Designing health IT to support falls prevention in hospitals: Findings from a realist review

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Abstract

Inpatient falls are an international patient safety concern, accounting for 30-40% of reported safety incidents in acute hospitals. They can cause both physical (e.g. hip fractures) and non-physical harm (e.g. reduced confidence) to patients. We used an approach known as a realist review to identify theories about what interventions might work for whom in what contexts, focusing on what supports and constrains effective use of multifactorial falls risk assessment and falls prevention interventions. One of these theories suggested that staff will integrate recommended practices into their work routines if falls risk assessment tools, including health IT, are quick and easy to use and facilitate existing work routines. Synthesis of empirical studies undertaken in the process of testing and refining this theory has implications for the design of health IT, suggesting that while health IT can support falls prevention through automation, such tools should also allow for incorporation of clinical judgement.

Introduction

Inpatient falls in acute hospitals are an international patient safety concern. Approximately 30-40% of reported safety incidents in acute hospitals are falls[1]. Injuries are reported to occur in 15-50% of hospital falls and up to 10% of these are serious, causing for example fractures or head or internal injuries[1]. The proportion of falls resulting in any fracture ranges from 1% to 3%, with reports of hip fracture ranging from 1.1% to 2.0%[2]. Outcomes for patients who acquire hip fractures in hospital are far worse than for those who acquire them in the community, with significant differences in in-hospital mortality (28% vs 9%, P = .03), discharge to long-term high-level nursing care facilities (33% vs 12%, P = .02), and return to preadmission activity of daily living status (9% vs 56%, P < .001)[3]. The psychological cost of falling also includes fear of falling again and associated loss of confidence[1, 4], loss of independence[5], and social isolation[6]. It can result in slower recovery[4], even when physical harm is minimal, and can have longer term consequences for the patient's health, as fear of falling may lead to restriction of activity and associated loss of muscle and balance function, thereby increasing further the risk of falling[1]. Falls can also be a cause of significant distress for families and staff[2, 4]. Falls in hospital are a common cause of complaints[7] and can be a source of litigation[8]. Falls in hospital are also associated with increased length of stay and greater use of health resources[2].

The traditional approach to managing falls in acute hospitals is to complete a falls risk prediction tool (such as STRATIFY[9]). Such tools typically stratify patients according to their calculated risk of falling (high, medium, low) with interventions targeting individuals at higher risk. Falls risk assessment forms are part of the patient record, as are the care plans that are established following the undertaking of a falls risk assessment. Evidence regarding the impact of the digitization of such forms, through their inclusion in the electronic patient record (EPR), is variable. A study of the impact of implementation of an EPR on nursing care outcomes, where the EPR included a falls risk assessment tool, found that introduction of the EPR did not lead to a statistically significant increase in documentation of falls risk assessment, nor did it lead to a decrease in fall rates[10]. In another study, the addition of a falls risk assessment tool to an EPR in the emergency department (ED), when implemented with a falls prevention strategy and staff education, led to a 48% decrease in fall rates[11]. Use of Fall TIPS (Tailoring Interventions for Patient Safety), a form of computerized decision support (CDS) that guides falls risk assessment and then presents

corresponding interventions tailored to patient-specific areas of risk, was found to result in a statistically significant reduction in falls in patients over 65 years old (rate difference=2.29 per 1000 patient days; 95% CIs 0.63-3.95)[12].

While using formal, structured assessment tools may improve decision making as they encourage healthcare professionals to focus on relevant information in a consistent fashion[13], there are issues with this approach to risk evaluation for falls. In particular, there are issues with the predictive validity of tools, which provides false reassurances about those with low risks as well as the issue of action to address or modify the identified risks[14]. Consequently, national guidance for England and Wales states that falls risk prediction tools should not be used and instead a multifactorial falls risk assessment should be undertaken[15]. Rather than categorizing a patient according to their perceived risk of falling, this approach to assessment identifies individual risk factors for each patient which may make them at risk of falling and that can be treated, improved or managed during their stay. These may include: cognitive impairment; continence problems; falls history, including causes and consequences (e.g. injury and fear of falling); footwear that is unsuitable or missing; health problems that may increase their risk of falling; medication; postural instability, mobility problems and/or balance problems; syncope syndrome; and visual impairment. Such an assessment should be undertaken for all inpatients 65 years or older and inpatients aged 50 to 64 years judged to be at higher risk of falling due to an underlying condition. On the basis of this assessment, a multifactorial intervention should be provided, tailored to address the patient's identified individual risk factors. Systematic reviews indicate that such an approach could reduce the incidence of inpatient falls by 25-30%[2, 15] and reduce the significant annual cost of falls by up to 25%[6]. However, although the guidance in England and Wales has included these recommendations since 2013, there is substantial unexplained variation between National Health Service (NHS) hospitals in these nations in terms of the number and type of assessments undertaken and interventions delivered[4].

Given the potential for CDS to support falls risk assessment and prevention, and the need to develop a tool that fits with the national guidance for England and Wales, we are undertaking a study to explore how and in what contexts CDS can support this process. The first part of the study is a realist review that seeks to explain what supports and constrains effective use of multifactorial falls risk assessment and falls prevention interventions. In this paper, we report those findings of the review that relate to the use of health IT (HIT) to support falls risk assessment and prevention. We first describe the methods of the review and then present our results. We conclude by discussing the implications of our findings for the design and evaluation of HIT to support falls risk assessment and prevention.

Methods

Realist review is a literature review method that represents a divergence from traditional systematic review methodology[16]. It is an approach that has much to offer the medical informatics community, providing a means to not only determine if HIT interventions deliver benefit in terms of outcomes, but to understand why and in what contexts such benefits may occur[17]. This is particularly useful when there is variation in outcomes, while a traditional systematic review would only determine whether an intervention is, on average, effective or not. Realist reviews have previously been used to understand how and in what contexts patient portals and interorganizational HIT offer the desired impacts.[18, 19] This type of review is based on the realist understanding that interventions do not produce outcomes but, rather, interventions offer resources to recipients. Outcomes then depend on how recipients choose to make use of, or not, those resources, which will vary according to the context. To focus the review, intervention or program theories are configured as Context-Mechanism-Outcome (CMO) configurations; these hypothesize what contexts support or constrain responses to intervention resources (mechanisms) which, in turn, give rise to a particular pattern of outcomes. Realist reviews start by identifying stakeholders' theories (including theories or ideas from healthcare practitioners and researchers) about how the intervention or program is expected to work and then use empirical evidence to systematically evaluate these, enabling the comparison of how an intervention is intended to work with how it works in practice. Below we provide a summary of the methods we used for this review but full details are available in the review protocol[20].

Phase 1: Theory elicitation

Searches were designed by an information specialist with expertise in realist reviews (JW) and peer reviewed by a second information specialist. The searches included words and synonyms for Falls, Risk Assessment/Accident Prevention, and Acute Hospital settings. In July 2020, we undertook the following searches to identify published and grey literature:

Practitioner theories: Stakeholders' theories are likely to be found in editorials, comments, letters, and news articles[21] so we searched CINAHL (EBSCOhost), Health Management Information Consortium (HMIC) (Ovid), and

Ovid MEDLINE for these publication types, as well as for studies mentioning theories/conceptual models. We also ran a Google search for reports of quality improvement projects. A search for falls risk assessment articles in professional/trade journals and magazines selected by the project team, was undertaken using CINAHL, Embase (Ovid), HMIC, and MEDLINE.

Academic theories: The discussion sections of systematic reviews often include the authors' theories about why the interventions did or did not achieve the desired effect[22]. Therefore, we searched CINAHL, Cochrane Central Register of Controlled Trials (Wiley), Epistemonikos (www.epistemonikos.org), HMIC, International HTA Database (www.inahta.org), MEDLINE, and PROSPERO (www.crd.york.ac.uk/prospero/).

The results of the database searches were stored and de-duplicated in an EndNote library. Titles and abstracts, and later full texts, were screened for relevance by three reviewers (NA, LM, and HZ). When screening the full texts, we prioritized papers for data extraction which captured author ideas and assumptions to inform theory construction. We focused on papers that expressed ideas about how, why, in what contexts, and for whom falls risk assessment and prevention work, and gave particularly rich expression to the mechanisms. Data extraction captured data concerning contexts, mechanisms, and outcomes. Data matrices were created to summarize findings and, from these, CMO configurations were constructed.

Results of Phase 1: The searches retrieved 990 unique records. Title and abstract screening identified 307 potentially relevant records. We extracted data from 78 full text papers, including 20 systematic reviews of multifactorial studies and 58 papers containing practitioner theories in the form of commentaries, letters, editorials, magazine articles and similar text. In addition, 39 further practitioner papers were included from the 44 documents retrieved from the Google search, including posters and case studies about falls initiatives. Therefore, a total of 117 texts contributed to theory construction. A total of 25 CMO configurations were identified. These were prioritized for testing by the study's lay researcher group (members of the public who are contributing to the conduct of this research, most of whom have personal experience of falling or caring for someone who has fallen in hospital). Through this, four CMO configurations were selected, concerned with leadership, multidisciplinary collaboration, patient and carer participation, and facilitation via HIT and other tools. This paper focuses specifically on the CMO configuration concerned with facilitation, detailed as follows:

> *If multifactorial falls risk assessment tools (including HIT) are relatively quick and easy to use and/or facilitate existing routines, staff will choose to integrate them and recommended practices into their work processes (M), helping to ensure that all eligible patients receive a comprehensive, multifactorial falls risk assessment and appropriate interventions (O).*

This describes the resources that the intervention provides (a tool that is quick and easy to use and/or facilitates existing routines) to which, in particular contexts, staff will respond by integrating the tool into their work processes, leading to the outcome of all eligible patients receiving a comprehensive, multifactorial falls risk assessment and appropriate interventions. A multitude of tools to support falls risk assessment were identified, with no clear pattern in the contextual factors that supported their use.

Phase 2: Theory testing

Search terms were identified for each of the 4 CMO configurations and the searches were peer-reviewed by a second information specialist. In May 2021, searches were run on CINAHL, Embase, MEDLINE, and Core Collection (Web of Science). Results from all four CMO searches were deduplicated and managed in one EndNote library. Screening of title and abstracts, and later full texts, was undertaken by two reviewers (NA and LM). Data extraction was undertaken by NA and LM using NVivo, with sections of the papers coded into themes that addressed the components of each CMO configuration, e.g., for the facilitation CMO configuration, an overarching theme covered facilitation, with sub-themes including alerts and reminders, assessment and decision support tools, and compliance and documentation. Quality of the papers included was assessed using the Mixed Methods Appraisal Tool (MMAT)[23]. To test the theories, coded data were summarized in matrices and compared against the 4 CMO configurations. Through this process, a series of additions and refinements were made to the CMO configurations.

Results

The Phase 2 searches returned 1,371 unique records. Based on title and abstracts screening, 442 papers were identified as potentially relevant. Screening of full texts left 130 papers included in the synthesis. Twenty-six papers

were used to test the facilitation CMO configuration. Seventeen of these papers, describing 15 studies, referred to the use of HIT. The HIT in these studies took different forms. Most commonly, they referred to falls risk assessment tools, and in some cases associated care plans, within the EPR without any explicit mention of CDS[10, 24-28], although one provided alerts to remind staff if hourly rounding had been selected as an intervention[29]. One paper we included did not explicitly mention falls risk assessment and prevention but described a qualitative study undertaken alongside a quantitative study looking at the impact of introduction of an EPR on completion of falls risk assessments[30]. Six papers described CDS to support falls risk assessment and associated care plans; of these, five were concerned with Fall TIPS[12, 31-33] (in one case as a component of a larger intervention[34]) and one paper described an EPR that included indicators if falls risk assessments had not been completed and an alert if patients at high risk of falls were not on a fall prevention plan of care[35]. Two papers described an iPad™-based tool where staff entered a patient's details and their perceptions of the patient's day and night-time falls risk for 13 different movement and location types and the tool then automatically generated black-and-white A4-sized tailored care plan posters[36, 37]. In one study, a change had been made to the EPR to clearly indicate if a patient had experienced a fall during their stay[38]. There were a range of study designs: a cluster randomized controlled trial (RCT)[12, 33], a stepped wedge randomized trial[34], an interrupted time series (ITS) study[10], a case control study[32], six uncontrolled before and after studies[24, 25, 27, 35, 38], including one that incorporated data from focus groups and surveys[36, 37], a qualitative multi-site case study[30], an audit[31], a quantitative descriptive study[28], and two descriptive accounts of QI projects[26, 29]. All the studies were undertaken in the acute hospital setting, 11 in ward settings[10, 12, 24, 25, 28, 30-37] and four studies in EDs[26, 27, 29, 38]. The majority of studies were undertaken in the United States[10, 12, 26, 27, 29-35, 38], but there were also studies from Australia[36, 37], Brazil[25], Spain[24], and Taiwan[28].

Impact on completion of falls risk assessments and care plans

Six studies provided quantitative data on impact of the intervention on completion of falls risk assessment. Two of the six studies looked at the impact of having a falls risk assessment tool within the EPR. In one of these studies, an EPR was introduced that incorporated a falls risk assessment tool, before which documentation had been mainly paper-based[10]. This ITS study across 29 US hospitals found that the overall increase in documentation of falls risk assessment following introduction of the EPR was not statistically significant, although documentation did increase over time. Interestingly, there was a statistically significant increase in documentation of pressure ulcer risk assessment. In the second study, conducted in Brazil, there had previously been no standard tool for falls risk assessment and, prior to the introduction of the Morse Fall Scale within the EPR, in the Internal Medicine Unit, 67% of patients received a falls risk assessment on admission and 45% received one on transfer[25]. In the Intensive Care Unit, 55% of patients received a falls risk assessment on admission and 67% received one on transfer. Following the introduction of the Morse Fall Scale, in the Internal Medicine Unit, 77% of patients received a falls risk assessment on admission and 100% received one on transfer. In the Intensive Care Unit, 72% of patients received a falls risk assessment on admission and 82% received one on transfer. Thus, there was improvement in both areas, although the statistical significance of these increases was not reported.

Two of the studies looked at particular technologies. Early results from the Fall TIPS trial reported a significant increase in falls risks assessments completed per patient[33]. The study where an iPad™-based tool was used by clinicians to record their perceptions of the patient's day and night-time falls risk, generating tailored care plan posters, was conducted in Australia in a Geriatric Evaluation and Management (GEM) unit and an acute medical unit (AMU)[36]. This study found a decrease in completion of falls risk assessment compared to the paper-based assessment tool but it was not significant (70% vs 63%, P = 0.47).

In two of the studies, falls risk assessment was done within the EPR in both the pre- and post-intervention conditions. Both of these studies also looked at the impact on completion of the care plan. In one study, conducted on two medical wards and one surgical ward in Spain, the falls risk assessment tool was not well known amongst staff[24]. Over a 6-month period, training was provided in falls risk assessment, including use of the tool, and head nurses and champions disseminated information and provided key messages about the importance of good records in relation to falls risk assessment. Following this, completion of falls risk assessment on admission increased in all three wards, although the increase was not statistically significant. However, completion of the falls care plan decreased in two of the three wards (statistical significance was not reported). In the second study, conducted in 16 adult units, indicators if falls risk assessments had not been completed and an alert if patients at high risk of falls were not on a falls care plan were added to the EPR[35]. There was a statistically significant increase in falls risk assessment documentation compliance, from 95.3% to 97.25% (P = .05). At the start of the project, one medical unit and one surgical unit were performing below the target 90% documentation compliance rate for falls risk

assessments and care plans and retrospective chart review was undertaken. In these two wards, there was a statistically significant increase in falls risk assessment on admission from 92.73% to 98.86%. However, there was a decrease in admission care plan for patients at high risk of fall from 77.1% to 61.5%, although this was not statistically significant. In the medical unit specifically, the decrease was statistically significant, from 75% to 32.1%. In focus groups, some staff reported not having seen the alert that the care plan had not been completed. There was also some disagreement with the results of the risk assessment, where it indicated a patient was at high risk of falling but staff did not think they were.

A related finding was reported in a study where they found that care plans were not in place for almost half the patients identified at high risk[28]. The authors considered this could be due to nurses questioning the accuracy of the risk ratings, as well as nurses not having time to complete the care plans. However, they also found that the percentage of patients with a care plan that fell was significantly higher than for those without a care plan (2.2% vs 0.1%, $P < .001$), which could suggest that nurse judgements about risk (and who to develop a care plan for) were fairly accurate. Following the Fall TIPS trial, researchers looked at those cases where Fall TIPS had been used and the patient had fallen, with the intention of generating learning that could be used to improve Fall TIPS[32]. The findings revealed that the patient had the correct care plan but the interventions were not in place at the time of the fall. Underlying our Facilitation CMO configuration is the assumption that completing a falls risk assessment will lead to selection of appropriate interventions but, based on completion rates of care plans, this is not necessarily the case. This break in the link between falls risk assessment and identification of interventions was one of the motivations for the development of Fall TIPS[33]. However, completion of a care plan does not necessarily mean those interventions will be consistently delivered.

In summary, the relationship between use of HIT and completion of falls risk assessments and care plans is complex. Below we look at the literature to consider whether the resources noted in our theory – speed and ease of use, and facilitating existing routines – can help to explain the outcomes described, before considering other mechanisms and contextual factors identified through the synthesis.

Speed and ease of use

While, as one would expect, the literature largely confirmed the importance of speed and ease of use, it also clarified what is meant by speed of use and suggested that speed and ease may not be essential for motivating use. For example, implementation of the iPad™-based falls risk assessment and care planning tool was prompted by negative staff feedback on the usability of the previous paper-based system which, following completion of a falls risk assessment, involved attaching colored dots to a paper poster to indicate falls risks[37]. In the GEM unit, there was only 20% staff compliance with the paper-based process. In a pre-trial focus group, staff expressed concern that the new tool, too, would increase their workload and possibly lead to inaccurate assessments and care planning if staff were under too much pressure. They were also worried that clinicians (especially older staff) might struggle to use the technology. Designers of the new tool attempted to address these concerns. The interface was simple, with buttons to click to indicate areas of risk and it took less than five minutes to use per patient. Linking the assessment to the care planning system to automatically generate care plans meant that staff no longer had to affix dots to posters, with the intention of facilitating the care planning process. Staff were offered up to six weeks of researcher training and reminders on tool use (three hour-long sessions each week). GEM staff undertook the full period of researcher-led support, whereas AMU staff declined it after one day, because they felt confident in using the tool. However, completion rates were higher in the GEM unit than in the AMU, which the authors suggest could be due to the longer staff training period and greater senior nursing endorsement and involvement in the design of the tool[36]. The post-trial survey revealed that, despite these measures, some staff continued to perceive the main barriers to use as lack of time to complete the tool (39.3%) and lack of usability (21.4% of respondents)[37]. The main recommendation for improvement was for more staff training (32.1% of respondents), especially from staff who had already used the tool, suggesting that the tool was not intuitive to use. Overall, this research reinforces the importance of the mechanisms relating to ease and speed of use, but suggests that even an assessment tool that took no more than five minutes to complete and had a simple, graphical user interface was not always perceived to meet these criteria, owing to the busyness of the ward environment and technological factors. Yet, despite this, most respondents (75%) to the post-trial survey wanted to continue using the tool and saw it as a useful snapshot of patients' falls risks, *contra* our theory that staff would choose to use the tool only if it was quick and easy to use.

A particular aspect of ease of use relates to the visibility of system features. Tools can act as a reminder, drawing attention to the task required, but the tool or alert has to be visible, a simple fact that is illustrated by two of the

studies included in the review. In one study, as described above, nurses reported not having seen the alert that the care plan had not been completed[35]. In another study, also described above, where completion of falls risk assessment on admission increased following education and dissemination of information, the authors note that the tool had been included in the EPR for 8 months before they began their study but it was not well known amongst staff[24].

Facilitating existing routines versus automating routines

In terms of facilitating existing routines, the only clear HIT-based example of this that we identified in the literature was the iPad™-based tool that generated a poster to replace and make easier the existing paper-based process[36, 37], although facilitating existing practices, such as use of signs to alert staff to fall risk status, was a consideration in the design of Fall TIPS[33]. What we did find though was that in all four ED studies, they changed the falls risk assessment tool in the EPR to one that was specific for the ED. In two studies, they changed to using KINDER 1[27, 38], in one they changed to using the Memorial Emergency Department Fall-Risk Assessment Tool (MEDFRAT)[29], and in one they developed their own tool[26]. This suggests that what is important may be less about facilitating existing routines and more about reflecting their particular setting and patient population. For example, MEDFRAT includes a question related to alcohol or substance abuse, which has been shown to be associated with falls in EDs[29], while in the ED where they developed their own tool, they included presence of a diagnosis affecting comprehension and coordination because, as a center for neurological care, they considered this to be a common site-specific risk factor[26]. While implementation of clinical area specific falls risk assessment tools was only reported in the ED studies, one of the ward-based studies discussed appropriateness of risk factors and the need for local adaptation[36].

A similarity between the iPad™-based tool and Fall TIPS is the use of automation, leading us to consider the importance of automation as a mechanism for supporting falls risk prevention and assessment. The Patient Safety Learning Laboratory, which incorporated Fall TIPS, extracted data in real-time from a newly implemented vendor EPR in 12 inpatient units in a US hospital and displayed the data to clinicians and patients, more fully automating the process (where feasible, as not all organizations were resourced to support this) so that tasks were completed without relying on staff having the time to do so manually[34]. In one Fall TIPS study, the impact of different levels of automation was explored[31]. Three modalities were studied: (1) the original EPR version that generates a tailored fall prevention poster; (2) a bedside display version that automatically populates the bedside monitor with the patients' fall prevention plan based on the clinical documentation in the EPR; and (3) a paper-based, laminated version of the tool that uses color to provide clinical decision support by linking patient-specific risk factors to the interventions. The three hospitals in the study reached clinically significant rates (>80%) of adherence for presence of the Fall TIPS poster at the bedside, regardless of modality and site, suggesting that level of automation had little influence on staff use of the poster. However, it took longer to achieve 80% adherence with the paper-based modality in one site, possibly indicating that more effort was required to integrate it into their work practice. This fits with another, non-HIT, study that we looked at in testing the Facilitation CMO configuration, where a novel Falls Wheel displayed on patients' doors to communicate falls risk and interventions was perceived as imposing additional tasks that staff struggled to prioritize[39].

However, even where some automation is provided, manual elements may present constraints; with the iPad™-based tool, it was reported that it was difficult to ensure that automatically-generated care plan posters were physically relocated when patients were moved into other beds, pointing to how the reality of care delivery can disrupt intended use and impacts of such tools[37].

Clinical judgement versus structure

While automation can provide a way of linking falls risk assessment and care planning, a theme that came up repeatedly in testing the facilitation CMO configuration, in both HIT and non-HIT studies, was the importance of clinical judgement. As noted above, staff may disagree with the results of a falls risk assessment tool[28, 35]. In one of the ED studies, staff liked the fact that the new tool allowed for nursing judgement; this was seen as reinforcing the belief that staff were empowered to assess for and prevent patient falls, rather than simply following the recommendations of a tool[38]. Other studies pointed to clinical judgement as a mechanism to bridge the gap between the ideal and the reality of care delivery, which may lead to staff overruling recommendations[40]. Application of clinical judgement may help reconcile tool guidance, patient preference and the reality of ward practice e.g., contextual factors like resources, including availability of recommended interventions, and staff capacity to deliver those interventions. This can also help to overcome limitations of existing falls risk assessment tools, allowing for

consideration of additional patient factors. It is in recognition of nurses' additional knowledge of the patient that Fall TIPS allows nursing staff to further tailor the choice of interventions (although constraints of local EPRs meant that this functionality could not be provided across all sites)[33].

Context

It is in considering the reality of care delivery that we start to understand the contextual factors that are likely to influence the use and impact of HIT-based tools designed to support risk assessment and prevention. Staff are busy, the workflows are complex, new policies and systems are frequently introduced, and falls prevention is one of many competing priorities for staff attention[33]. One of the studies described the necessity for nurses to constantly juggle the competing requirements of documenting care while simultaneously having to provide care to patients, which may help to explain why completion of the falls risk assessment does not necessarily lead to the completion of a care plan, even though fall prevention interventions may be delivered[30]. It was noted that, on occasion, nurses were unable to complete their documentation at the point at which they delivered the care, in which case they would do this retrospectively later in the shift.

The issue of culture was mentioned in several studies[27, 30, 38]. For example, in a pre-trial focus group for the iPad™-based tool, clinicians perceived the main barrier to implementation as shifting a workplace culture that resisted change and did not view inpatient falls as a problem[37]. Thus, a culture is needed where inpatient falls are seen as a problem and where staff feel empowered to prevent falls.

Discussion

Inpatient falls are an international safety concern and the most common type of safety incident reported by acute hospitals. We have undertaken a realist review to explain what supports and constrains effective use of multifactorial falls risk assessment and falls prevention interventions. This is the first realist review of falls risk assessment and prevention and the first review to consider the role of HIT in supporting falls prevention. We have drawn on a range of empirical studies undertaken across five different countries. The review has revealed that, while HIT can support falls risk assessment and care planning, the impacts are variable. However, the use of realist review has allowed us to go beyond the question of whether HIT helps, to answer questions of how, why, and in what contexts. In summary, we can suggest the following as a refinement of the facilitation CMO configuration presented above, focusing specifically on HIT as a resource:

> *In a culture where inpatient falls are seen as a problem (C), if HIT tools are clearly visible and relatively quick and easy to use, automating aspects of falls risk assessment and care planning but allowing for clinical judgement, staff will feel empowered to integrate them and recommended practices into their work processes (M), helping to ensure that all eligible patients receive a comprehensive, multifactorial falls risk assessment (O).*

These results have implications for the design of HIT to support falls risk assessment and prevention. They suggest that, while speed and ease of use are important, allowing for clinical judgement is important for adoption. In practical terms, this implies the need for a combination of automation and the ability to tailor or override care plan recommendations, as is the case with Fall TIPS. There may also be the need to adapt risk assessment tools to the specific clinical area, in order to increase staff acceptance of them. The study where nurses reported not having seen the alert that the care plan had not been completed[35] also acts as a reminder that tools need to be clearly visible for staff in their routine use of the EPR, or at a minimum training should be provided to support use of the tool.

The results of the review also reveal that we cannot assume completion of falls risk assessments or care plans mean that appropriate interventions are provided to patients. This suggests that, while documentation completion is useful as a measure of adoption, evaluations of HIT that are designed to support falls prevention should measure whether appropriate interventions are delivered in order to assess success, rather than using documentation completion as a surrogate measure.

A potential limitation of this review is that we have focused on studies from the acute hospital setting. Although fall rates are higher in hospital than in the community[41], the majority of existing research on falls prevention has focused on community dwelling adults[1], and thus there may be useful literature from this setting that could add to our understanding and increase the applicability of our theories. There may also be useful literature from the care home setting. While realist review allows for the inclusion of literature from other settings, the quantity of literature we

obtained from the acute hospital setting meant that expanding our search was beyond our resources but this suggests an area for future work. Because the key unit of analysis in a realist review is the intervention mechanism, literature concerning other interventions that have the same underlying mechanism are also deemed relevant[21, 42], so similarly there may be benefit in considering literature on the assessment and prevention of other patient risks.

Conclusion

We have undertaken a realist review to explain what supports and constrains effective use of multifactorial falls risk assessment and falls prevention interventions. The results of the synthesis of empirical studies have implications for the design of HIT, suggesting that while HIT can support falls prevention through automation, such tools should also allow for incorporation of clinical judgement. In current work, we are building on this review, further refining our literature-based theories through a multi-site case study of falls risk assessment and prevention.

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