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Identifying and mapping measures of medication safety during transfer of care in a digital era: a scoping literature review

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ABSTRACT

Background Measures to evaluate high-risk medication safety during transfers of care should span different safety dimensions across all components of these transfers and reflect outcomes and opportunities for proactive safety management.

Objectives To scope measures currently used to evaluate safety interventions targeting insulin, anticoagulants and other high-risk medications during transfers of care and evaluate their comprehensiveness as a portfolio.

Methods Embase, Medline, Cochrane and CINAHL databases were searched using scoping methodology for studies evaluating the safety of insulin, anticoagulants and other high-risk medications during transfer of care. Measures identified were extracted into a spreadsheet, collated and mapped against three frameworks: (1) 'Key Components of an Ideal Transfer of Care', (2) work systems, processes and outcomes and (3) whether measures captured past harms, events in real time or areas of concern. The potential for digital health systems to support proactive measures was explored.

Results Thirty-five studies were reviewed with 162 measures in use. Once collated, 29 discrete categories of measures were identified. Most were outcome measures such as adverse events. Process measures included communication and issue identification and resolution. Clinic enrolment was the only work system measure. Twenty-four measures captured past harm (eg, adverse events) and six indicated future risk (eg, patient feedback for organisations). Two real-time measures alerted healthcare professionals to risks using digital systems. No measures were of advance care planning or enlisting support.

Conclusion The measures identified are insufficient for a comprehensive portfolio to assess safety of key medications during transfer of care. Further measures are required to reflect all components of transfers of care and capture the work system factors contributing to outcomes in order to support proactive intervention to reduce unwanted variation and prevent adverse outcomes. Advances in digital technology and its employment within integrated care provide opportunities for the development of such measures.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ High-risk medications such as insulin and anticoagulants can cause harm if issues occur during transfer of care. Studies to improve the safety of these processes have used many different measures to determine whether these interventions had an impact.

WHAT THIS STUDY ADDS

⇒ This study identifies a range of measures currently used and assesses their comprehensiveness as a portfolio for evaluating the safety of high-risk medications during transfer of care. It identifies where gaps in measurement exist.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The measurement gaps found provide an opportunity to develop indicators which reflect healthcare complexity, real-time risks and can be used to improve safety proactively. Digital systems in integrated care present new opportunities for comprehensive measurement approaches through real-time data collection and analysis spanning the whole patient pathway.

INTRODUCTION

Keeping patients safe from harm is a central goal of health services. Despite decades of international effort, improvement is still required.[1] Medication errors are a leading cause of avoidable harm.[2] During transfers of care (ToC) patients move between healthcare settings and are at greater risk of medication-related harm.[3] Adverse events following ToC from hospital to home are common.[4] Nearly 40% of medication errors occur during care transfer, and 20% of those

errors are estimated to cause harm.[5] Between 30% and 70% of people experience an error with their medications after ToC.[6 7] Multiple processes must be undertaken to ensure that people's medications are managed safely during this period. Common barriers to safe transfer include poor communication, inadequate patient, family and/or carer involvement and insufficient provision of supporting services.[8] Failures in these processes or activities can lead to incorrect medications or doses, causing harm from underdosing or overdosing, or through accidental provision of an incorrect medication. Where support systems are not identified and arranged, patients may not be able to obtain or take their medications at all.[3 8 9] The WHO set a Global Safety Challenge in 2017 to reduce severe, avoidable medication-related harm by 50% over 5 years, with 'Medication Safety in Transitions of Care' identified as a key focus for improvement.[3] In developing this safety challenge, a comprehensive review of the literature was performed and the WHO provided some suggested measures that could be used to evaluate the impact of improvement programmes; however, these do not constitute a detailed measurement portfolio.[3] Other systematic reviews of safety during ToC focus on potential strategies for improvement rather than methods for evaluating success.[10 11]

High-risk medications (HRMs) carry a greater risk of harm when errors occur.[12 13] Errors are not necessarily more common with these medications, but the consequences of errors are potentially life threatening. People taking these medications have a heightened risk of medication-related harm during or following ToC.[3 4] Commonly recognised HRMs include insulin, anticoagulants, opioids, sedatives, concentrated electrolytes, anti-infectives and chemotherapeutic agents.[14] These medications continue to cause serious harm despite focused safety improvement work. Insulin and anticoagulants are common HRMs used to treat long-term conditions across all care settings in adults of all ages and are associated with risks during ToC.[15–19] In England, targeted patient safety alerts have aimed to improve access to up-to-date dosing information and related blood tests for HRMs (insulin and anticoagulants) during ToC through patient-held records.[15 17]

To improve safety, it is important to define what safety is. Traditionally, it has been considered as the absence of harm, and improvement efforts have focused on learning from past adverse events.[20] This assumes that poor outcomes are caused by discernible, measurable factors that can be addressed and eliminated to prevent recurrence.[20 21] It is now understood that healthcare takes place in a complex, dynamic system requiring work to be adapted and adjusted in the face of individual circumstances.[20 22 23] The healthcare work system is commonly understood to include people (patients, informal carers, healthcare professionals and other staff), equipment, tasks and the environments in which the healthcare is provided (both locally and more widely).[24–27] The adaptations and adjustments that are necessary to maintain high-quality care in the face of variation and challenges are known as healthcare resilience.[28] Resilient adaptations can be made by individuals or at higher levels, such as in a ward or across an organisation.[28–30] Using this perspective, safety can be conceptualised as the capacity of the system to enable things to go well.[31] Resilience engineering is the study of the work system and healthcare resilience to develop mechanisms to promote successful outcomes; see figure 1 for an illustration of these concepts in relation to ToC.

Measurement and monitoring are required to assess whether safety is improving. As safety cannot be measured directly, measures are used as indicators of safety. Carefully developed portfolios of indicators are required to ensure comprehensive measurement covering multiple aspects of safety including different perspectives of staff, organisations and patients.[32] Traditionally, retrospective (lagging) measures of harm have been employed to provide intelligence around safety and allow comparison over time.[33] Assessing safety, characterised as an emergent phenomenon within a complex work system,[34] requires measures that are collected prospectively (leading) or in real or near-real time which identify areas of variation in work system factors and tasks that make up the processes of care. Capturing variation provides insight into both areas of potential risk where intervention can be made to prevent harm and also system resilience by revealing how challenges are being resolved, and how conditions for successful outcomes are created.[31 35] Resilience engineering approaches can be used to identify these indicators,[21 36] and the advent of digital technology provides opportunities for their collection.

Digital technology is critical for the development of a broader array of safety measures. It enables rapid, targeted sharing of information to promote proactive interventions to improve safety. Advances, such as the introduction of artificial intelligence tools and natural language processing, promise efficient analysis of data gathered across multiple care settings.[37 38] They will facilitate searching for indicators of safety across the vast quantities of textual information held within health records and feedback forums to provide rapid insights around staff and patient experience and outcomes.[39–41] Integration of data from patient portals and wearable technology, such as fitness trackers and continuous glucose monitors, can enable remote monitoring and identification of risks in near real time.[42–45]

The focus of this scoping review was to identify the range of measures that are currently being used to evaluate the safety of insulin, anticoagulants and other HRMs during ToC. The objectives were to establish how well existing measures reflect a comprehensive indicator portfolio for the safety of these medications at ToC, whether they reflect systems, processes or outcomes and whether these may be used for both

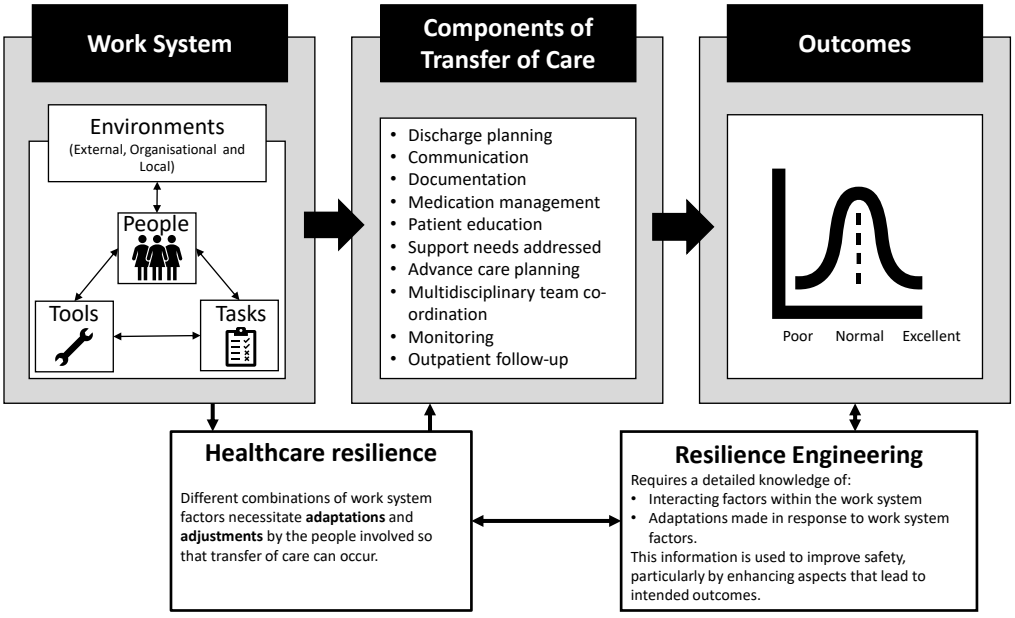

Figure 1 Healthcare resilience and resilience engineering and how these influence the components of transfers of care (ToC) and outcomes.[26 47]

ongoing monitoring of safety and proactive intervention to prevent harm. The secondary aim was to assess the adaptability of the measures for digitisation.

METHODS

Embase, Medline, Cochrane and CINAHL databases were searched using a scoping methodology.[46] This approach allowed the systematic identification and mapping of measures related to safety improvement across a broad literature employing disparate approaches to the evaluation of safety improvement interventions in varying contexts. These measures were then compared, and gaps identified. Selected databases were deemed most likely to contain studies relating to medication safety improvement. Search terms included transfer*, medic* reconciliation, transition, transfer, and insulin*, anticoag*, anti-coag* and high-risk medic*. Full details are included in online supplemental file 1. Searches were performed using the full databases including all years available. Results were limited to English language and human studies. A protocol can be found in online supplemental file 2.

Duplicate references were removed, and titles and abstracts were screened according to the following criteria. To be included, the study had to relate to adults of 18 years or over, involve a ToC (including between wards within a single organisation), focus on anticoagulants, insulin or HRMs as a group and involve evaluation of an intervention designed to improve the safety or quality of the medications involved. Studies where no interventions were performed or where the impact of an intervention on safety or quality was not evaluated were excluded. All measures used to determine the effectiveness of a safety intervention were included provided there was sufficient information to replicate the measure. Randomised and non-randomised controlled trials, before and after studies, interrupted time-series studies, historically controlled studies and research protocols detailing clearly planned measures were included. Case studies, case reports, unpublished studies, opinion pieces and cross-sectional studies were excluded. Conference abstracts were included providing there was sufficient detail to understand the measures used to evaluate the intervention.

The full text of papers that met the inclusion criteria was scrutinised to identify the intervention, whether it targeted anticoagulants, insulin or HRMs as a group, the type of ToC and whether electronic health systems were used, and in what manner. Measures were extracted from the studies and grouped into inductively developed categories according to the overarching aim of the measure. Three frameworks were used to map the measures of the different activities involved in ToC, the extent to which work systems, processes and outcomes were each measured and the spread of these measures in terms of whether they were lagging, leading or real time. By using three frameworks, the different aspects of complexity, potential for proactive measurement and across the care transition, could be explored.

The first framework, the Key Components of an Ideal Transfer of Care (KCoIToC), is a theoretical model capturing the different activities such as discharge

planning or communication required to perform a successful ToC developed by Burke *et al*.[47] The second framework, Systems Engineering Initiative for Patient Safety (SEIPS), was used to determine whether identified measures provided insight into work systems, processes or outcomes. SEIPS is a human factor-based framework 'nested within'[27] Donabedian's quality model of structure, process and outcomes.[24–27] It was created as a tool to support the in-depth understanding of health and care structures (termed work systems) and to identify barriers and facilitators of safety within them. Processes are defined as a combination of tasks and the work system components required to perform them.[24] Variation in processes which drive outcomes stems from the interactions between work system components and tasks. For each process measure, where relevant, the different work system factors that contribute to that process were considered. For example, the process of communication between inpatient and outpatient clinicians involves several different work system factors including people, tasks and tools. The people involved are the patient whose care is being discussed, the inpatient clinician and the receiving outpatient clinician. The tasks include performing the communication (verbal or written), receiving the communication and documentation. The tools required could include communication devices such as telephones, electronic health systems or emails. By considering the range of factors contributing to the process, potential targets for additional measures can be found. These can be used to provide more detailed insight into process variation. The timing of the measures in terms of whether they were lagging, leading or real time[35] was used as the third framework. Considering the measures in this way allows the spread of reactive and proactive measures to be assessed.

Finally, studies were examined to determine whether measures were obtained from digital health systems (DHS) in real time or if they had the potential to be obtained in this way. Real-time measures might be derived from digital systems that identify if a key task has not been completed and alert staff of required action, those that collect real-time information from patients via patient-held digital health records or alerting systems related to extreme blood test results.

One author extracted the data, developed the categories and mapped the measures to the frameworks. The mapping was discussed with the other two authors and consensus reached in cases of disagreement. The measures and the mapping were reviewed at intervals, and any uncertainties were considered and addressed as a team. The team was composed of three healthcare professionals, two with a hospital background and one with a background in primary care. This provided insight into the activities being measured, particularly in mapping according to the SEIPS framework.[24–27]

RESULTS

A total of 8488 studies were identified from the four databases, with a total of 7235 unique studies (see figure 2). An additional six articles were identified by scrutinising the references of included articles.

After applying the inclusion and exclusion criteria, 35 studies were eligible. They were published between

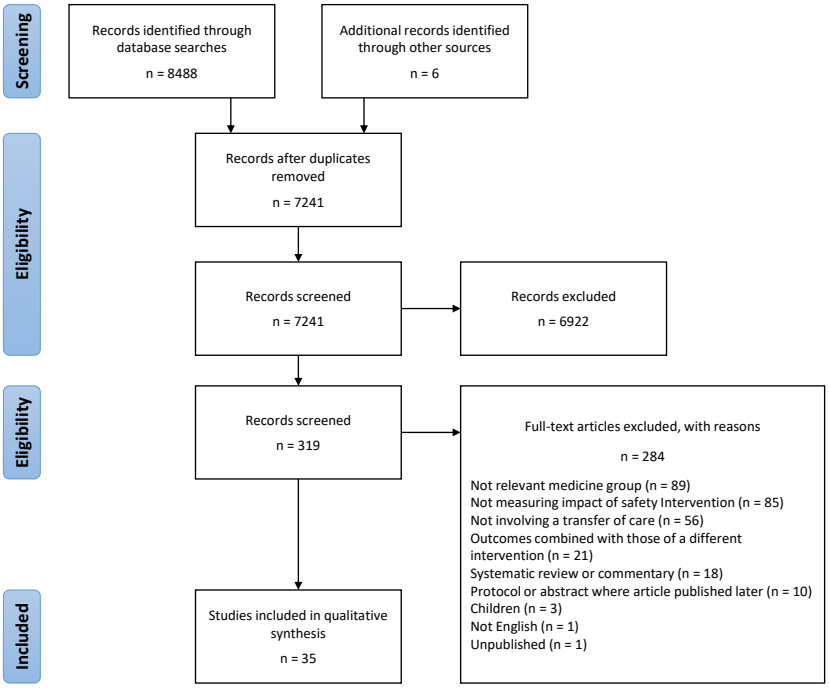

Figure 2 Literature screening process.

2011 and 2022. Most studies took place in the USA (25), with four from Australia and one each from Brazil, China, France, Italy, Saudi Arabia and Spain. The studies principally focused on anticoagulation (21). The remaining studies explored HRMs as a group of medications (10) and insulin (4). Twenty-five were original research reports and ten were abstracts from conference proceedings. See table 1 for an overview of each study. A more detailed table is provided as online supplemental table 1 listing the measures used in each study.

A total of 162 measures were collated and mapped. There were 15 measures identified from studies relating to insulin, 38 for HRMs and 109 from studies relating to anticoagulants. Eight measures were excluded as they were not described in sufficient detail to understand how they were used, for example, 'laboratory ordering practices' and 'medication stopped' with no further information.

Measures were grouped into 29 inductively developed categories. These were adverse events (thrombosis, bleeding, death, hypoglycaemia or hyperglycaemia, readmission rates) (n=61), time in therapeutic range (n=14), medication-related problems (numbers identified (n=12), their potential for harm (n=3), recommendations made (n=2) and recommendations accepted (n=2)), adherence (the extent to which patients follow a medication regimen agreed with their prescribing healthcare professional) (n=7), assessment of patient knowledge, understanding and beliefs (n=7), patient satisfaction (n=6), education and counselling (n=3), outpatient appointments (time to follow-up (n=4), appointment attendance (n=4), enrolment into clinic or appointment made (n=3)), time to reach therapeutic range (n=2), pharmacist time (n=2), protocol adherence (n=4), availability of medicines confirmed (n=2), patients with blood test within 10 days (n=1), therapeutic drug monitoring performed (n=1), baseline laboratory information available (n=1), time outside therapeutic range (n=1), cost of intervention (n=1), documentation of information in discharge letter (n=4), pharmacist coordination documented (n=1), clinician satisfaction (n=1), medication titration frequency (n=1), inadequate follow-up arrangements (n=1), documented communication (inpatient-to-outpatient (n=1) and inpatient-to-anticoagulation clinic (n=1)) and intravenous access obtained (n=1).

Measures identified

Most measures identified were lagging, outcome measures of adverse events and aspects of blood test monitoring. There were process measures that included both leading and lagging indicators. Although many potential specific work system factors were referred to in papers, these were not measured. Only one work system measure (the rate of appointments booked) was identified in the studies.

By far, the most frequently used category of measures were the rates of adverse events such as bleeding or thrombosis (with anticoagulants) or hypoglycaemia (insulin) as well as rates of readmissions and mortality. These were lagging, outcome indicators and related to the 'Medication Safety' component of the KCoIToC. Other medication safety measures included the number of issues identified or rectified and rates of adherence to protocols, all of which were lagging measures counted retrospectively. 'Educating patients to promote self-management' was the second most frequently measured component with measures of patient satisfaction and medication adherence falling into this category. These were often lagging measures for the patients for whom the healthcare experience had been completed but could be used as a leading measure by the organisation. Monitoring and managing symptoms after discharge was another component with many lagging outcome measures and one real-time measure identified. These included aspects of blood test monitoring, particularly for insulin and anticoagulants. Documentation and communication measures were lagging and of processes. They related to the 'Complete communication of information component'. Availability of baseline bloods was measured in one study and related to the component of 'Availability, timeliness, clarity and organisation of information'. Aspects of 'Co-ordinating care among team members' were measured through documentation of pharmacist involvement and clinician satisfaction. These were process and outcome measures, which were all lagging. The 'Outpatient follow-up' component included measures of appointment attendance (a lagging process measure) and the time taken for the follow-up to occur (a lagging outcome measure). No measures were found that covered the components 'Advance Care Planning' or 'Enlisting the help of social and community supports'.

Studies that aimed to improve the safety of anticoagulants and HRMs as a group often focused on measuring specific aspects of prescribing quality and accuracy along with interventions made by healthcare professionals to improve safety. Follow-up arrangements were measured in several studies. Three studies measured aspects of efficiency such as the time involved to undertake the intervention and the cost of the intervention. One study measured staff experience.

Table 2 summarises the range of measures identified, mapped according to KCoIToC component, SEIPS and timing.

DHS use

Only two studies collected real-time (or near real-time) measures and used these to adjust care. Kane-Gill *et al*[48] alerted healthcare professionals of patients at risk of harm via an electronic patient record to facilitate early intervention. Wei *et al*[49] used an internet-based portal to monitor study participants' blood sugar levels,

Table 1 References and key information

Year	Author	Article/ abstract	Study design; number of participants	Medication type	Intervention to improve safety	Care transition
2011	Avanzini *et al*[57]	Article	Observational study; 142	Insulin	Standardised protocol	Intensive cardiac care unit to general ward
2011	Nordenholz *et al*[58]	Abstract	Cohort study; 106	Anticoagulant	Clinical care pathway	Emergency department to primary care
2011	Reger *et al*[59]	Article	Observational study; 207	Anticoagulant	Discharge pathway	Hospital to primary care
2011	Schillig *et al*[60]	Article	Randomised controlled trial; 500	Anticoagulant	Pharmacist involvement	Hospital to primary care
2011	Stafford *et al*[61]	Article	Cohort study; 268	Anticoagulant	Pharmacist involvement	Hospital to primary care
2012	Falana *et al*[62]	Abstract	Cohort study; 88	Anticoagulant	Pharmacist involvement	Hospital to outpatient clinic
2013	Martin III *et al*[63]	Article	Cohort study; not defined	High-risk medications	Pharmacist involvement	Hospital to primary care
2014	Falconieri *et al*[64]	Article	Cohort study; 32	Anticoagulant	Transfer of care programme	Emergency department to primary care
2014	Martins *et al*[65]	Abstract	Randomised clinical trial; 280	Anticoagulant	Outpatient clinic	Outpatient clinic to primary care
2015	Padron and Miyares[66]	Article	Cohort study; 409	Anticoagulant	Anticoagulation stewardship programme	Hospital to outpatient care
2015	Dunn *et al*[67]	Article	Cohort study; 797	Anticoagulant	Information pack	Hospital to outpatient clinic
2015	Quach *et al*[68]	Abstract	Randomised controlled trial; 307	High-risk medications	Medication reconciliation	Primary care to the emergency department
2015	Yilmaz *et al*[69]	Abstract	Randomised controlled trial; protocol only	High-risk medications	Medication reconciliation and discharge counselling	Hospital to primary care
2016	Ha *et al*[70]	Article	Cohort study; 109	Anticoagulant	Standardised protocol	Hospital to primary care
2017	Bryant *et al*[71]	Abstract	Retrospective observational analysis; 220	Anticoagulant	Pharmacist involvement	Emergency department to primary care
2017	Castelli *et al*[72]	Article	Randomised controlled trial; 25	Anticoagulant	Information pack for patients	Hospital to primary care
2017	Chamoun *et al*[73]	Article	Cohort study; 206	Anticoagulant	Standardised protocol	Hospital to primary care
2017	Wei *et al*[49]	Article	Randomised controlled trial; 28	Insulin	Remote glucose monitoring	Hospital to primary care
2017	Zdyb *et al*[74]	Article	Retrospective record analysis; 85	Anticoagulant	Counselling and education	Emergency department to primary care
2018	Herges *et al*[75]	Article	Retrospective record analysis; 1004	High-risk medications	Pharmacist involvement	Hospital to primary care
2019	Dempsey *et al*[76]	Abstract	Observational study; 247	High-risk medications	Pharmacist involvement	Hospital to primary care
2019	Pyrlis *et al*[77]	Article	Randomised controlled trial; 105	Insulin	Transition diabetes team	Hospital to primary care
2020	Kapoor *et al*[56]	Article	Randomised controlled trial; 162	Anticoagulant	Pharmacist involvement	Hospital to primary care
2020	Liang *et al*[78]	Article	Randomised controlled trial; 152	Anticoagulant	Pharmacist involvement	Hospital to primary care
2020	Lim *et al*[79]	Article	Retrospective case series; 120	Anticoagulant	Outpatient clinic	Emergency department to outpatient clinic

Continued

Table 1 Continued

Year	Author	Article/ abstract	Study design; number of participants	Medication type	Intervention to improve safety	Care transition
2020	Tyedin *et al*[80]	Article	Cohort study; 238	Anticoagulant	Pharmacist involvement	Hospital to primary care
2020	Andre *et al*[81]	Abstract	Observational study; 162	Anticoagulant	Medication reconciliation	Primary care to hospital
2022	Bakey and Nguyen[82]	Article	Cohort study; 58	Anticoagulant	Pharmacist involvement	Emergency department to primary care
2021	Bawazeer *et al*[83]	Abstract	Randomised controlled trial; 107	High-risk medications	Medication reconciliation, counselling, follow-up	Hospital to primary care
2021	DeSancho *et al*[84]	Article	Quality improvement; 409	Anticoagulant	Counselling and education	Hospital to primary care
2021	Gurwitz *et al*[85]	Article	Randomised controlled trial; 361	High-risk medications	Pharmacist involvement	Hospital to primary care
2021	Kane-Gill *et al*[48]	Article	Quality improvement; 2127	High-risk medications	Pharmacist involvement	Primary care to nursing home
2021	Magny-Normilus *et al*[86]	Article	Randomised controlled trial; 180	Insulin	Discharge intervention	Hospital to primary care
2021	Zabrosky *et al*[87]	Abstract	Quality improvement; 218	High-risk medications	Standardised protocols for transfer of care	Hospital to primary care
2022	Lázaro Cebas *et al*[88]	Article	Cohort study; 589	High-risk medications	Pharmacist involvement	Hospital to primary care

and where significantly abnormal, the results were reviewed and insulin doses adjusted. Although not described in any studies except Kane-Gill *et al*,[48] many measures had the potential to use DHS to alert staff in real time where tasks have not been documented and therefore may be overdue for completion, as shown in table 2. There were additional lost opportunities to use specific test results and patient-documented adherence information in a real-time manner.

DISCUSSION

Although many measures were identified they did not constitute a comprehensive portfolio for assessing HRM safety during ToC. Measures did not fully represent all components of ToC and were primarily focused on past events. Traditional outcome-based measures were the most used. Although useful for gaining a broad overview of the safety and effectiveness of HRM during ToC, they offer limited insight into where interventions for improvement might be best focused. There were many potential work system factors that could have been measured across studies but there was only evidence of one being measured directly, rates of enrolment to a clinic. Work system factors are key to understanding variation in process measures and ultimately outcomes and providing insight into resilience. This is especially valuable if performance is directly communicated in real time, providing the opportunity for proactive interventions to improve safety.

The KCoIToC are very broad, each consisting of many tasks and influenced by many work system factors. Without a more detailed understanding of each component, the role of adaptations and adjustments in determining outcomes cannot be understood. For example, 'Co-ordinating care among team members' would benefit from a comprehensive understanding of how work system factors such as staff and equipment availability impact on outcomes and drive variability in safety. Such an understanding would identify approaches that could strengthen healthcare resilience.[21]

Comprehensive measurement portfolios can support understanding of how good outcomes are maintained despite varying conditions, providing a window of opportunity for proactive care adjustments to avoid harm. Peñaloza *et al*[50] developed five 'guidelines' to assess whether indicator frameworks can be used to measure the resilience capacities within the healthcare system and therefore be used to improve safety using resilience engineering.[28] These guidelines state that measures must provide insight into the resilient adaptations and complexities of healthcare that are contributing to outcomes. Second, measures should be targeted to the relevant individual who needs to act and should be provided in real time. Third, they should support efforts to learn from what is going well in addition to what is unsuccessful. Fourth, the measures should provide insight into trade-offs between safety and other issues, for example, if safety checks are being omitted due to time pressures

Table 2 Measures identified categorised according to the KCoIToC processes and mapped according to SEIPS, their timing and the potential for real-time use

KCoIToC component	Measures associated with KCoIToC components (SEIPS work system elements involved (people, tasks, tools, environments))	SEIPS framework measured/timing (lagging, leading, real time)	Potential for real time using digital health systems
Discharge planning	Enrolment into clinic/outpatient appointment made[60 84 87] Tasks: booking appointment, documenting appointment	Work system/leading	Documentation and alert.*
	Access obtained for home injections of high-risk medication[87] People: patient, staff Task: performing cannulation Tool: cannulation equipment	Outcome/lagging	Documentation and alert.
	Medication availability confirmed[76 87] People: patient and/or carer, staff Task: determining medication availability Tools: medication, telephone, computer	Process/leading	Documentation and alert.
	Percentage of inadequate warfarin follow-up arrangements[63] People: patient and healthcare professional Tasks: identify follow-up requirements, arrange follow-up Tools: digital health system, telephone, computer, diary	Process/lagging	†
Complete communication of information	Documented inpatient-to-outpatient provider contact[60] People: healthcare professionals Task: documentation Tool: form of communication (paper or electronic)	Process/lagging	Documentation and alert.
	Documented inpatient-to-anticoagulation clinic communication[60] People: healthcare professionals Task: documentation Tool: form of communication (paper or electronic)	Process/lagging	Documentation and alert.
	Information in discharge letter[70 80 82 87] People: healthcare professionals Task: documentation Tool: form of communication (paper or electronic)	Process/lagging	Documentation and alert.
Availability, timeliness, clarity and organisation of information	Baseline laboratory information available[87] People: patient, staff, laboratory staff Tasks: request, take, analyse and report blood test Tools: blood test result (electronic or paper report), patient record	Process/lagging	Alert if baseline blood test results are not available when prescription written.

Continued

Table 2 Continued

KCoIToC component	Measures associated with KCoIToC components (SEIPS work system elements involved (people, tasks, tools, environments))	SEIPS framework measured/timing (lagging, leading, real time)	Potential for real time using digital health systems
Medication safety	Adverse events (hypoglycaemia or hyperglycaemia, venous thromboembolism, readmissions, death, cardiovascular events)[49 57–62 64–66 69 70 72–80 82–84 86–88]	Outcome/lagging	Some, for example, abnormal blood tests.
	Medications managed according to protocol[71 72 74 87] People: patient, prescriber, pharmacy Task: prescribing Tools: medication, prescription, protocol	Process/lagging	†
	Medication discrepancies, errors or issues identified[63 69 75 76 80–83 85 87] People: patient, prescriber, healthcare professional reviewing medications Task: medication review Tools: medications, references (eg, medication information leaflets, reference books)	Process/lagging and real time	Documentation with targeted alert to prompt review.
	Rate of recommendations agreed[63 75] People: patient, staff (recommendation maker and prescriber) Tasks: prescribing, documentation	Process/lagging	†
	Medication safety recommendations made[71 75] People: patient, staff (recommendation maker and prescriber) Tasks: prescribing, documentation	Process/lagging	Documentation and alert.
	Impact of interventions to optimise medications[48 68 81]	Outcome/lagging	†
Educating patients to promote self-management	Measures of adherence[64 69 72 74 84 86] People: patient (and caregiver) Task: taking medication Tools: medication, packaging, compliance aids (eg, tablet cutters)	Process/leading	Through patient-owned digital method, for example, access to their electronic health record or smartphone application.
	Patient satisfaction[56 64 69 72 77 83]	Outcome/lagging for patient Leading for organisation	
	Provision of education and counselling[71 82 87] People: patient, healthcare professional Task: providing education Tools: information leaflets, medication charts	Process/leading	Partially—tasks (eg, education) can be documented and highlighted if outstanding.
	Assessment of patient knowledge, understanding and beliefs[56 72 78 81 84] People: patient, assessor Task: assessment of knowledge Tool: assessment template/quiz	Process/leading	†
Enlisting social and community supports			
Advance care planning			

Continued

Table 2 Continued

KCoIToC component	Measures associated with KCoIToC components (SEIPS work system elements involved (people, tasks, tools, environments))	SEIPS framework measured/timing (lagging, leading, real time)	Potential for real time using digital health systems
Coordinating care among team members	Percentage of patients with pharmacist coordination documented[59] People: patient, pharmacist, multidisciplinary team Tasks: 'co-ordination' tasks, documentation Tool: patient records	Process/lagging	Documentation and alert.
	Pharmacist time per patient[59 87]	Outcome/lagging	†
	Cost of intervention[88]	Outcome/lagging	†
	Clinician satisfaction[67]	Outcome/lagging	†
Monitoring and managing symptoms after transfer	Time in therapeutic range[49 57 61 65 66 70 73 77 78 83 86]	Outcome/lagging and real time	Viewed within patient record.
	Time outside therapeutic range[78]	Outcome/lagging	†
	Time to reach therapeutic range[67 73]	Outcome/lagging	†
	Therapeutic drug monitoring performed[87] People: patient, staff, laboratory staff Tasks: request, take, analyse, report blood test Tools: blood test equipment, laboratory equipment to analyse, blood test result (electronic or paper report)	Process/lagging	Documentation and alert.
	Percentage of international normalised ratio taken within 10 days of transfer of care[67] People: patient, staff, laboratory staff Tasks: request, take, analyse, report blood test Tools: blood test equipment, laboratory equipment to analyse, blood test result (electronic or paper report)	Process/lagging	Documentation and alert.
Outpatient follow-up	Clinic appointment attendance[64 66 67] People: patient, staff Tasks: book, communicate and attend appointment	Process/lagging	Documentation and alert.
	Time to follow-up[60 64 71 83]	Outcome/lagging	†

*Documentation of a specific task with an associated alert targeted to relevant staff prompting action if that task remains outstanding.
†Not applicable.
KCoIToC, Key Components of an Ideal Transfer of Care; SEIPS, Systems Engineering Initiative for Patient Safety.

in a clinic. Finally, the portfolio of measures should evolve as the processes and work changes over time.[50] Without indicators illuminating the complex, interacting factors of the work system and resilient activities performed during ToC of HRMs, the measures obtained from this literature scoping review cannot yet be used for resilience engineering and enhancing capacity for successful, high-quality care. Incorporating these guidelines when developing measurement portfolios will foster the inclusion of indicators that provide insight into the complexity and resilience of healthcare delivery and the underlying causes of variability linked to safety. This enables exploration of factors that contribute to success and focused interventions to improve safety.

Many safety measures would be amenable to real-time measurement if certain tasks were recorded in the electronic patient record. It is essential that all users are involved in the development and testing of such measures as well as the design of electronic health systems so that capturing the required information is not too burdensome for users (healthcare staff and patients).[32 51] As digital technologies are advancing, there is great potential for developing new measures taking advantage of these systems. For example, wearable technology, smartphone applications and data warehouses could all potentially be valuable sources of data if used within appropriate governance arrangements. Machine learning and natural language processing also provide opportunities for identifying measures within unstructured narrative data that have previously been too labour intensive for routine use, for example, from medical notes, compliments and complaints.

Patients and their caregivers contribute greatly to the safety of ToC, adapting their actions to prevent and overcome issues.[52 53] There were very few measures that accounted for the active role that patients perform in the ToC process. Patient contributions are becoming ever more possible with ongoing developments to digital patient-held records and healthcare tools.[54] Within the measurement category of 'Educating the patient to promote self-management', measures included elements of patient involvement, for example, adherence. The patient is key in this process; however, many factors influence their decision to adhere to the medication regimen such as their core beliefs about taking medications, their risk and benefit analysis of the medications and lifestyle factors.[55] Many of these factors are not reflected by the indicators identified in this literature review, with only Kapoor *et al* assessing aspects of patient's beliefs regarding anticoagulation.[56] Evaluating the contribution of patients and the resilience activities they perform will provide valuable ways to include these essential aspects of safety. This will result in a more holistic measurement approach.

Strengths and limitations

The literature review used a systematic approach with clearly defined concepts to explore and identify a wide range of indicators. Inclusion of insulin and anticoagulants along with HRMs in general expanded the breadth of measures identified. Most interventions in the review were aimed at improving discharge from hospital to primary care, with other aspects of ToC less well represented. There may be additional relevant measures that could be detected by including studies of other HRMs, medication safety in general or other potential contexts for ToC. Components of ToC may also vary between countries which potentially limits wider generalisability. Furthermore, the framework of the KCoIToC is designed to assess the transition from hospital to primary care, although many components remain valid for other ToC. The SEIPS framework is a tool that is designed to highlight the impact of interactions between different factors within the work system, processes and outcomes. The limited detail in the literature did not lend itself to in-depth analysis of interacting work system factors using SEIPS. The authors used their prior knowledge and experience to identify some of these factors, but this was not exhaustive. In developing further measures, a more detailed exploration of the relevant work systems is required.

CONCLUSION

This literature review identified a range of measures that can be used as part of a portfolio to evaluate the safety of ToC for people taking anticoagulants, insulin or HRMs. The identified measures were insufficient to provide insight from a resilience engineering perspective. Measures predominantly stemmed from a traditional approach to safety management, providing an overview of general outcomes. There is potential to identify new leading indicators of safety by obtaining a deep understanding of the complex work system interactions and resilience activities that maintain the safety of HRMs during ToC. A comprehensive, patient-centred safety measurement framework for ToC and HRMs should include such leading indicators, targeted in real time to relevant people across care pathways that can enable early intervention. Digital health technology implementation is essential for such an approach.

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Literature search terms

Medline

Database: Ovid MEDLINE(R) ALL <1946 to May 19, 2022>
Search Strategy:
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1 (transfer* adj3 care).mp. (3892)
2 (escalation* adj3 care).mp. (558)
3 medic* discrepanc*.mp. (454)
4 medic* reconciliation.mp. (2508)
5 (transition* adj3 care).mp. (10410)
6 (hospital adj3 discharge).mp. (43449)
7 admission.mp. (235405)
8 Patient transfer/ (9417)
9 or/1-8 (290357)

10 insulin*.mp. or insulin/ or insulin passport*.mp. (453098)
11 (anticoag* or anti-coag*).mp. or anticoagulant agent/ (146420)
12 (("high alert" or "high risk") adj2 (medicine* or medication* or drug*)).mp. (1780)
13 (safe* or harm* or risk* or error* or hazard*).mp. (4559838)
14 (("high alert" or "high risk") adj2 (medicine* or medication* or drug*) adj4 (safe* or harm* or risk* or error* or hazard*)).mp. (1658)
15 ((insulin* or insulin passport*) adj4 (safe* or harm* or risk* or error* or hazard*)).mp. (7702)
16 ((anticoag* or anti-coag*) adj4 (safe* or harm* or risk* or error* or hazard*)).mp. (6653)
17 or/14-16 (15961)

18 9 and 17 (634)
19 limit 18 to (english language and humans) (480)

Embase

Database: Embase Classic+Embase <1947 to 2022 May 19>
Search Strategy:
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1 (transfer* adj3 care).mp. (7396)
2 (escalation* adj3 care).mp. (1240)
3 medic* discrepanc*.mp. (924)
4 medic* reconciliation.mp. (4382)
5 (transition* adj3 care).mp. (17795)
6 (hospital adj3 discharge).mp. (185175)
7 admission.mp. (536983)
8 Patient transfer/ (30946)
9 or/1-8 (714538)

10 insulin*.mp. or insulin/ or insulin passport*.mp. (922269)
11 (anticoag* or anti-coag*).mp. or anticoagulant agent/ (282900)
12 (("high alert" or "high risk") adj2 (medicine* or medication* or drug*)).mp. (3224)
13 (safe* or harm* or risk* or error* or hazard*).mp. (7041191)
14 (("high alert" or "high risk") adj2 (medicine* or medication* or drug*) adj4 (safe* or harm* or risk* or error* or hazard*)).mp. (2971)
15 ((insulin* or insulin passport*) adj4 (safe* or harm* or risk* or error* or hazard*)).mp. (11952)

16 ((anticoag* or anti-coag*) adj4 (safe* or harm* or risk* or error* or hazard*)).mp. (11555)
17 or/14-16 (26323)

18 9 and 17 (1763)
19 limit 18 to (human and english language) (1631)

Cochrane

Search Name: May22
Date Run: 20/05/2022 16:20:48

ID Search Hits
1. ((care near/1 model*)):ti,ab,kw OR ((model* near/1 service delivery)):ti,ab,kw OR ((model* near/1 (healthcare or health care or health-care))):ti,ab,kw OR ((transform* near/1 (service* or care))):ti,ab,kw (Word variations have been searched) 2641
2. MeSH descriptor: [Patient Transfer] explode all trees 166
3. (transfer near/3 care):ti,ab,kw OR (escalation* near/3 care):ti,ab,kw OR (medic* discrepanc*):ti,ab,kw OR (medic* reconciliation):ti,ab,kw OR (transition* near/3 care):ti,ab,kw 2754
4. #1 or #2 or #3 5410
5. ((safe* or harm* or risk* or error* or hazard*) near/4 (insulin* or anti-coag* or anticoag*)) 4690
6. ((safe* or harm* or risk* or error* or hazard*) near/4 ("high risk medicine" or "high risk medication" or "high risk medicines" or "high risk medications")) 70
7. ((safe* or harm* or risk* or error* or hazard*) near/4 ("high risk drug" or "high alert drug" or "high risk drugs" or "high alert drugs")) 37
8. ((safe* or harm* or risk* or error* or hazard*) near/4 ("high alert medicine" or "high alert medication" or "high alert medicines" or "high alert medications")) 6
9. #5 or #6 or #7 or #8 4796
10. #4 and #9 in Trials 38

Cinahl

EBSCOhost

Friday, May 20, 2022 2:10:37 PM

#	Query	Limiters/Expanders	Last Run Via	Results
S52	S35 AND S51	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	Display
S51	S50 n4 S49	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	Display
S50	S39 OR S44	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	Display
S49	S45 OR S46 OR S47 OR S48	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	Display
S48	errors or mistakes or incidents or adverse events	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	Display
S47	hazard*	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	Display

S46	harm	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	Display
S45	safety or danger or risks	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	Display
S44	S40 OR S41 OR S42 OR S43	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	Display
S43	high alert medicine	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	Display
S42	high alert medication	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	Display
S41	high risk medicine	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	Display
S40	high risk medication	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	Display

S39	S36 OR S37 OR S38	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	Display
S38	anti-coag*	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	Display
S37	anticoagulant therapy or anticoagulants	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	Display
S36	insulin	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	Display
S35	S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33 OR S34	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	Display
S34	medication discrepancies	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	Display
S33	medication reconciliation	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	Display

S32	medicine reconciliation	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	Display
S31	hospital discharge	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	Display
S30	hospital admissions or hospitalization or hospitalisation or hospital stay	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	Display
S29	transition of care	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	Display
S28	escalation of care	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	Display
S27	transfer of care	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	Display
S26	S9 AND S25	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	2,062

S25	s24 n4 s23	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	41,850
S24	S13 OR S18	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	110,092
S23	S19 OR S20 OR S21 OR S22	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	1,515,702
S22	errors or mistakes or incidents or adverse events	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	219,238
S21	hazard*	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	118,537
S20	harm	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	42,032
S19	safety or danger or risks	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	1,332,654

S18	S14 OR S15 OR S16 OR S17	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	559
S17	high alert medicine	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	5
S16	high alert medication	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	170
S15	high risk medicine	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	39
S14	high risk medication	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	348
S13	S10 OR S11 OR S12	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	109,625
S12	anti-coag*	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	417

S11	anticoagulant therapy or anticoagulants	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	28,087
S10	insulin	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	81,424
S9	S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	147,848
S8	medication discrepancies	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	294
S7	medication reconciliation	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	2,572
S6	medicine reconciliation	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	85
S5	hospital discharge	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	14,505

S4	hospital admissions or hospitalization or hospitalisation or hospital stay	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	133,984
S3	transition of care	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	1,808
S2	escalation of care	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	193
S1	transfer of care	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	429

Review Protocol:

Identifying and mapping measures of medication safety during transfer of care in a digital era: A scoping literature review

Background:

When people experience ToC, they are at heightened risk of medication-related harm, particularly from high-risk medications.[1] Anticoagulants and insulin are high-risk medications used long term across all care settings in people of all ages. They have been the focus of safety improvement work, and issues related to ToC are well documented.[2,3]

For successful ToC, multiple activities and processes must be performed. Ten Key Components of an Ideal ToC (KCoIToC) from a hospital to a community setting have been described by Burke et al.[4] They include: discharge planning, complete communication of information, availability, timeliness, clarity and organisation of information, medication safety, educating patients to self-manage, enlisting social and community support, advance care planning, co-ordinating care among team members, monitoring and managing symptoms after discharge and outpatient follow-up.

Safety in health and care is maintained by the resilient adaptations of the people involved in performing the processes of ToC in response to the varying requirements and demands of the work system.[5] The Systems Engineering Initiative for Patient Safety (SEIPS) is a human-factors based framework designed to support visualisation of the health and care system "nested within" Donabedian's quality model of structure, process and outcomes.[6–9] It was created as a tool to support the in-depth understanding of health and care work-systems, and to identify barriers and facilitators of safety within them.

Measurement portfolios also require measures that provide insight into what has happened in the past and monitor this over (lagging measures) in addition to measures that can highlight areas of potential risk (leading indicators).[10] Digital technology allows greater and more immediate access to data, which could facilitate the use of leading indicators.

Objective

The aim of the literature review is to identify measures used to evaluate interventions improve the safety of anticoagulants, insulin, and high-risk medications during or after transfers of care. It aims to evaluate the comprehensiveness of these measures as a measurement portfolio.

The objectives are:

1. To systematically identify studies that evaluated an intervention designed to improve the safety of insulin, anticoagulants or high-risk medications as a group of medications
2. To identify all measures used and to map them according to three frameworks:
    a. How the measures relate to work systems, processes or outcomes using the SEIPS framework.[6]
    b. Whether the measures can provide evidence for the key components of a successful transfer of care according to the framework developed by Burke et al.[4]
    c. Whether the measures were lagging, leading or real-time.[10]
3. To identify any gaps in the measurements when assessed against the three frameworks.
4. To consider whether the measures could be identified in real-time with electronic health systems.

Criteria for inclusion and exclusion of studies

Table 1: Criteria for inclusion and exclusion of studies

	Included	Excluded
Population	Must focus on all three of the following: • Patients transferring between care settings (including between wards within a single organisation). • Patients taking anti-coagulants, insulin or high-risk medications in general.	• Focus on care in a single setting, e.g., Intensive Care Units with no reference to the transfer process. • Focus of study not on insulin, anticoagulants, or high-risk medications.
Construct of interest	Any measure used to describe the effectiveness of the safety intervention including: • Performance-based • Clinician-reported • Patient-reported	Studies that did not seek to determine whether intervention led to an improvement in safety or quality
Comparison	Comparison of patients who received the intervention compared with a control group, including randomised controlled trials, case-control and cohort studies.	Studies with no comparator groups, for example measures developed: • by expert opinion or Delphi consensus. • using population level data.
Outcomes	All measures used to assess whether the safety intervention had an impact will be identified from the studies and used for analysis to determine the comprehensiveness of the measures in terms of: • Whether they represent all the essential elements of transfer of care using the Key Components of an Ideal Transfer of Care framework. • Whether they provide insight into the work-system, processes and outcomes using the Systems Engineering Initiative for Patient Safety framework. • Whether they include lagging, leading and real-time measures. The potential for identifying the measure in real-time using electronic health systems will also be examined.	Measures where there is not enough description or detail to understand how these were obtained or calculated.
Study design	Primary research studies	Case reports, case reviews, review articles, unpublished studies, opinion pieces, cross-sectional studies.
Publication date	No limit	No limit
Language	English	Languages other than English

Search strategy for identification of studies

Four databases will be searched to identify relevant studies: Embase, Medline, Cinahl, and Cochrane databases. These are the prominent health and care related databases deemed most likely to contain studies relating to safety in healthcare.

Search terms will include:

- Transfer of care:
  - Transfer of care
  - Transition of care
  - Escalation
  - Medicine/medication discrepancies
  - Discharge
  - Admission
- Safety:
  - Safe
  - Harm
  - Hazard
  - Risk
  - Error
  - Resilience
- High-Risk Medications:
  - High-risk medication/medicine/drug
  - High-alert medicine/medication/drug
  - Insulin
  - Anticoagulants

Study Selection

An initial review of titles from the search results will identify any potentially meeting the inclusion criteria. A second review of the studies against the abstracts will identify any studies that do not meet the inclusion criteria. Where there is uncertainty, the full text of the article will be obtained to confirm. Any articles meeting the inclusion criteria will be selected, and the full text of the study will be obtained. Where articles are excluded, the reason for exclusion will be documented.

Assessment of methodological quality

The type of article will be identified and recorded, for example whether it was an article published in a journal, or an abstract presented at a conference. Methodological quality assessments will not be performed, as the aim of the study is to identify as many measures of improvement for medications during transfer of care as possible.

Method of data extraction

Each study included in the review will be listed in an excel spreadsheet. For each article, the full text will be read line-by-line and the following will be recorded:

- Citation (author and year of publication)
- Geographical location
- Type of study (design and publication type)
- Number of participants
- Intervention undertaken to improve safety
- Medication involved
- Type of transfer of care being investigated

- Measures used to evaluate the intervention
- Use of digital health systems in identifying, calculating or sharing the measurement data

Data synthesis

The author, CL, will review each measure and consider where they can be grouped together into a broader category, for example different types of adverse events. Each category of measure will then be mapped against three different frameworks in a table, using the framework synthesis approach.

The first framework is the Key Components of an ideal Transfer of Care.[4] This framework lists 10 stages of a discharge that must be completed for that transfer to be successful. By mapping against this framework, the measures will be assessed to understand whether they represent all the activities key to safe transfer. Each measure will be considered as to which component it best represents.

The second framework is the Systems Engineering Initiative for Patient Safety (SEIPS).[6–9] This conceptualises healthcare as taking place in a work system comprising of people, their environments, the tasks performed, and tools used. Processes are performed, and outcomes are influenced by the combination and interactions between the components of the work system and their impact on processes. The measures will be categorized as to whether they are providing insight into work systems, processes, or outcomes. Where possible, the author will use her knowledge and experience to consider what work system factors may influence the measure and list these.

Finally, the measures will be assessed to determine whether they measure past events (lagging indicators), provide an indication of whether an event may occur in the future (leading indicator), or provide real-time data about relevant measures.[10]

The results will be displayed in a table showing how the measures map across different frameworks, and where there are gaps and opportunities for new measures to be developed.

At each stage of data synthesis, the preliminary results will be shared and discussed with the co-authors (categorisation and mapping against each framework and consideration of digital use). The categorisation and mapping will be reviewed, and any ambiguities or challenges will be discussed and considered. The mapping and categorisation will then be agreed by all authors. This process will be repeated at regular intervals as the data synthesis progresses. The three authors are all healthcare professionals, two have a hospital-based background and one with a background in primary care. This provides insight into the context of the studies and measures identified and some aspects of the work-systems.

Results

The search results will use the PRISMA flowchart, detailing the review process and search results, how many articles were excluded and the reasons for exclusion for the exclusion for the articles where the full text was screened.

The included articles will be shared in a table listing the citation, type of study, intervention used, medication involved, the type of transfer of care studied and all the measures used to evaluate the intervention, and digital health system use. Descriptions of the geographical areas will be given in the text.

The measures mapped against the different frameworks will also be presented in a table, and a description of the gaps will be provided in the narrative text.

References:

1 World Health Organization. Medication Safety in Transitions of Care. 2019. http://apps.who.int/bookorders.

2 National Patient Safety Agency. Patient Safety Alert NPSA/2011/PSA003 The adult patient's passport to safer use of insulin. 2011.

3 NPSA. Patient Safety Alert 18: Actions that can make anticoagulant therapy safer (NPSA/2007/18). Published Online First: 2007.http://www.nrls.npsa.nhs.uk/resources/type/alerts/

4 Burke RE, Kripalani S, Vasilevskis EE, *et al.* Moving beyond readmission penalties: creating an ideal process to improve transitional care. *J Hosp Med* 2013;**8**:102–9. doi:10.1002/jhm.1990

5 Wiig S, Aase K, Billett S, *et al.* Defining the boundaries and operational concepts of resilience in the resilience in healthcare research program. *BMC Health Serv Res* 2020;**20**:1–9. doi:10.1186/s12913-020-05224-3

6 Holden RJ, Carayon P. SEIPS 101 and seven simple SEIPS tools. 2021;1–10. doi:10.1136/bmjqs-2020-012538

7 Carayon P, Schoofs Hundt A, Karsh BT, *et al.* Work system design for patient safety: The SEIPS model. *Qual Saf Health Care* 2006;**15**:i50. doi:10.1136/qshc.2005.015842

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9 Carayon P, Wooldridge A, Hoonakker P, *et al.* SEIPS 3.0: Human-centered design of the patient journey for patient safety. *Appl Ergon* 2020;**84**:103033. doi:10.1016/j.apergo.2019.103033

10 Vincent C, Burnett S, Carthey J. Safety measurement and monitoring in healthcare: A framework to guide clinical teams and healthcare organisations in maintaining safety. *BMJ Qual Saf* 2014;**23**:670–7. doi:10.1136/bmjqs-2013-002757

Table 1: References and key information measures used

Year	Author and year	Article or abstract	Medication type	Intervention to improve safety	Care Transition	Electronic Health System Use	Measures used
2011	Avanzini et al.[1]	Article	Insulin	Standardised protocol	Intensive cardiac care unit to general ward	Not described	Percentage of blood glucose: • Within a narrow range on the first, second and third days after ToC • Within a wider range after meals on the first, second and third days after ToC Percentage of hypoglycaemia episodes on the first, second and third days after ToC Deaths Rates of main non-lethal cardiovascular complications
2011	Nordenholz et al.[2]	Abstract	Anticoagulant	Clinical care pathway	Emergency department to primary care	A standardized electronic order set	Laboratory ordering practices Readmission to an emergency department (ED) Readmission with deep vein thrombosis (DVT)
2011	Reger et al.[3]	Article	Anticoagulant	Discharge pathway	Hospital to primary care	Patients identified by scanning computer-based reports. Data collection.	Percentage patients with pharmacist coordination documented Pharmacist time spent per patient Recurrent venous thromboembolism (VTE) Major bleeding
2011	Schillig et al.[4]	Article	Anticoagulant	Pharmacist involvement	Hospital to primary care	Not described	Enrolment in anticoagulation clinic Documented inpatient-to-outpatient provider contact Documented inpatient provider-to-anticoagulation clinic communication Patient follow-up with the anticoagulation clinic within five days of discharge Composite of any INR[1] over 5, any episode of major bleeding or development of new

[1] INR stands for international normalised ratio, a blood test used to determine response to vitamin K antagonists (for example warfarin).

Year	Author and year	Article or abstract	Medication type	Intervention to improve safety	Care Transition	Electronic Health System Use	Measures used
							thromboembolic events within 30 days of hospital discharge
2011	Stafford et al.[5]	Article	Anticoagulant	Pharmacist involvement	Hospital to primary care	Not described	Major bleeding events within 90 days of discharge Thromboembolic events Rates of death Other adverse events (including minor bleeding) Unplanned hospital readmissions INR: • Control at eight days post-discharge and to day 90 • Rates of INR over 4 • Rates of INR within, below or above the therapeutic range Rates of persistence with warfarin therapy
2012	Falana et al.[6]	Abstract	Anticoagulant	Pharmacist involvement	Hospital to outpatient clinic	Not described	Major or minor bleeding Thromboembolic events INR greater than 5 Anticoagulation-related readmissions: • Emergency department (ED) visit • Readmission within 30 days of discharge Successful ToC to the next care provider at discharge.
2013	Martin III et al.[7]	Article	High-risk medications	Pharmacist involvement	Hospital to primary care	Pharmacy computer system produced a report identifying patients taking HRMs.	Percentage of discharge orders requiring resolution of: • Medication safety recommendations • Inadequate warfarin follow-up arrangements

Year	Author and year	Article or abstract	Medication type	Intervention to improve safety	Care Transition	Electronic Health System Use	Measures used
							• Unintentional medication changes Rate of physician acceptance of the team's clinical recommendations
2014	Falconieri et al.[8]	Article	Anticoagulant	TOC programme	Emergency Department to primary care	Not described	Follow up: • Percentage of patients who attended a follow-up appointment by 30 days • Time to follow-up appointment post-discharge Self-reported anticoagulation adherence Readmission rates Patient satisfaction
2014	Martins et al.[9]	Abstract	Anticoagulant	Outpatient clinic	Outpatient clinic to primary care	Not described	Time in therapeutic range Thromboembolic events Number of bleeding events
2015	Padron et al. [10]	Article	Anticoagulant	Anticoagulation stewardship program	Hospital to outpatient	Not described	Clinics: • Number of patients seen in clinic • Percentage of patients with therapeutic, subtherapeutic or supratherapeutic INR at clinic appointment • Appointment attendance Adverse events: • Bleeding • Thromboembolic events Readmissions to hospital or ED
2015	Dunn et al.[11]	Article	Anticoagulant	Information pack	Hospital to outpatient clinic	Retrospective administrative database review. Electronic health record use not	Change in the frequency of obtaining an INR value within 10 days of discharge Percentage patients attaining a therapeutic INR level within 10 days of discharge

Year	Author and year	Article or abstract	Medication type	Intervention to improve safety	Care Transition	Electronic Health System Use	Measures used
						described.	Clinician satisfaction
2015	Quach et al.[12]	Abstract	High-risk medications	Medication reconciliation	Primacy care to the Emergency Department	Not described	Potential for errors discovered to cause patient harm or discomfort
2015	Yilmaz et al.[13]	Abstract	High-risk medications	Medications reconciliation and discharge counselling	Hospital to primary care	Not described	Adherence Rate of medication reconciliation discrepancies Readmission rates Patient satisfaction
2016	Ha et al.[14]	Article	Anticoagulant	Standardised protocol	Hospital to primary care	Patient with medication interactions were identified retrospectively using electronic health record. Standardised data extraction form developed.	Time in therapeutic range Rates of the following during the time of interaction or within 30 days of antimicrobial discontinuation: • Thromboembolic events • Major bleeding events Documentation rates of significant antimicrobial-warfarin interactions
2017	Bryant et al.[15]	Abstract	Anticoagulant	Pharmacist involvement	Emergency department to primary care	Not described	Percentage of patients who received appropriate anticoagulation at time of discharge Number of patients with a pharmacist intervention Rates of patient education provided prior to discharge Time to outpatient follow-up

Year	Author and year	Article or abstract	Medication type	Intervention to improve safety	Care Transition	Electronic Health System Use	Measures used
2017	Castelli et al.[16]	Article	Anticoagulant	Information pack for patients	Hospital to primary care	A daily report generated to identify patients diagnosed with VTE prescribed rivaroxaban.	Percentage of patients who: • Transitioned to rivaroxaban 20 mg daily on day 22 • Had greater than 90% adherence • Stopped rivaroxaban for any reason Adherence Patient understanding of correct dose and timing of medication Overall satisfaction (patient) Rates of: • Minor bleeds • Events that required contacting physician or visiting an emergency department • Recurrent VTE • Death
2017	Chamoun et al.[17]	Article	Anticoagulant	Standardised protocol	Hospital to primary care	A report was generated from a patient database, and data collected from electronic healthcare records.	Bleeding: • Rates of bleeding events • INR on day bleeding occurred • Severity of bleeding event • Total number INR: • Composite of changes by 0.5 or more per day or INR greater than 4 during inpatient stay and follow up Percentage of patients achieving a therapeutic stable INR by day 7 and by day 14
2017	Wei et al.[18]	Article	Insulin	Remote glucose monitoring	Hospital to primary care	Remote monitoring of glycaemic control using a web-based communication portal.	Mean blood glucose level Exploratory outcomes of hypoglycaemia/hyperglycaemia Insulin titration frequency

Year	Author and year	Article or abstract	Medication type	Intervention to improve safety	Care Transition	Electronic Health System Use	Measures used
2017	Zdyb et al.[19]	Article	Anticoagulant	Counselling and education	Emergency department to primary care	Electronic health record used to identify patients requiring interventions. Standardised electronic form for documentation.	Appropriateness of medication dosing Rates of prescription collection If patient had contacted or seen their primary care provider Documented readmission or representation to a hospital within 90 days potentially related to anticoagulation
2018	Herges et al.[20]	Article	High-risk medications	Pharmacist involvement	Hospital to primary care	Electronic health record used to calculate risk of patient death or unplanned readmission. Used to calculate percentage of drug therapy problems and medication discrepancies metrics.	Readmission risk at 30, 60 and 180 days Number of drug therapy problem recommendations for all medications and HRMs Percentage of recommendations that were acted on by the clinician within 7 days Number of medication discrepancies for all medications and for HRMs
2019	Dempsey et al.[21]	Abstract	High-risk medications	Pharmacist involvement	Hospital to primary care	Not described	Average number of medication discrepancies per patient Number of medication access issues resolved 30-day medication related hospital readmissions
2019	Pyrlis et al.[22]	Article	Insulin	Transition diabetes team	Hospital to primary care	Not described	Hospital readmissions and emergency department presentations Patient satisfaction Change in HbA1c
2020	Kapoor et al.[23]	Article	Anticoagulant	Pharmacist involvement	Hospital to primary care	Nurse reviewed medication list and provided an up-to-date colour version with instructions to the patient by mail.	Quality of care transition using Coleman et al.'s Care Transition Measure (CTM) Patient knowledge regarding anticoagulation, interactions, risks, signs, and symptoms to report to prescriber Anticoagulant beliefs

Year	Author and year	Article or abstract	Medication type	Intervention to improve safety	Care Transition	Electronic Health System Use	Measures used
2020	Liang et al.[24]	Article	Anticoagulant	Pharmacist involvement	Hospital to primary care	Not described	Proportions of time within the target INR range during follow-up period Proportions of time within the expanded target range during follow-up period Time spent outside the critical INR range (≤1.5 or ≥ 5.0) Adverse events: • Bleeding • Recurrent thrombosis • Death Readmission Warfarin-related knowledge level
2020	Lim et al[25]	Article	Anticoagulant	Outpatient clinic	Emergency department to outpatient clinic	Guidance to clinicians via an electronic clinical decision support tool.	Readmissions Thromboembolic events Bleeding events
2020	Tyedin et al.[26]	Article	Anticoagulant	Pharmacist involvement	Hospital to primary care	Electronic health record used by pharmacists to chart and monitor warfarin. Electronic health records used for data collection.	Proportion of patients: • With an INR greater than 5.0 • Readmitted relating to anticoagulation • With a complete warfarin dose plan at discharge • With warfarin related errors during admission
2021	Andre et al.[27]	Abstract	Anticoagulant	Medication Reconciliation	Primary care to hospital	Not described	Frequency and type of reconciliation discrepancies at admission and discharge Patient knowledge Medication discrepancies rated for severity

Year	Author and year	Article or abstract	Medication type	Intervention to improve safety	Care Transition	Electronic Health System Use	Measures used
2021	Bakey et al.[28]	Article	Anticoagulant	Pharmacist involvement	Emergency department to primary care	EHS used to identify eligible patients and document pharmacist recommendations.	Rates of issues relating to care components: • Anticoagulation medication errors at discharge • Patient counselling on anticoagulation • Anticoagulation prescription at discharge Adverse events: • ED or hospital admission for bleeding within 30 days • ED or hospital admission for VTE within 30 days
2021	Bawazeer et al.[29]	Abstract	High-risk medications	Medication Reconciliation, counselling and follow up	Hospital to primary care	EHS used to identify patients on insulin and/or warfarin and for data collection	Adverse events: • Readmission rate within 30 days of discharge • Time to first unplanned health care utilization Time to the first outpatient clinic visit Disease-specific parameters (glycosylated haemoglobin (HbA1C) and INR Number of medication-related problems identified during the reconciliation stage Patient satisfaction with the service
2021	DeSancho et al.[30]	Journal	Anticoagulant	Counselling and education	Hospital to primary care	Not described	Scheduled follow up appointment Re-admission rates Adverse events: • Recurrent thrombosis • Bleeding events Adherence Anticoagulant recall errors: • Dose • Dose frequency

Year	Author and year	Article or abstract	Medication type	Intervention to improve safety	Care Transition	Electronic Health System Use	Measures used
2021	Gurwitz et al.[31]	Article	High-risk medications	Pharmacist involvement	Hospital to primary care	Communication with primary care team through the EHS relating to medication safety. Data collection.	Number of adverse drug-related incidents Clinically important medication errors
2021	Kane-Gill et al.[32]	Article	High-risk medications	Pharmacist involvement	Primary care to nursing home	Electronic clinical surveillance system highlighting medication risks.	Patient care recommendations evaluated by degree of harm prevented
2021	Magny-Normilus et al.[33]	Article	Insulin	Discharge intervention	Hospital to primary care	Patients identified by scanning EHS reports. Data collected using hospital's clinical data repository.	Adherence Monitoring: • Glycaemic control - change in A1c 60 to 120 days after discharge compared with the A1c in the 90 days before or at the time of index hospitalization • Proportion of monitored patient-days with severe hypoglycaemia (less than 40 mg/dL) within 30 days of discharge Readmissions
2021	Zabrosky et al.[34]	Abstract	High-risk medications	Standardised protocols for ToC	Hospital to primary care	Not described	Rate of referral to outpatient follow-up Readmissions Successful TOC protocol completion where evaluation/performed and documentation of following documented: • Baseline laboratory values • Therapeutic drug monitoring • Intravenous access • Drug-drug interactions • Medication availability • Patient counselling on medications • Pharmacist documentation in discharge

Year	Author and year	Article or abstract	Medication type	Intervention to improve safety	Care Transition	Electronic Health System Use	Measures used
							letter Pharmacist time Rate of inappropriate protocol initiation
2022	Lázaro Cebas et al.[35]	Article	High-risk medications	Pharmacist involvement	Hospital to primary care	Not described	Readmissions Cost of intervention

References:

1 Avanzini F, Marelli G, Donzelli W, *et al.* Transition from intravenous to subcutaneous insulin: Effectiveness and safety of a standardized protocol and predictors of outcome in patients with acute coronary syndrome. *Diabetes Care*. 2011;34:1445–50.

2 Nordenholz KE, Carlson T, Misky G, *et al.* SAEM Abstracts, Plenary Session. *Academic Emergency Medicine*. 2011:S91. https://doi.org/10.1111/j.1553-2712.2011.01073.x

3 Reger MA, Chapman JL, Lutomski DM, *et al.* Outcomes of a comprehensive, pharmacist-managed injectable anticoagulation discharge program for the prophylaxis and treatment of venous thromboembolism. *J Pharm Technol*. 2011;27:199–205.

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5 Stafford L, Peterson GM, Bereznicki LRE, *et al.* Clinical outcomes of a collaborative, home-based postdischarge warfarin management service. *Ann Pharmacother*. 2011;45:325–34.

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