanistic outcomes. The lack of emphasis on humanistic outcomes was surprising given the claimed patient-centric nature of DMRs. The review showed that DMRs can have, although not always, a positive impact on the three outcome categories. There was a large amount of heterogeneity amongst outcomes reported in the literature. The literature review showed that there was a lack of evidence around how the value of DMRs should be captured. It also showed that work needed to be carried out to understand where the value of DMRs lies for the individuals who use the service.

8.3 The research journey

The research journey started with some initial path finding. Action research methods were used to develop a data system that would capture the inputs (patient demographics) and outputs (number and type of interventions) from DMRs. This work was developed from an earlier web-based data capture system developed by a group of intensive care pharmacists (Shulman et al., 2015). The system was adapted to enable the capture of the volume and complexity of data recorded as part of a DMR.

Part of the work developing a web-based data collection tool (the PiR system) involved critically evaluating tools for ranking medication related interventions that could be embedded within the data capture system. However, similar to the findings of the literature review, the tools had a principally clinical focus. Choosing one of these tools did not feel appropriate when they did not permit the evaluation of the variety of interventions that occur during a real-time DMR.

Reflection on the early work resulted in a re-focus of how the research question could be framed and addressed. A more exploratory approach was taken in order to try and understand where the value of DMR services lay. As the critical appraisal of the literature suggested, the value of DMRs could be represented by clinical outcomes such as number of interventions an in-depth statistical interrogation of DMR data was carried out. Correlational approaches were used to attempt to understand the relationships between demographic variables and outcomes (interventions).

As the literature review revealed a lack of patient viewpoints or input into DMR research it was decided that these correlational techniques were also a professional-centred path to follow. It became clear that this could not be the only way the research question was investigated. Semi-structured interviews and focus groups were carried out in a bid to understand the perspectives of stakeholders, with a focus on the patient service users.

8.4 Discussion

This research set out to understand the value of DMR services to the patient, an ambition which has been met through the investigation of the patient perspective within each study. The multi-method analysis of DMR services provided a rich understanding of where the value of DMR services might lie based on 'real-world' data.

The results of each study (Figure 19) were used to obtain a layered and triangulated answer to the research question. There was overlap (convergence) between findings and key themes of studies. There was also findings and themes that were predominantly found in one study over another (divergence).

The methods revealed novel, and at times surprising findings which are discussed in the following section. Finally a re-framing of where the value of DMR services lies is proposed.

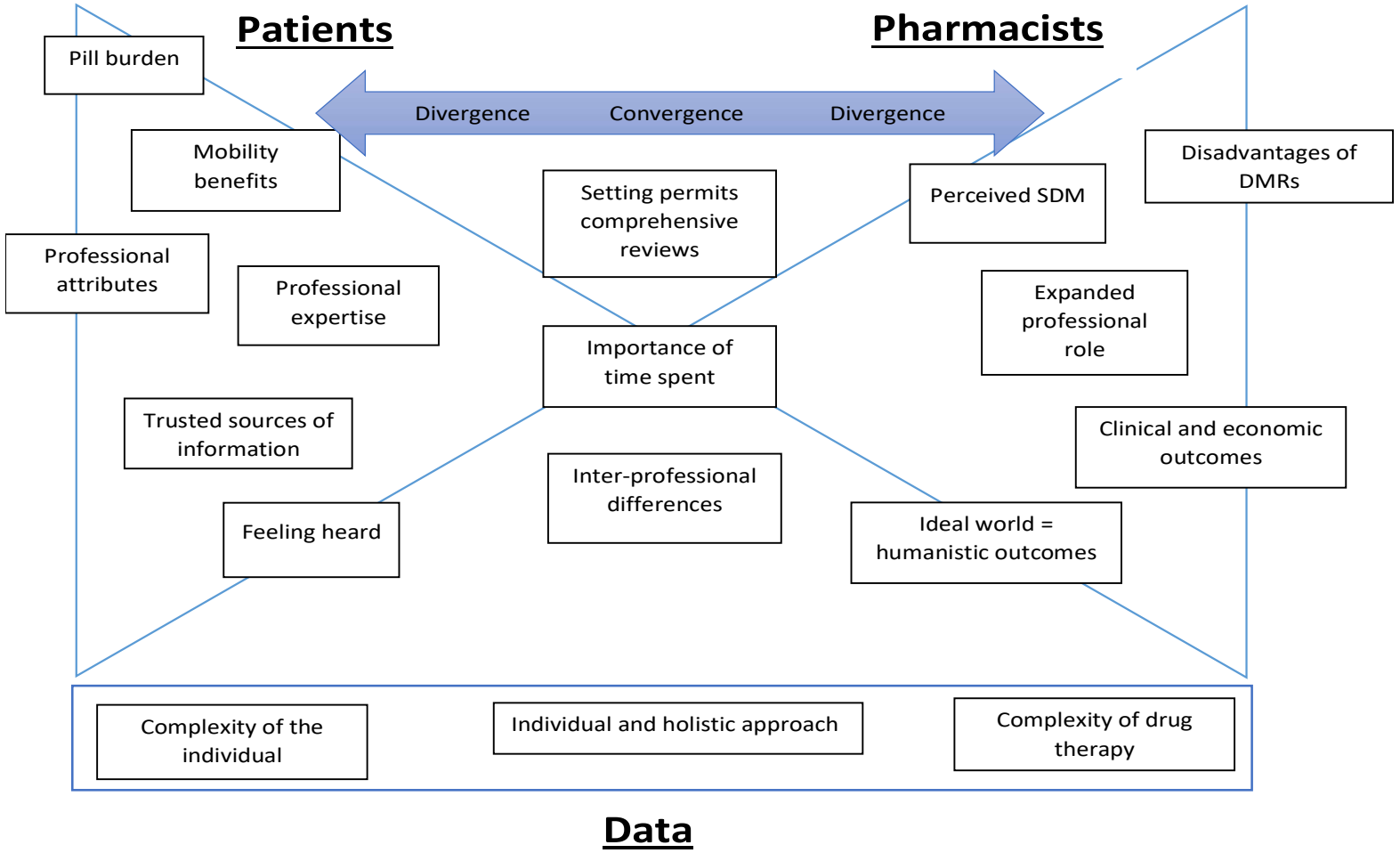


Figure 19: Summary of main themes from the research studies

The correlational techniques used showed that were real relationships between variables. However, some of these findings were surprising, and not the relationships that were expected. In the analysis sample as service users got older, they were prescribed less medications and, less time was spent with them conducting a DMR. This finding challenges the belief that as people get older, they take more medications (Department of Health and Social Care, 2021; Rochon et al., 2021) . The notion that older people would have more medication related needs (Simonson & Feinberg, 2005) was also challenged by the lack of correlation between age and the total number of interventions. These findings were the first indication that there might be sub-sets within the study sample with different needs and that a one-size fits all approach may not work for DMR service provision. This idea was echoed by the results of the cluster analysis, which highlighted that although there were hints of relationships between demographic variables, putting people into groups based on these variables may be artificial.

The bi-modal age distribution (up to 60 years and 60 years and over) within the sample was an interesting idea to explore. The literature review in chapter one suggested older people, generally defined as those over 65 years (NHS England, n.d.-b), tend to be the focus of medication reviews services. The focus on the older population could be linked to various reasons that increase their risk of medication related misadventure (Pazan & Wehling, 2021). This research suggests that an age limit should be not an arbitrary inclusion criterion for DMR services. There were younger patients in this sample who had medication related needs. The cluster analysis suggested that the cluster with the youngest membership were most likely to be referred for a DMR because of 'medication expertise' reasons, rather than access or compliance reasons. There may be an opportunity to impart medication expertise as part of a proactive medication review, rather than a reactive review when an individual has already been identified as non-adherent or is experiencing medication related problems such as side effects.

The individual, and a person-centred approach appears to be important to the DMR process. Person-centred care is not a new concept. However, over the years definitions and the extent to which it has been implemented have varied (Delaney, 2018; Pelzang, 2010; Stewart, 2001). Mediation review services are no different. A review by Heaton et al. (2017) suggested that although policy around medicines optimisation in polypharmacy calls for a patient centred approach, only one arms-length organisation considered evidence from the perspectives of patients when constructing their policy document. There appears to be a knowledge gap when developing policy. Carrying out research which assesses medicines optimisation interventions and captures the viewpoints of patients, such as the research described in this thesis can help plug this gap.

Another unexpected finding from the research was how much individuals who had received a DMR highlighted the personability, or 'niceness' of the pharmacist. The opportunity to engage in conversation with someone who was accessible and made them feel "listened to" clearly resonated with the patients. This was a surprising finding as personability was highlighted more in the qualitative data than the professional expertise the DMR pharmacists displayed. A particularly interesting finding when the remit of these services - to conduct in-depth medication reviews - is considered. The importance of the personability of the DMR professional was a novel finding which had not previously been discussed in the literature and was not directly linked to traditional clinical outcomes.

This insight does not infer that medication expertise is not an essential requirement, or that pharmacists are the fulfilling purely social needs (acting as quasi-social workers) as part of the provision of domiciliary-based health services. Data from both the quantitative and qualitative studies clearly showed that individuals have medication related needs that required intervention. The data also showed that individuals are accepting of the DMR service and professional expertise. However, it appears the individuals also want additional, non-technical, support which is part of the therapeutic landscape for them. They appreciate the socialisation that occurs

through delivery of the DMR service which seems to be valued as much as the expertise, which they perhaps take for granted.

In the published literature there is limited consideration of the attributes DMR pharmacists should have to enable them to be effective in a DMR role. The researchers involved with the HOMER trial examined whether differences in professional characteristics could account for differences in outcomes after a DMR (Holland et al., 2006). However, the focus in this study was on the differences in skills and experience level rather than the 'softer' skills attributes of the pharmacist. The socialisation aspect of the DMR not only brings about valued benefit for the individuals, but also appears to be an enabler for in-depth conversations that occur. DMR service managers should consider with more care what skill-mix and attributes pharmacists should have, beyond medication expertise, to be successful in their role in domiciliary settings.

A clear finding of the research was that the domiciliary setting was preferred to, and conferred benefits over, traditional institutional healthcare settings (i.e. settings managed directly by healthcare professionals). Individuals preferred it for convenience reasons, but also because they felt the setting permitted longer, and more in-depth interactions to take place. Professionals also echoed the sentiment that the domiciliary setting permitted in-depth reviews. Professionals felt the home-based setting gave them an insight into how the individual managed their medications day-to-day and their wider health needs. Nationally there is a policy shift towards "integrated" healthcare and providing specialist services closer to home, to enable more flexible and accessible care that will result on better outcomes (NHS England, 2019a; NHS England et al., 2014). DMR services are an example of how this can be achieved.

Some of the professional respondents highlighted concerns about their safety when going into someone's home. This is a finding that has been echoed by other DMR services (Flanagan & Barns, 2018). As DMR services align with the national priority of 'care closer to home' (NHS England, 2019a), measures should be taken to ensure

DMR professionals feel safe when they go into individuals' homes. If pharmacists do not feel comfortable this could have a knock-on effect on the *rapport* they need to establish. This could negatively impact the comprehensiveness and the socialisation aspect of DMR services which was highlighted as being valued.

The time spent by the healthcare professional conducting a DMR was also valued highly by patients. Both DMR participants and professionals felt increased time spent conducting a DMR permitted more in-depth consultations where individuals felt heard and listed to. The DMRs investigated in this thesis took an average of 46 minutes (±19) minutes. When the benefits of time were highlighted this was frequently discussed in comparison to consultation time granted with GPs. In the UK a GP consultation will last for an average of 9.2 minutes (Irving et al., 2017). Descriptions of time pressured interactions with other healthcare professionals often leaves individuals feeling frustrated and misunderstood. It is clear that there needs to be enough resource within a pharmaceutical DMR service to permit longer professional-patient interactions than would happen in other healthcare settings. This research suggests that time is an important variable for DMR services as the focus is not on one medication or problem but rather all medications being taken, as well as the wider needs of individuals.

The comprehensive scope of a DMR service is key. The informal carers who participated in interviews appreciated that a medication expert was taking the time to review their family member's medication and ensuring that all the medicines were appropriate. Having informal carers present reflects the 'real-world' environment of healthcare, where informal carers share, or take on responsibility, for another person's health (Beesley, 2006). Being an informal carer often puts a psychological strain on the carer and they can feel they are acting without support (Chipchase et al., 2001; Donnelly et al., 2008). For the informal carers who participated in interviews, the comprehensive DMR clearly removed confusion and stress around appropriateness of medication therapies.

It is clear that medicines needs cannot be looked at in isolation. The Multiple Correspondence Analysis (MCA) examined correlational relationships between categorical variables, extending the parametric correlational techniques conducted within this research. The relationships between these category variables suggest complex situations that a pharmaceutical DMR might encounter. There is a suggestion that both the complexity of the medication therapy and the complexity of the individual will impact on the outcome of a DMR. In addition, both the quantitative and qualitative data analysis highlighted that non-pharmaceutical issues were often discussed and actions were taken to resolve them during DMRs. This research suggests that DMR pharmacists needs to be able to address the wider health and social needs of an individual as well as medication-related needs. This is not something that has been considered in the literature around DMRs before and is only just beginning to emerge as an education and training component of career development.

As a consequence of this comprehensive and holistic approach pharmacists conducting DMRs feel their services have a wider impact than just pharmaceutical outcomes. However, they don't necessarily feel the outcomes they record capture this wider scope. In line with insights from the literature review, pharmacists focused principally on clinical, economic and process measure outcomes. Pharmacists all felt they would like to be able to record outcomes that additionally demonstrated the wider social impact of the service on the individual patients and carers. If the traditionally used outcomes do not represent the whole value and impact of the service, the continued use needs to be challenged.

The published literature around DMRs paints a picture which is professional-centric. It is akin to the orthodox biomedical approach to health in which professionals view health as the 'absence of disease or symptoms' and does not leave scope to consider wider determinants of health such as social or patient factors (Farre & Rapley, 2017). The literature suggests that DMR services are mostly led by healthcare professionals (HCPs) and that decisions are taken by these HCPs. There is limited focus on the

patients who use these services. This is despite findings in this thesis that there is a modern approach to DMR service delivery which is patient centric. There still appears to be some factors in DMR service development that don't quite meet the full patient-centric ideal.

Pharmacist report that they aim to conduct reviews in conjunction with patients but shared decision making is not always articulated enough in DMR services. Pharmacists believe understanding an individual's objectives and trying to meet them is an important part of the DMR service. Despite this aim, findings from the service user interviews indicated that true shared decision making was not a strong feature of the DMR reviews that had taken place. Shared decision making is a stated national priority (NHS England et al., 2014). However, it is not always a priority for patients. The interviews with DMR participants revealed instances of individuals wanting to be involved with decisions about their medications. However, this was more a desire to be kept informed than a request for true shared decision making.

Previous work examining the information needs of hospital patients proposed that 'a desire for information is not the same as shared decision making' (Duggan & Bates, 2008a). A systematic review conducted by Willeboardse et al. (2014) exploring healthcare professional and patients interactions concluded that interactions rarely go beyond information exchange. If this is a phenomenon we are also observing within DMRs, then we need to examine why. Is it because individuals don't want to make shared decisions during the DMR and are happy to defer to the pharmacists' expertise? Or is it because pharmacists are not providing information through a shared decision framework despite their aim of providing a patient-centric service? Ensuring that DMR pharmacists have the appropriate skills to engage individuals and ascertain how much they want to be involved in the decision-making process is of utmost importance.

Findings from qualitative data highlight within DMRs pharmacists are able to extend their professional boundaries and work with enhanced roles. DMR pharmacists enjoy their enhanced roles, particularly prolonged interactions with patients. This finding

backs up earlier research by Goodwin et al. (2010) suggesting that pharmacists get their professional rewards from aspects of their role, such as a challenging position and opportunities for development rather than financial renumeration. The benefits of a DMR are not only for the participants but also the professionals.

The research findings suggest that paying attention to the education and training needs of pharmacists will be key to delivering more impactful DMR services. There needs to be an educational move beyond simple consultation skills. Developing 'Advanced Generalists' is a national priority (NHS England, 2019a) and DMR pharmacists are ideally placed to take on this role. Findings from the interviews suggest DMR pharmacists are already operating beyond their orthodox professional boundaries, which they enjoy. To date, post-registration professional education and training of pharmacists has focused on early year 'foundation' training (Rueben et al., 2020). There now needs to be a strategic plan for pharmacy workforce development that better describes how the competencies that advanced practitioners need can be integrated into career pathways.

8.4.1 Implications for service delivery

This research has shown that the domiciliary setting is key as it enables more comprehensive mediation reviews and more in-depth patient-professional interactions than other settings. When planning future models for medication reviews the domiciliary setting needs to remain an option for delivery, and perhaps be considered more widely.

The literature review and this research highlighted that some services have inclusion criteria for their DMR services. Although using certain demographic criteria, based on the evidence base, can help predict which groups are likely to have medication related needs, it can also exclude those who may benefit from a DMR. For example, this research revealed it is not just housebound or individuals over a certain age that

have medication related needs. Wherever possible, and resource permits, there needs to be flexibility within DMR services to review any individual who has been identified as having a medication related need.

Sufficient time to conduct a DMR is key to the comprehensiveness of the medication review. Domiciliary medication reviews should not be subject to arbitrary time limits. There is limited consideration of the time taken to conduct a review in the literature, and this research focused on the time taken for the face-to-face element of the review. A mapping exercise to understand the preparation time needed before a review and the time needed for action after a review could help those planning DMR services understand how much personnel resource they need, or how many reviews an individual pharmacist is likely to be able to complete.

A positive of DMRs is the multi-disciplinary team working it show cased, linked to pharmacists' ability to detect and support the wider health and social care needs of patients. To enhance future service delivery time should be taken map out key MDT stakeholders DMR pharmacists are likely to have to work with. Doing this proactively at a service delivery level rather than reactively when an individual pharmacist identifies patient need could help make services more efficient. Particular attention should be paid to links to General Practitioners. Implementing actions from a DMR takes time, and at times is difficult without direct links to GPs. At the point of service planning there needs to be engagement with local GPs, this should include development of pathways for how recommendations from DMRs can be discussed and implemented.

8.4.2 Summary

This research shows the current model of DMR service delivery has strengths and weaknesses. Despite this the service model clearly has value. It is proposed that the value of DMR services is not just in the outcomes, but also in the inputs and the

process of the DMR itself (Figure 20). The wider value lies in a well thought out service, delivered by knowledgeable medication experts (pharmacists), who can engage with patients and understand their needs, even when they are not medication related. The value also lies in taking action to address the needs of the individual which again, are not always medicines related. These expected outcomes should demonstrate impact for the individual and have greater meaning for them.

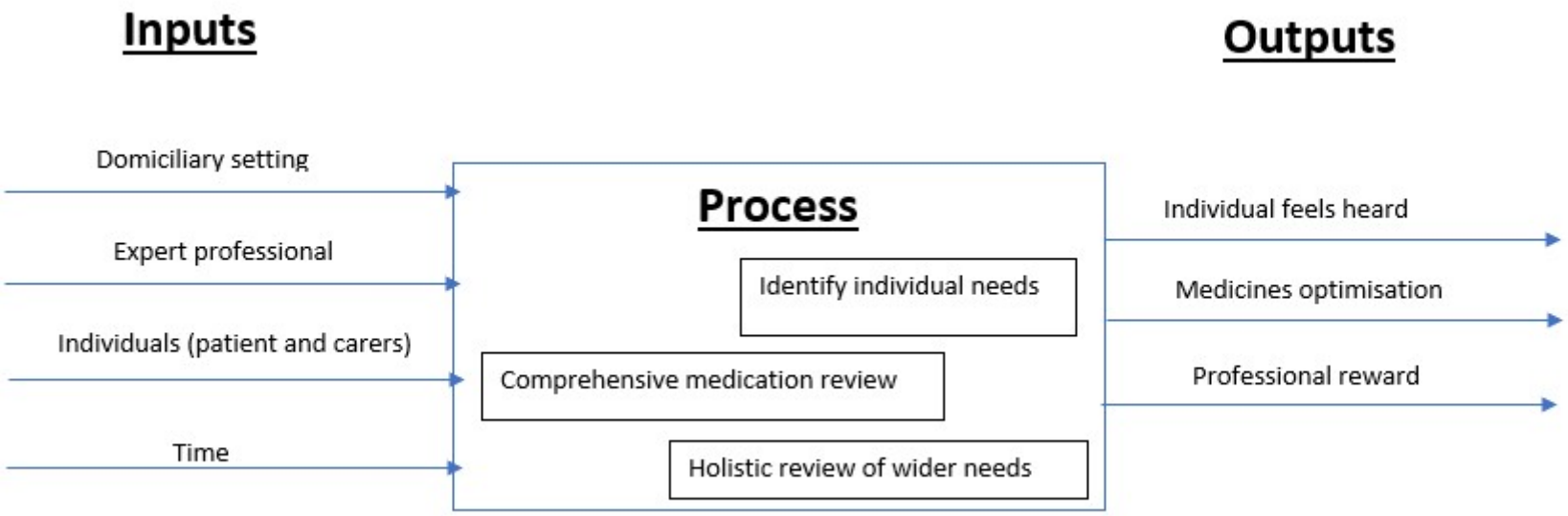


Figure 20: Diagram depicting the value of DMR services

8.5 Overall limitations of the research

Individual study limitations are discussed within the relevant chapters. In addition, there are some general limitations to the research.

The sample size for the quantitative data analysis is a limitation to this research. However, this was exploratory research aiming to investigate trends and relationships in data to gain a better understanding of DMR services, not to prove a hypothesis.

It could also be argued that sample size is a limitation of the qualitative analysis. However, in qualitative thematic analysis a large sample size is not a pre-requisite for reliable data. Interviews were continued until it was felt data saturation was reached to ensure a breadth of feedback.

Although this research was intended to real-world research, this presents some limitations to the research. The quantitative research is based on the available data from one DMR service.. although novel insights and relationships have been revealed there is further knowledge to be had for this topic. More detailed demographic and intervention data may have produced a more in-depth understanding of the topic with more generalisable findings for service delivery.

Overall the scope of the research is a limitation. It is not clear how generalisable the results of this research are to other settings or patient populations. The data analysis focused on one DMR service, the patient study recruited from two boroughs in London, the professional study recruited professionals from across the United Kingdom and the commissioner study recruited across England. However, for the latter two studies the location of the service was not a focus of the research. Being able to include a wider study sample may have enabled a broader perspective of the value of DMR services. Nonetheless, the mixed methods used in this research to investigate the value of DMR services would be relevant to other DMR services, particularly those in England.

The triangulation of results was used to reduce the limitations of each individual study and avoid over-interpretation of results. Triangulation resulted in a layered and considered conclusion of where the value of DMR services might lie.

8.6 Future work

This research has identified several opportunities for future work.

It is clear that the outcomes recorded by DMR services need to be reviewed to move from a professional centric point of view to including those of service users. A future study involving both professionals and patients could aim to use consensus methods to decide upon a set of core outcomes that could be recorded across DMR services. Use of common outcomes would be useful from a service development point of view as it would permit benchmarking between services.

For the three informal carers who took part in this research, they valued the professional knowledge and medication that expertise DMR pharmacists displayed. It appeared they felt reassured that someone had taken the time to ensure medications taken were appropriate for their family member. Future work should examine whether these findings are mirrored in a larger sample of informal carers.

The correlation analysis techniques carried out in this research could be conducted on a larger dataset to establish whether this changes the strengths of relationships, or lack of relationship between variables. This would test the generalisability of the findings of the quantitative analysis in a larger dataset.

The data analysis could also be repeated with more detailed demographic data as suggested in chapter X (cross-ref) to establish investigate whether this would change the nature and strength of the relationships between DMR variable.

The quantitative data analysis suggested the presence of a younger age sub-group within the sample, with different needs. For a future qualitative study could explore this suggestion with the recipients of DMRs who are under 65. The study could also examine whether the value of the DMR is the same for this younger cohort.

8.7 Conclusion

This is the first in-depth exploration of the value of DMRs using a mixed-method approach. The quantitative data correlational analysis goes beyond what has been published in the literature to date, which has mainly been descriptive analysis of process measures and frequencies of interventions, or comparison of the number of interventions between a control and intervention arm. The qualitative data analysis, particularly the interviews with service users, fills a gap in DMR knowledge and provides an important perspective, perhaps the most important perspective in a professional-centric published evidence base. The findings from this real world research have been used to come up with a new contextual view of DMR services and their wider value.

DMR services clearly provide benefit and are valued by stakeholders. However, the value is much more than the 'number of interventions made'. There is more to healthcare than carrying out targeted interventions. As a result, there needs to be a move beyond consultation skills training for pharmacists. DMR pharmacists need to be able to engage individuals in conversations about their health and how the medication they are being asked to take links to their wider needs. They also need to be able to elicit personalised objectives for the DMR so that the interaction has meaning. DMR Pharmacists need to understand patients' relationships with complex medications and how patients live with their medications so that they can deliver interventions which relate to the holistic needs of individuals. Pharmacists need to be immersed in healthcare rather than being the 'gateway professional' they are sometimes viewed as being. DMR pharmacists clearly have foundation skills in this

area, the lasting impact of the DMR was that individuals felt listened to. These skills need to be enhanced.

Equally, focusing solely on outcomes when assessing value is too simplistic. Outcomes are important, and medicines are complex technological products. We need the medicines expertise but the process of applying that expertise may be just as valuable to patient care and wellbeing as counting how many interventions are being made, in patients with complex medication regimes.

The value of DMRs is afforded through the domiciliary setting and the time spent, permitting longer in-depth interactions between individuals and the DMR pharmacist. This has important implications for service provision. Pharmacists need to be afforded enough time to have comprehensive and individualised conversations during DMRs. The emphasis should be on quality of the DMR interaction, not the quantity of DMRs completed.

The multi-method and multi-perspective approach enabled a richer understanding of where the value of DMRs services lie, which was previously unknown. It demonstrated the wider social impact DMR services provided by medication experts can have. Comparing the objective data analysis, findings from stakeholder analysis and the published literature leads to the conclusion that there needs to be a change to how DMR services are approached, designed, delivered and even outcomes recorded for patient focused domiciliary services.

8.8 Afterword: Post COVID-19

The studies in this thesis were completed pre-COVID-19 pandemic. There will inevitably be questions about relevance given the seismic shifts that COVID brought about. In 2020 the pandemic disrupted life as we know it. In healthcare it prompted major shifts in how services are delivered (Majeed et al., 2020; Willan et al., 2020). Technology use was enhanced and remote consultations became the norm for many services to keep both professionals and individuals safe (Wosik et al., 2020). A lot of these changes to healthcare delivery are likely to stay around. However, remote and technology enabled consultations cannot to be the answer to all health care provision. Anecdotally, DMR practitioners have reported their services have been put on hold. I would argue that when it is safe to do so that DMR services should return. This research has shown that the domiciliary setting affords advantages over traditional healthcare settings. Given the highlighted importance of personal interactions it is hard to imagine the same connections being made via a video call. It should also be remembered that recipients of DMRs are generally from an older population who are known to be on the wrong side of the age-based digital divide (Martins Van Jaarsveld, 2020). Failure to return to DMRs would represent a missed opportunity to make a difference to them and their health.

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Appendix 1: RAG-rated risk of bias within prevalence studies, assessed against JBI critical appraisal checklist for prevalence studies

Study	Was the sample frame appropriate to address the target population?	Were study participants sampled in an appropriate way?	Was the sample size adequate?	Were the study subjects and the setting described in detail?	Was the data analysis conducted with sufficient coverage of the identified sample?	Were valid methods used for the identification of the condition?	Was the condition measured in a standard, reliable way for all participants?	Was there appropriate statistical analysis?	Was the response rate adequate, and if not, was the low response rate managed appropriately ?
Black and Glaves 2011									
Castelino 2010 (1)									
Castelino 2010 (2)									
Coleman 2001									
Dilks 2016									

Study	Was the sample frame appropriate to address the target population?	Were study participants sampled in an appropriate way?	Was the sample size adequate?	Were the study subjects and the setting described in detail?	Was the data analysis conducted with sufficient coverage of the identified sample?	Were valid methods used for the identification of the condition?	Was the condition measured in a standard, reliable way for all participants?	Was there appropriate statistical analysis?	Was the response rate adequate, and if not, was the low response rate managed appropriately ?
Gilbert 2002									
Hsia 1997									N/A
MacAuley, 2008									
Moultry 2008									
Naylor and Oxley, 1997									
Ong 2016									

Study	Was the sample frame appropriate to address the target population?	Were study participants sampled in an appropriate way?	Was the sample size adequate?	Were the study subjects and the setting described in detail?	Was the data analysis conducted with sufficient coverage of the identified sample?	Were valid methods used for the identification of the condition?	Was the condition measured in a standard, reliable way for all participants?	Was there appropriate statistical analysis?	Was the response rate adequate, and if not, was the low response rate managed appropriately ?
Pherson, 2014									
Quirke 2006									
Schneider 1996									
Steele 2016									
Triller 2003									

	Yes		Partially
	No		Unclear risk (not enough information provided)

Appendix 2: RAG-rated risk of bias with randomised control trials, assessed against Cochrane risk of bias assessment tool v5.1

RCT	Random sequence generation	Allocation concealment	Blinding of participants & personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting
Elliot 2012						
Holland 2005						
Holland 2006	As per Holland 2005					
Krska 2001						
Krska 2007	As per Krska 2001					
Lenaghan 2007						
Lowe 2000						
Naunton 2003						

RCT	Random sequence generation	Allocation concealment	Blinding of participants & personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting
Nissen 2005						
Olesen 2014						
Pacini 2007	As per Holland 2005					
Sorensen 2004						

	Yes		Partially
	No		Unclear risk (not enough information provided)

Appendix 3: RAG-rated risk of bias in cohort studies, assessed against JBI critical appraisal checklist for cohort studies

Study	Were the two groups similar and recruited from the same population?	Was the exposure measured in a valid and reliable way?	Were confounding factors identified?	Were strategies to deal with confounding factors stated?	Were the participants free of the outcome at the start of the study?	Were the outcomes measured in a valid and reliable way?	Was the follow up time reported and sufficient to be long enough for outcomes to occur?	Was follow up complete, and if not, were the reasons to loss to follow up described and explored?	Were strategies to address incomplete follow up utilized?	Was appropriate statistical analysis used?
Bellone 2012										
Cheen 2017	.									
Reidt 2014										

	Yes		Partially
	No		Unclear risk (not enough information provided)

Appendix 4: Development of an electronic data capture system for DMR services

Introduction

The published literature around DMRs pointed to the impact of services being clinical and economic. To explore this theory and whether it matched findings for real-life services such as the Islington Reablement DMR service an in-depth exploration of data was planned. Before this could happen there needed to be a way of capturing data in a useable format – a data capture system was needed. When inputting and categorising data questions arose that needed to be answered. This chapter describes the early path finding in the research process and how the defined studies in chapters five to eight were decided upon. The path finding involved developing the PiR system, exploring whether a published scale could be used to evaluate interventions and investigating the usability of the PiR system.

Setting the scene: pre-doctorate work

Before the work described in this chapter began, data from each domiciliary visit was recorded in a word document template. This was important from a governance point of view as it contained a record of the information gathered during a medication review and the resulting actions. However, the records did not enable easy analysis of data, due the amount of free text within the record and because the information was not captured in a consistent way, making data entry difficult. When reports on service activity were compiled paper records were used to describe service activity. However, there was a duplication of work, as information had to be extracted and turned into a format appropriate for simple analysis. Completion of paper records was arduous and resource intensive; sections of the record could be completed during the review but in the main notes were made during the review and paper records were completed at a later point.

The following section describes how the paper template was first developed (pre-doctorate work) and the subsequent development of PiR.

Development of the domiciliary visit record

The paper template recorded interventions and outcomes from domiciliary medication reviews according to four main categories: access, compliance, clinical and other. This was decided after attending 'Clinical Pharmacy in the Community Peer Group Meetings' run by a Care of Older People Consultant Pharmacist. In these meetings, case studies were reviewed and discussed by pharmacy professionals involved in medication review outside the traditional hospital and community pharmacy settings. In these case studies, interventions were always presented under three categories - access, compliance and clinical. This was based on experience of conducting reviews as part of the Lambeth Integrated Clinical Pharmacy (ICP) Service (NHS Lambeth Clinical Commissioning Group, n.d.). This classification system has subsequently been published (Oboh et al., 2018).

Locally a decision was taken to add a fourth category of 'other' to the Reablement DMR paper-based records. This was incorporated based on experience of service users asking for input on, or the pharmacist identifying non-medication related issues during the medication review.

The final section of the paper-based records contained a table summarising the problems identified, interventions taken and outcomes (usually whether an intervention had been actioned, or not) within these four categories.

Identifying the need for an electronic data system

To demonstrate activity from the Islington DMR service it was always felt that a method of enabling timely capture and analysis of DMR data was needed. As only one pharmacist was employed within the Islington Reablement service there was a finite amount of resource for preforming medications reviews. Therefore, efficient processes that would enable the maximum amount of time for medication reviews was important.

Timely data capture became more important when the Reablement DMR service became part of the PhD research described in this thesis. Before the research question could be addressed, a meaningful method of capturing data that would enable analysis of the demographics of service users and the type of interventions that occur during DMRs was needed. There needed to be an exploration as to whether the claimed benefits of DMRs matched the impact in a real-world service.

To help identify an appropriate system a 'wish list' outlining the key features of the desired system was compiled (Table 4a).

Table 4a: Wishlist for data capture system

Wish list	Why?
Can be assessed at multiple sites and from service users' homes	To allow real time capture and update of data
Format of data captured permits easy analysis	Interrogation of data is key to answering research question. Data reporting against KPIs is needed to demonstrate activity within the service
The system is efficient to use	Resource is limited. New method of recording visit data should be faster than current method to release time for further visits
Easy/ Intuitive to use	System is intended to be used by multiple users

The Pharmacy Care Record System

Through knowledge of another project that had taken place at Whittington Health it was known that a web-based intervention data collection tool had been developed for use in the inpatient hospital setting to capture the interventions of clinical pharmacists. A group of intensive care unit pharmacists published a paper detailing the impact of their interventions using this system (Shulman et al., 2015). This tool was known as the Pharmacy Care Record (PCR); a web-based tool for capturing the clinical interventions of hospital-based pharmacists.

It was initially hoped that this system could be used directly in the domiciliary setting. However, review of the system quickly demonstrated that it was not fit for this purpose as it did not allow data capture of all the complex interventions that occurred in the domiciliary settings. As the PCR system was developed for use in the inpatient setting, it had a strongly clinical focus. The system only allowed capture of clinical interventions, it did not consider wider-reaching medication and health related problems, meaning access, compliance and other category problems, as well as the interventions taken to address these issues could not be recorded within the system.

It was decided to use the PCR system as a basis for a new data capture system that could be used by DMR services. It was also decided that ideally a scale would be integrated within a system to enable an assessment of the impact of interventions, rather than just recording problems and actions.

Real-world applications

As a step in determining whether PiR has any real-world capabilities for capturing DMR data it was decided to test the usability of the system. This was explored to investigate the potential of having a data capture system that could be used by different DMR services to capture data in a consistent way.

Aim and objectives

The aim of this path-finding work was to:

Develop and test the usability of a system that could be used to capture data from DMRs

Underpinning this aim was four objectives:

- To develop an electronic data capture system that could be used to record DMR information
- To turn information inputted into data that could be extracted for analysis
- To synthesise the literature of available intervention ranking scales and assess usability to DMR services examining: the development of the scales, outcome measures and domains of the scales
- To assess the usability of the PiR system by interrogating three parameters; how intuitive the system is, how long it takes to use and user satisfaction

Method

Repeated action research cycles were followed: information from DMR records were input into the PiR system, problems preventing input of data were identified, solutions were proposed (and usually discussed with PCR developer) and enacted. At several points, after a one-month pilot (Nov-Dec 2015), 1 years retrospective input of data (2015) and 1 years prospective input of data (2016), data was extracted, cleaned and analysed to review whether the aim had been met. The results from data analysis are discussed in Chapter 4. At the end of each cycle there was reflection on whether the problem(s) identified relating to data input had been resolved. New cycles occurred for remaining or additional problems. Before statistical analysis of data occurred a further 6 months of data (January – June 2017) was added to increase the number of cases available for analysis. No further changes to the system were made during the addition of the final 6 months of data.

To find a scale for ranking interventions a literature search of the Medline and Embase databases until June 2016 was conducted using subject headings. Abstract and full text screening was carried out. Systematic review papers were excluded but individual papers appraised were assessed for relevance. Reference lists of included papers were searched for other relevant papers.

Subject headings for Medline search: **(1) Health impact assessment, (2) clinical coding, (3) patient safety, (4) medication errors, (5) evidence-based medicine, (6) evaluation studies, (7) pharmacists**

For the usability testing a target sample size of 5 participants was set – this was established as an appropriate size in usability testing to enable a problem being detected 85% of the time (Nielsen & Landauer, 1993). A mini analysis was planned after 2 participants, to review whether issues were being detected or whether sample size needed to be reviewed.

An invite letter and information sheet explaining the usability testing was sent to pharmacists conducting domiciliary medication reviews in the local boroughs, Haringey and Islington. This population has been chosen as their experience would help them understand scenarios and because they are a target user group. They were also chosen for practical reasons; to reduce the chance of travel distance being a reason that an individual would not participate. The testing took place at the Whittington Hospital.

Two observers were present during this process: PhD candidate/developer (PM) and PhD supervisor/ observer (BC). The PhD supervisor was present to reduce the chance of bias from the PhD candidate/developer who also evaluated usability. A research protocol was followed. Participants were asked to input data from written scenarios into the PiR system using the 'Think Aloud' methodology. An instructional video was used to demonstrate the technique (https://www.youtube.com/watch?v=9wQkLthhHKA). Prompting questions were used if a participant was not explaining their actions. A user guide was provided. Field notes were taken and sessions were recorded. Problem statements, severity of problems and action plans for correcting them were compiled (Usability.gov, n.d).

Results

The following section describes the results of the study within the context of the study objectives.

Development of the PiR system

Action Research methodology enabled prompt development based on real time feedback. There were various stages in the development stages of the PiR system (Figure 4a).

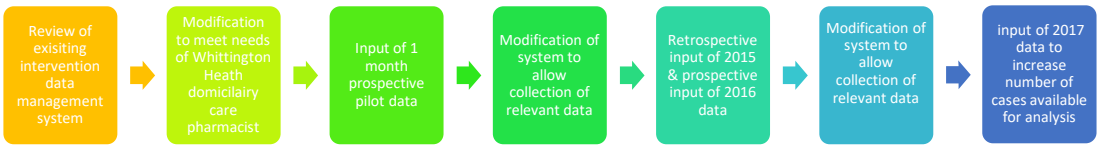

Figure 4a: Stages of PiR development

As the system was set-up as a web-based database which could be accessed anywhere there was an internet connection the first 'wish' (**Error! Reference source not found.**) was met; the system could be used from multiple sites.

During the development of the PiR system several changes to the system were made (Table 4b).

Table 4b: Changes made to the PiR system during development

Changes made to the PiR system	Rationale
Stage: initial development	
Breakdown of each intervention record into problem, reason, intervention and outcome	To enable gathering of as much information as possible – at beginning of the research it was unclear which metrics or outcomes would prove important during analysis
Addition of visit page	Felt it was important to capture why individuals were referred for a domiciliary medication review and the face-to-face time they spent with a pharmacist. Knowing this information could enable later targeting of service user groups/ case finding
Additional fields added to demographic page	Again, to capture as much data as possible to enable examination of trends and correlations that could be used for service development

Changes made to the PiR system	Rationale
Addition of WHO ICD-10 classification system	To capture co-morbidities individuals had. WHO ICD-10 classification system used as it is recognised world-wide. ICD-10 has multiple levels of categories and sub-categories; highest level used to avoid data overload. Most common categories encountered were added with the addition of an 'other' category to ensure experience matched new cohort of patients.
Stage: one-month pilot (23/11/15 – 18/12/15)	
Addition of new categories	Original category lists did not allow capture of the variety of problems and interventions that are identified and recommended as a result of a domiciliary medication review
Option to record whether outcome to recommendation was achieved at the time/ during the medication review or after	If data from PiR is to be used to service evaluation and development, it will be useful to know how often a problem requires additional action from the pharmacist after the medication review
Tick box added to indicate that a record was complete	Due to the iterative nature of medication reviews it can take varying periods of time to bring a case to conclusion. This means that an individual's records may not be completed in full at the same time. Introducing a tick box enables searching for 'incomplete' records
Reason for referral added to patient record	When review extracted data from PiR we felt that knowing why and individual had been referred would be useful for service planning. It is also useful for understanding whether the person referring has an accurate understanding of the individual's medication issues
Stage: input of 2016 and 2017 data	
Addition and deletion of data labels in system based on input of real-world data. When data was exported it became apparent that certain codes had never been used; generally, because another code covered the information needed. When multiple codes were felt to have the same meaning they were replaced with a new overarching code.	To avoid duplication and keep data labels to a minimum while still capturing the relevant information from DMRs and permitting statistical analysis
Abbreviations: WHO = World Health Organization, ICD-10 = International Classification of diseases-10, PiR = Patient Intervention Record	

Changes made to PiR system during pilot

The main change during the pilot was the development of categories for capturing drug related problems (DRPs). There is a body of research around the concept of (DRPs). It was hoped that a DRP classification system could be used within PiR to enable comparison of data across services or care settings. During the development of PiR an aggregated DRP list developed by Basger et al. (2015) was found. The aggregated list was developed from 7 previously published categorisation systems: 2 versions by Cipolle et al. (2004, 2012), The D.O.C.U.M.E.N.T system (Mackenzie Williams et al., 2012), the iMAP system (Crisp et al., 2011), the Norweigan system (Ruths et al., 2007), the PCNE system (Pharmaceutical Care Network Europe, 2010) and the Westerlund system (Westerlund & Marklund, 2009). The resulting list had 3 levels of complexity describing DRPs. It was decided to use this aggregated system within PiR as it was developed from classifications developed for use in multiple care settings. . Based on experience of the type of problems found during DMRs it was decided that the subcategories from the second level of the aggregated system would be most appropriate for use. However, when incorporated into the PiR system the categories still did not encompass all the areas found in practice so supplementary categories had to be added.

The aggregated DRP list focused on problems related to clinical issues, with a spotlight on medication usage. The PiR system also contained access, compliance and other categories, in addition to clinical. The problem lists for these categories were populated from information recorded in previous domiciliary visits and professional knowledge. Intervention categories were compiled from those listed in the original PCR system and logical outcomes to the problems posed in each category.

Changes made during the input of 2015 data

Recording of the 2015 referrals permitted the iterative process of reviewing the category labels that had been added for the problem, recommendations and actions in each intervention type record to ensure they adequately captured the detail of the reviews without developing an overly lengthy list of options. This process also involved ensuring codes had not been added that duplicated the meaning of others and changing the titles of some codes to make their meaning clearer.

Other housekeeping issues such as changing all medication names to generic was carried out to prevent confusion when recording the names of medicines DMR participants were taking.

Changes made during the input of 2016 and 2017 data

Input of 2016 continued the process of reviewing and updating category labels. At the end of this time period if was felt that the system was ready for statistical and usability testing. The 2017 data was input to increase the number of cases included in the statistical analysis.

Scales for ranking interventions

The literature search for a scale to rank interventions returned 19 papers describing scales for ranking or assessing interventions were found. One tool (Chedru & Juste, 1997) was excluded as an English translation could not be located. Eighteen scales were assessed for use within PiR. The scales were developed in various healthcare settings, they had different structures and focused on different outcome measures (Table 4c).

Table 4c: Overview of scales for ranking interventions

Authors	Setting	Domains examined by tool	Structure of scale	Developed from work of previous researchers?	Outcome measures (economic / clinical / humanistic)
Shulman et al. (2015)	Critical care units across UK	Errors – how much potential harm has been avoided Optimisations – contribution to enhance patient care Consults – information provided in response to a specific request	Low impact Moderate impact High impact Life saving	DOH: Building a safer NHS (2014) Bates et al. (1995) Folli et al. (1987)	Clinical Humanistic(?)
Folli et al. (1987)	2x paediatric hospitals; comprising paediatric intensive, neonatal intensive and non-intensive paediatric beds in USA	Errors – how much potential harm has been avoided	Significant Serious Potentially lethal	Information not provided, appears to be an original scale	Clinical
Bates et al. (1995)	2x tertiary care hospitals in USA	Adverse drug events – how much potential harm has been avoided	Significant Serious Life-threatening Fatal	Modified from earlier work by Folli et al (1987)	Clinical

Authors	Setting	Domains examined by tool	Structure of scale	Developed from work of previous researchers?	Outcome measures (economic / clinical / humanistic)
Hatoum et al. (1988)	Tertiary care hospital in USA	Impact of interventions linked to medication appropriateness on quality of patient care and cost avoidance	1.Adverse significance 2.No significance 3.Somewhat significant 4.Significant 5.Very significant 6.Extremely significant	Based on earlier theory by Sorby et al. 1976, McGhan et al. 1987and Schranz and Kaczmarek 1986	Clinical Economic
Overhage and Lukes (1999)	General hospital in USA	Impact of interventions relating to medication errors and cognitive services; examining severity of error and value of service	***Severity of error:*** A.Potentially lethal B.Serious C.Significant D.Minor E.No error ***Value of service:*** 1.Extremely significant 2.Very significant 3.Significant 4.Somewhat significant 5.No significance 6.Adverse significance	Literature search performed and decided to use work of Folli et al. 1987 for severity of error and Hatoum et al. 1988 for value of service *No explanation given as to why authors wanted to change numerical value of scale items*	Clinical

Authors	Setting	Domains examined by tool	Structure of scale	Developed from work of previous researchers?	Outcome measures (economic / clinical / humanistic)
Somers et al. (2013)	Geriatric ward in Belgium	Clinical relevance of pharmacist interventions	0.Adverse significance 1.No clinical relevance 2.Possibly low relevance 3.Possibly important relevance 4.Possibly very important relevance 5.Possibly lifesaving	Claims to be based on Overhage and Lukes (1999) which was originally developed by Hatoum et al. 1988 although the word *significance* has been interchanged with *relevance* *Authors change numbering of scale slightly from 1-6 to 0-5*	Clinical
Society of hospital pharmacists of Australia (2005)	N/A – not developed as a result of a study	Impact of pharmacist interventions – not specific to errors	1.Insignificant 2.Minor 3. Moderate 4.Major 5.Catastrophic	Unclear from original document but Vo et al. (2016) states that this scale is developed from Western Australian Pharmacist Group (1991). modified without explanation	Clinical Economic

Authors	Setting	Domains examined by tool	Structure of scale	Developed from work of previous researchers?	Outcome measures (economic / clinical / humanistic)
NHS Croydon – adapted RiO scale (2012)	Domiciliary setting, residential homes, care homes and GP practice reviews	Likelihood that an intervention will avoid a hospital admission	Level 1: no likelihood Level 2: possible Level 3: likely	Adapted from the hospital avoidance scale within the Rio system	Economic
Rupp (1992)	Community pharmacies in USA	Likelihood that without intervention a prescribing problem would have resulted in patient harm	Likert scale from 0 to 1 Very unlikely somewhat unlikely Neither likely nor unlikely Somewhat likely Very likely	Details not given but appears to be a simple Likert scale	Clinical (errors) Economic
Blix et al. (2006)	Internal medicine and rheumatic disease wards in Norway	Clinical significance of pharmacist interventions in response to DRPS identified	Extremely important significance Major clinical significance Moderate Clinical significance Minor clinical significance	Authors do not provide details. Appears to be an original scale	Clinical

Authors	Setting	Domains examined by tool	Structure of scale	Developed from work of previous researchers?	Outcome measures (economic / clinical / humanistic)
Cornish et al. (2005)	General medicine wards in a Canadian hospital	Potential of medication discrepancies at admission to cause harm	Class 1: No potential to result in discomfort or clinical deterioration Class 2: potential to result in moderate discomfort or clinical deterioration Class 3: potential to result in severe discomfort or clinical deterioration	Information not provided, appears to be an original scale	Clinical (discrepancies)
Hawksworth et al. (1999)	Community pharmacies in the UK	Impact of interventions, centred around harm	Scale of 0 (definitely not) to 10 (100%) that the following outcomes were avoided: Detrimental to the management of the patient Improved efficacy of the patient's therapeutic management	Information not provided, appears to be an original scale	Clinical (harm)

Authors	Setting	Domains examined by tool	Structure of scale	Developed from work of previous researchers?	Outcome measures (economic / clinical / humanistic)
			Prevented harm to the patient Prevented a hospital admission		
Dean and Barber (1999)	4 NHS hospitals on the UK	Severity of errors based on potential patient outcomes	Visual analogue scale from 0 (no potential effect) to 10 (death)	Not a lot of information provided but authors state they decided to use a 10-point scale for maximum sensitivity	Clinical (potential outcomes)
Alderman 1997	Acute psychiatric hospital in Australia	Significance of interventions (to either optimise therapy or reduce ADRs)	Minor Moderate Major	Information not provided, appears to be an original scale	Clinical Economic
Lesar et al 1990	Tertiary care hospital in USA	Significance of errors	Potentially fatal or severe Potentially serious Potentially significant	Folli et al – with some slight modifications	Clinical
Western Australia Clinical Pharmacist Group (1991)	Metropolitan and country hospitals in western Australia	Examining relationship between frequency of errors and the potential clinical significance	Potentially lifesaving Preventing major toxicity and end-organ damage	Hatoum et al – with modifications	Clinical

Authors	Setting	Domains examined by tool	Structure of scale	Developed from work of previous researchers?	Outcome measures (economic / clinical / humanistic)
			Optimising drug therapy Minor		
Hartwig et al. (1991)	Ohio State University Hospitals - Acute teaching hospital and research institution	Assessing severity of medication errors	0: No medication error 1: No harm 2: Need for increased monitoring of the patient. No change to vital signs and no harm 3: Need for increased monitoring of the patient. Change to vital signs but no harm 4: Need for treatment of an adverse event with another drug, increased length of stay or affected the patient's participation in an investigational drug protocol 5: Permanent harm to patient 6: Death of the patient	Information not provided, appears to be an original scale	Clinical

Authors	Setting	Domains examined by tool	Structure of scale	Developed from work of previous researchers?	Outcome measures (economic / clinical / humanistic)
NCC MERP (2001)	Unclear – developed by expert group?	Severity of medication errors	No error (a) Error, No Harm (b, c & d) Error, Harm (e, f, g & h) Error, Death	Based on earlier work by Hartwig et al. (1991)	Clinical

Abbreviations: DOH = Department of Health, NHS = National Health Service, USA = United States of America, DRP = Drug related problem, UK = United Kingdom, ADR = Adverse drug reaction, NCC MERP = National Co-ordinating Council for Medication Error Reporting

The development of the scales

The authors rarely described the means of scale development in detail within their papers, making it difficult to appraise the methods of development. An exception to this is the work of Overhage and Lukes (1999) who described the development of their scales in detail. The authors started with a literature search, the results of which were described and an explanation given as to why the work of Folli (1987) and Hatoum (1988) was preferred over others for incorporation into their scales.

Authors such as Somers et al. (2013) used tools originally developed by other researchers. They did not detail the development of their scale but cited the original publication. Other authors such as Shulman et al. (2015) and Lesar et al. (1990) stated that their scale was based on the earlier work of other researchers (Bates et al., 1995; Department of Health, 2014; Folli et al., 1987). They made, usually small modifications and did not describe how or why this had taken place. For example: Lesar et al. (1990) changed the 'fatal' category to 'potentially fatal or severe' which can cause confusion to the reader as there is already a 'serious' category for interventions that may have prevented a large scale harm to the patient category.

For some scales, which were based on the work of previous authors the ordering of scales was changed. Overhage and Lukes (1999) used an earlier scale developed by Hatoum et al. (1988). Both authors use numerical values to depict the significance of interventions. However, Overhage and Lukes (1999) inverted the order which could lead to a misinterpretation of results if comparing interventions between the two authors. Somers et al. (2013) also used the same scale but they started the numerical ordering from zero rather than one which could also introduce confusion to users.

The outcome measures

In Chapter One DMR outcomes were categorised outcomes as clinical, economic and humanistic, in line with definitions taken from the ECHO theoretical model (Kozma et

al., 1993). The ECHO model was also used to categorise the outcomes captured by the scales for ranking interventions. Most of the scales had an overarching clinical focus derived from the potential impact of avoiding errors. As the role of clinical pharmacists has developed, so too has the focus of intervention scales. Although, medication errors are still examined, additional clinical interventions relating to cognitive services (Dooley et al., 2005; Overhage & Lukes, 1999), appropriateness of medications (Hatoum et al., 1988; Somers et al., 2013) and optimisations (Shulman et al., 2015) were also considered.

Shulman et al. (2015) claimed to examine 'clinical significance/ importance to the patient. However, there is no discussion of patient reported outcomes or a clinician's assessment of how the patient might feel. Instead the focus of impact is in fact clinical. It is worth noting that this study was carried out on critical care units. The nature of the condition of patients in this setting may mean that assessment of the importance to the patient was very difficult or impossible.

Several researchers (Alderman, 1997; Croydon Borough Pharmacy Team, 2012; Hatoum et al., 1988; Rupp, 1992; Society of Hospital Pharmacists of Australia, 2005) assessed economic impact, estimated from the costs of the potential clinical outcome avoided as a result of the pharmacists' interventions. Techniques for estimating cost varied, most authors used the probability of an extended hospital stay or in the case of the adapted Rio scale admission avoidance as interventions take place in an individual's home.

The structure and domains of the scales

The number of points on the scales appraised varied from three to six. A common theme throughout the intervention scales was that authors provided examples for each of the points within scale. It appears that this is an important element of having an understandable and useable scale.

Most the scales in the literature are single scales either evaluating the potential consequences of an error or inappropriate prescribing had not action been taking or the converse, the impact of the intervention. The exception to this is the scale developed by Overhage and Lukes (1999). They argued that a scale cannot examines both errors and the value of service simultaneously, as a conflict would arise from using a single scale. They demonstrate this using identical studies and present two scales. However, in their conclusion they postulate that using both scales to assign a single code to interventions could be a way to simplify this process. Interestingly Somers et al (2013) built on the work of Overhage and Lukes (1999) but the authors did not feel the need to differentiate between interventions relating to medication errors and other pharmacist interventions, instead they used a single scale. This raises the question as to whether it is possible to use a single scale for intervention impact without creating the conflict that Overhage and Lukes (1999) argue would arise in their paper.

The adapted RiO scale (Croydon Borough Pharmacy Team, 2012) was developed in the domiciliary setting and focuses on potential economic impact of interventions. It is unique in its encouragement of users to consider the individual circumstances of an intervention; it highlighted that the same intervention in two different people could have a different impact depending on the health and social factors present.

Usability testing

The PiR system was tested against three parameters: how intuitive it was to use, how long it took to use and user satisfaction with the system.

Is the system intuitive

How intuitive the system was to use was measured by 3 parameters (Table 4d).

Table 4d: PiR intuitive measures

	No. times refers to user guide	Asks researcher a question	Input errors
User 1	11	0	0
User 2	1	3	3
User 3	4	1	1

During testing there were some barriers to input of data, indicating areas where the system may not have been intuitive to use.

Recording of the number of conditions according to the ICD-10 classification system caused confusion for all participants. One user understood that that the ICD-10 system should be used to categorise co-morbidities. However, they did not realise that these should be quantified numerically. One user did not spot the ICD-10 link (URL) and categorised the co-morbidities using their own knowledge. The final user found the ICD-10 link but thought the intention was to copy and paste the relevant codes into the PiR record.

Categorisation of interventions as either (1) access, (2) compliance, (3) clinical or (4) other was the main reason that participants referred to the usability guide. There appeared to be a conflict between the wording in the scenarios and how users thought interventions should be categorised.

The presence of extra details and free-text boxes caused confusion with users who thought that adding details to the box was compulsory. As there was no clear instruction regarding what to add, the information recorded varied from user to user. Adding information to the boxes increased the time it took for users to record the scenario they were given within PiR.

One user felt that the home page was cluttered and that this made it difficult to understand how to start using the system without referring to the user guide. This blockage was not commented on and did not appear to affect the other users.

For the same user the lack of uniformity between intervention record pages caused irritation and increased reliance on the user guide.

Is the system efficient?

The time taken to add the scenario to the PiR system varied by 18 minutes 37 seconds between users (Table 4e). The user who referred to the user guide most took the longest time to complete the task and the user who did not refer to the user guide at all was the quickest.

Table 4e: Time taken to use the PiR system

	Time taken (mins : secs)
User 1	45:27
User 2	27:50
User 3	34:40

All participants felt that using the PiR system would be faster than the current process they used to record their medication review interventions.

User satisfaction

Overall users felt that having a system to record data from DMRs would be useful but they all suggested that changes would need to be made before the system became fit for purpose (**Error! Reference source not found.** 4f).

Table 4f: User satisfaction with PiR system quotes

Positive	Negative
"That's useful it comes up with a drop-down menu I like that" (User 1)	"Lots of things on screen immediately….I'm not quite sure where I'm meant to go to first" (User 1)
"As you use the system is becomes easier, when understand how it breaks things down" (User 1)	[process is] "Quite lengthy" (User 1)
"I think it's quite easy to use" (User 2)	"System not made for user… it's a system that's made for the researcher…" (User 1)
"I think with practice it will be easy to use" (User 2)	When reviewing an 'extra details' box - "I'm not sure what they want" (User 3)

Problem statements

The results of the usability testing were used to compile problem statements, with RUE severity ratings (Russ et al., 2010) and recommendations for resolution (Table 4g).

Table 4g: PiR problem statements

Problem	Severity of problem	Recommendation
Enhanced clarity around the role of the ICD-10 hyperlink and how the presence of co-morbidities should be recorded is needed	Minor	Make it clear within system that ICD-10 classification system should be used OR remove the need to use ICD-10 and allow users to categorise based on clinical experience
Users are unsure how to classify interventions	Minor	Definitions for each intervention type could be added to appear when cursor hovers over record type
Overuse of free-text boxes and confusion over what information to record	Serious	Removal of most free-text boxes with one box at end to record anything extra the user feels is useful
Abbreviations: ICD-10 = International Classification of Diseases-10		

Discussion

This path finding work explored whether an electronic system could be developed to capture DMR data. This aim was not met. In the following section the successes and challenges of the study are discussed.

Development of the PiR system

Spending time developing a data capture system highlighted the complexities of DMRs. There were a lot of steps to a DMR, from the reviewing the referral reason through to closing a DMR case. As a result a lot of information was captured. Turning lengthy patient consultation records into numerical or categorical data that

encapsulated this complexity was challenging, but it had to be attempted as without categorisation, analysis would not have been impossible. .

Prospective input of the 2016 data permitted evaluation of whether the system could be used in 'real time'. The main limitation to this was the DMR process itself. The holistic and in-depth nature of reviews meant that interventions were rarely made and completely resolved during reviews. Most interventions required action after the review was complete and, frequently input from other professionals or carers etc. As a result the PiR intervention records were completed after the domiciliary medication review had taken place.

Developing a data capture system was a time-consuming task but at the time a necessary one to enable data processing and analysis. After the action research described in this chapter began it became known that another local DMR service; the ICAT service was given direct access to their service users GP records to record data from visits. This was not possible when the Islington Reablement service was set up; relationships between different health and social care sectors were still developing and there were concerns around information governance, that created barriers to information sharing. To provide context, the Islington Reablement DMR service was piloted 2012, ICAT were given access to GP records and summary care record (SCR) access for Whittington Health trust employees was permitted in 2016. Use of a shared data capture system removed the need for a stand-alone system.

Scales for ranking interventions

Generally, assessing clinical impact is from the perspective of clinicians. This has remained despite the evolution of the activities that interventions scales measure. It could be argued that clinicians should be able to extrapolate humanistic outcomes, for example: it can be assumed that an individual would be upset if an error resulted

in injury. However, this is not something any of the researchers seem to have suggested or explored within their papers.

The narrow focus of domains means their use in the DMR setting is limited; they would not enable capture and assessment of the variety of interventions that take place. This could be linked to the setting in which these scales have mainly been used; the inpatient ward when patients are acutely unwell, when it is unlikely that a holistic medication review examining access to medications, compliance, clinical appropriateness and need for input from other professionals simultaneously would have been carried out.

Usability testing

Testing the usability of the PiR system was an important step to take. It revealed that there were some usability issues that needed to be addressed before the system could be used more widely. There was clearly a want from the professionals who tested the system who felt that standardised data collection would enable better data analysis for their services.

Although it took a while to input data into the system it could be quicker than paper-based records. An electronic data capture system could bring about efficiencies within DMR services. The time to input the PiR scenario varied between users. Future work could look at what potential end users would consider an acceptable time taken to input interventions into the PiR system. This could then be compared to time taken for current record keeping methods.

The testing highlighted that DMR pharmacists spend time after a DMR completing records of the visit. The time taken for this important governance task should be considered as part of resource planning. Professionals need to have time to complete the whole DMR cycle.

Limitations

It could be suggested that the Action Research methodology is a potential limitation to the development of PiR. However, it was an appropriate choice when both action and research were needed simultaneously as the work described in this chapter was linked to a 'live' service. The aim was to enable data capture in a useable format as quickly as possible so that the real reviews that were being conducted could be recorded directly into the system.

For the usability testing the sample size was small and the target of 5 was not reached. However, it was felt that users provided valuable feedback that enabled initial recommendations on the usability of the system to be made.

Study participants knew the PhD student/ developer and the research happened in a face-to-face environment which may have increased the likelihood of the Hawthorne effect; whereby study participants alter their behaviour to what they believe is desired (Franke & Kaul, 1978). The talk aloud methodology was employed to try and reduce this phenomenon as participants would explain their reasoning while undertaking actions. The presence of a second researcher aimed to reduce the likelihood of altered behaviours not being detected by the PhD student and to ensure the PhD student did not inadvertently give hints as to how the task should be completed. If this research was repeated remote testing could be considered to further reduce the likelihood of altered behaviours. This was not possible at the time as the PhD student did not have access to appropriate software. Inter-observer comparisons of notes and conclusions reduced the chance of observer bias.

Conclusion

Being able to record and use data to understand service and stakeholder needs is important as it can enable data driven care which has continued to be highlighted as a national priority (NHS England, 2019a). As the national direction of travel moved

towards one health and social care record, and DMR pharmacists were granted access to patient records to record reviews, the need to develop a system for DMRs became less important and so was not pursed further.

In general, the scales already published in the literature did not adequately capture the holistic aim of these reviews, at least in their present form. The published scales tend to have clinical focus from the point of view of practitioners and do not attempt to reflect the impact DMRs had for the individual and/or carer concerned. An ideal scale would include the following specifications:

1. Easy to understand points on scale
2. Not time consuming to use
3. Captures the impact of the outcome to service user (humanistic outcomes)
4. Captures the impact to service provider (clinical impact)
5. Provides data which has the potential to be translated into economic outcomes

The architecture of one existing scale by Hatoum et al. (1988) does present itself as amenable to development, to be appropriate for use in the domiciliary setting. A six-point scale would allow degrees of impact to be captured, which will be useful when examining the inputs (interventions) and outputs (potential changes to an individual's health and wellbeing). If this scale is trialled in the future for DMR services examples need to be updated to have a patient centric focus that captures the individuality of the outcomes of interventions.

Appendix 5: Descriptions of variables included in the quantitative data analysis

Correlation and regression analysis	
Variable	**Description**
Age	The age of the recipient of the DMR at the time the review took place, recorded in years
Gender	Recorded as one of the dichotomous options male or females
Number of visits	The total number of visits the recipient of a DMR received. Most recipients received one visit. However, at the discretion of the DMR pharmacist additional visits could take place. These were generally follow-up visits, rather than further interventions visits.
Total length of visits	The length of time the DMR pharmacist spent in an individual's home conducting the DMR, during all visits, recorded in minutes. This variable does not include any time spent before, preparing for the review or after, implanting interventions.
Length of first visit	The length of time the DMR pharmacist spent in an individual's home conducting the DMR, during the first visit, recorded in minutes. This variable does not include any time spent before, preparing for the review or after, implanting interventions.
Number of medicines	The total number of medicines a patient was taking at the time of the review. This included prescribed medicines, both regular and when required, as well as any additional medicines and individual reported that they were taking e.g. OTC medicines
Number of access interventions	The number of interventions linked to an individual's access to medicines
Number of compliance interventions	The number of interventions linked to whether an individual was taking a medication as intended, this included intentional and non-intentional deviation from the recommended usage
Number of clinical interventions	The number of interventions linked to the appropriateness of medications and their clinical effectiveness at managing underlying conditions

Number of other interventions	The number of interventions that did not fall under the three traditional intervention categories, commonly linked to the wider health and social needs of an individual
Total number of interventions	The total number of interventions that the pharmacist recommended during the medication review process
Multiple correspondence and cluster analysis	
Referral reason*	The reason a domiciliary medication review was requested. There were four potential categories for this variable: • Supply • Medication expertise • Compliance • Safety/ disposal
Access problems*	The reason an access intervention was required. There were three potential categories for this variable: • Supply • Safety/ disposal • Domestic
Access recommendations*	The intervention recommended to address the access problem identified during the DMR intervention. There were three potential categories for this variable: • Supply • Medication expertise • Involve others
Compliance problems*	The reason a compliance intervention was required. There were two potential categories for this variable: • Medication expertise • Compliance
Compliance recommendations*	The intervention recommended to address the compliance problem identified during the DMR intervention. There were five potential categories for this variable: • Supply • Medication expertise • Compliance • Safety/ disposal • Involve others
Clinical problems*	The reason a clinical intervention was required. There were four potential categories for this variable: • Medication expertise • Compliance • Safety/ disposal

	• Dosing/ administration
Clinical recommendations*	The intervention recommended to address the clinical problem identified during the DMR intervention. There were four potential categories for this variable: • Medication expertise • Compliance • Safety/ disposal • Dosing/ administration
Other problems*	The reason an other intervention was required. There were four potential categories for this variable: • Safety/ disposal • Domestic • Unmet health need • Preventative health
Other recommendations*	The intervention recommended to address the other problem identified during the DMR intervention. There were three potential categories for this variable: • Involve others • Safety/ disposal • Preventative health
Total interventions	For categorical analysis the total number of interventions variable was transformed into three categorical variables, based on distributions within histograms: • Less than 5 • 5-10 • More than 10
Number of medicines	For categorical analysis the number of medicines variable was transformed into two categorical variables, based on distributions within histograms: • Up to 19 • 20 or more
Total length of visit(s)	For categorical analysis the total length of visits variable was transformed into three categorical variables, based on distributions within histograms: • Up to 40 minutes • 41-100 minutes • More than 100 minutes
GP surgery	In the cluster analysis the registered GP surgery was used as a categorical variable. Within the study sample patients were registered with 44 different GP practices

Aggregated postcode	In a bid to reduce the number of categories for the GP surgery, cases were re-classified according to the aggregated postcode using the outward postcode (first part). From the GP practice address. This reduced the number of categories to 14
Primary Care Network	In the cluster analysis the PCN a GP surgery was located within was used as a categorical variable. Within the study sample patients were registered with five different PCNs
Health and disability decile**	In the UK health inequalities are measured using deciles. The health and disability decile measures the amount of disability individuals experience with when they live with certain conditions
Income decile**	In the UK health inequalities are measured using deciles. The income decile measures the average income groups in society
Income deprivation affecting older people decile**	In the UK health inequalities are measured using deciles. The income deprivation affecting older people decile measures the proportion of individuals aged 60 years and over who experience income deprivation
Index of multiple deprivation decile	In the UK health inequalities are measured using deciles. The index of multiple deprivation decile measures different components of deprivation weighted into a single measure
***Definitions of problems and recommendations described in Table 4-3**: Definitions of consolidated codes for Multiple Correspondence Analysis	
** **Public Health England, Inequalities in Health** https://www.gov.uk/government/publications/health-profile-for-england-2018/chapter-5-inequalities-in-health	
Abbreviations: DMR = Domiciliary Medication Review. OTC = Over the counter, GP = General practice, PCN = Primary Care Network, UK = United Kingdom	

Appendix 6: Topic guide for service user interviews

Please note: this topic guide is evolving document. Questions may be added based on findings of previous interviews. All questions will be related to aims and objectives described in protocol.

Introduction: As I mentioned on the telephone, my name is Patricia McCormick. I am carrying out research looking into the experiences of people who have had medication reviews in their home as part of my PhD. I would like to ask you some questions about your recent medication review. I will record our conversation so that I have a record of our conversation for analysis purposes. I will also make some notes. Please do not be put off by this.

Any questions before we begin?

Are you happy to start?

PART 1: How did the DMR come about

Somebody visited you recently to talk to you about your medicines. Tell me how this came about
(the interviewer will need to have a brief understanding of which service and individual provided the review for context)

Prompting questions:

1. did you request the review?
2. request information on who requested or suggested review if not service user

PART 2: Expectations of DMR

(*If not answered during response to first question)* Did you have specific issues that you wanted to resolve during the medication review?

Prompting questions:

1. Can you tell me what the purpose of the review was?
2. What did you want to get out of the review?

PART 3: The DMR

Tell me what happened during your DMR

Prompting questions:

1. What type of things were discussed?

Part 4: Outcomes of DMR

What changed because of the medication review?

Prompting questions:

1. did anything change with regards to your medications after the review?
2. *Potential examples which can be given wo help stimulate conversation: some people have medications stopped or started when they have medication reviews or they may have been given information to help them understand what their medications are for*
3. if yes, ask whether the changes make a difference to your everyday life?
4. if no, clarify: No changes were made to your medications as a result of the medication review?
5. why do you think changes were made?/ Why do you think changes were not made?
6. How much did you know about your medications before the medication review?

PART 4: The setting

How did you find having a medication review in your home?

Prompting questions:

1. have you had a medication review before in another setting*, give examples if necessary e.g. in your community pharmacy, at your GP surgery*
2. How was this medication review different? *Probes:* Was anything better? OR Was anything worse?
3. when presented with differences ask whether these issues are important to the interviewee?
4. In general, how do you feel about the number of medications you are prescribed to take?
    a. Do you mind having to take medications
    b. Do you feel you take too little or too many?

PART 5: The professional providing the service

Can you tell me a bit about the person who can to your home to carry out the medication review?

Prompting questions:

1. did you feel comfortable talking to them?
2. did they explain who they were and what they did?
3. did they explain how the review would take place?
4. 'What did you particularly like / the best thing about the pharmacist who came to visit you?'
5. Are there any differences between this person and other pharmacists you have had an interaction with? What are these differences?
6. In general, do you like to be involved with decisions about your health OR are you happy for professionals to make decisions on your behalf
7. Could the pharmacist have done anything differently?

PART 6: Finally

Would you like to ask me any questions?

Examples of general probes:
And then what happened?
Can you tell me more about that?
Anything else?

Appendix 7: Topic guide for service provider focus groups and interviews

Please note: this topic guide is evolving document. New questions may be added based on findings of previous interviews. All questions will be related to aims and objectives described in protocol.

Introduction: As you are aware from reading the information sheet the focus group being run today forms part of an MPhil/PhD examining the value of domiciliary medication reviews. We are interested in gathering your opinions and perceptions of carrying out domiciliary medication reviews. The focus group will be recorded to aid analysis. I will also make some notes. Please do not be put off by this.

Any questions before we begin?

Are you happy to start?

PART 1: Introduction/ background

Can we go around introducing who we are and how long you have been conducting medications referrals for and whether you have experience conducting medication reviews in any other setting.

PART 2: The reason for referral

How do DMRs generally come about? Are users referred in? Who completes the referrals?

Some service users report that they did not request the DMR – does this affect the interactions you have with these individuals?

Prompting questions:

1. Who decides an individual needs a medication review?
2. Does anyone carry out case finding? *If yes, how do you introduce the idea of a medication review to the individual*
3. Does anyone work in a service where individuals will refer themselves for a medication review?

PART 3: Expectations of DMR

What do you hope to achieve by conducting a domiciliary medication review?

In your opinion do patients/ service users recognise that they need help with their medications?

Service users are reporting that they did not have problems with their medications before the review, does this affect what is achieved during the review?

Prompting questions:
How do you decide on the 'aim' of a medication review?

PART 4: The setting

How do you feel about conducting a medication review in someone's home?

How do you think the individual feels about you being in their home?

Prompting questions:
1. What do you believe the benefits are?
2. Are there any drawbacks?
3. How do you think the domiciliary setting differs to other settings you have conducted medication reviews in? *Probe: what was different and why? Was anything better? Was anything worse?*

PART 5: metrics

What outcomes do you record after conducting a domiciliary medication review?

In an ideal world what do you think we should be recording?

Prompting questions:
1. Why do you record these outcomes?
2. How did you decide what outcomes to record?
    a. When reason is given e.g. it demonstrates efficacy of service **probe** how metric demonstrates this
    b. If outcomes are dictated by an external source e.g. CCGs **probe** why do you think they chose these metrics

PART 6: Value/ importance

In your opinion what changes as a result of domiciliary medication reviews?

What do you think patients/ service users get out of the DMR?

Prompting questions:
1. Why is 'change X' important?
2. Do you think the changes make a difference to the life of the individual?

Part 7: Reaction to service user opinion
To be written after initial semi-structured interviews with service users. Participants will be presented with some early themes that have emerged from the service user

interviews and asked whether they agree or disagree with them and whether they were aware that these were some of the opinions that service users held.
Questions have been built into earlier sections – in italics

Examples of general probes:
And then what happened?
Can you tell me more about that?
Anything else?
Does anyone have a similar experience?
Does anyone have a different experience?

Appendix 8: CCG questionnaire

1.Can you tell me if you currently commission a domiciliary medication review service?
1.YES→Q3 2.NO→Q2
2. Can you tell me if you have commissioned a domiciliary medication review service in the past?
1.YES→Q4 2.NO→End of survey
3. Can you tell me the reasons for commissioning the current service?
1. Reduce the medication cost 2. Reduce the medication risks 3. Improve clinical benefits 4. Improve the adherence of patients 5. Improve patients' quality of life 6. Others: →Q6
4. Can you tell me why you commissioned the previous service?
1. Reduce the medication cost 2. Reduce the medication risks 3. Improve clinical benefits 4. Improve the compliance of patients 5. Improve patients' quality of life 6. Others: →Q5
5. Could you choose from the following reasons why you decided to decommission the service?
1. Cost factors 2. Not enough staff to provide the service 3. Not enough patients are willing to attend the service 4. Failed to achieve expected results 6. Others: →Q6
6. What are your inclusion criteria for patients involved in service?
1. Age

2. Number of medication 3. Specific disease 4. Recently discharged patient 5. No clear inclusion criteria 6. Others: →Q7
7.Which professionals provide the service?
1. General practitioners 2. Medical specialists 3. Primary pharmacists 4. Hospital pharmacists 5. Community pharmacists 6. Nurses 7. Technicians 8. Others: →Q8
8. Is it one-time visit or multiple visit service?
1. One-time visit→Q10 2. Multiple visit→Q9
9. For your multiple visit service, how frequently is the patient seen?
1. Every two weeks 2. Every three weeks 3. Every four weeks 4. Every eight weeks 5. It depends on the situation 6. Others: →Q10
10.What are your main outcomes to assess the quality of service?
1. Total number of interventions 2. Hospital readmission rates after service 3. Number of medicines stopped 4. Cost savings 5. Quality of life 6. Others: →Q11
11.Have you formally evaluated your domiciliary medication review service?
1. YES→1 2. NO→ End of survey
12. If answer is yes, what type of evaluation has been carried out?

1. Audit
2. Service evaluation
3. Case study
4. Cohort study
5. Randomized controlled trial
6. Others:

→ End of survey