Safety Science 129 (2020) 104844

Contents lists available at ScienceDirect

Safety Science

journal homepage: www.elsevier.com/locate/safety

Closing the research-practice gap in healthcare: The development and usability evaluation of a patient handling incident investigation toolkit

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ARTICLE INFO

Keywords:
Systems thinking
Safety management
Workplace safety
Usability evaluation
Patient
Handling
Healthcare

ABSTRACT

It is widely acknowledged that work-related musculoskeletal disorders (MSDs) are created by a complex network of factors. However, it is questionable if this knowledge has been effectively translated into practice, especially concerning incident investigations. This is partly attributed to the lack of a tailored, systems thinking approach for investigating MSDs. This article describes the development and evaluation of an investigation toolkit, the Patient Handling Injuries Review of Systems (PHIRES) Toolkit. Underpinned by Rasmussen's (1997) Risk Management Framework, the PHIRES Toolkit was developed to help healthcare practitioners adopt a systems thinking approach when investigating injuries sustained to workers following patient handling. This paper presents the key findings from the initial development and usability evaluation of the PHIRES Toolkit conducted with three health services in Victoria. The findings suggest that the Toolkit is effective in helping practitioners apply systemsthinking to understand and address the complex system of factors involved in patient handling injuries. The results from the usability evaluation identified several actions to drive future research.

1. Introduction

Work-related musculoskeletal disorders (MSDs) represent a significant burden on individuals, organisations, and society and are a particular problem within the healthcare sector. Between 2009/10 and 2013/14, the health care and social assistance industry accounted for the highest percentage (18 per cent) of serious MSD claims and the industry also reported the highest frequency rate (7.1 claims per million hours worked) (Safe Work Australia, 2016). This trend is not improving in Australia with 2016/17 data showing that injury and MSDs represented 89% of serious claims in the health care and social assistance industry (Safe Work Australia, 2017). The problem is not limited to Australia. The Occupational Health and Safety Administration in the U.S. reported that nursing assistance had the second highest number of cases of MSDs involving days away from work (i.e., 166.3 MSDs per 10,000 workers); this equating to more than five times the average for all industries (OSHA, 2019).

Best practice guidelines currently advocate multifaceted approaches to managing the risks to workers associated with patient handling, which cover many factors from individual to organisational interventions (American Nurses Association, 2012; National Back Exchange, 2010; Smith, 2011). For example, Fray and Hignett (2013) examined interventions that hospitals have used to control the risks associated with patient handling and identified a range of interventions focused at the organisational (e.g., introduction of hazard register, management systems), physical/engineering (e.g., staffing levels, equipment maintenance) and personal (e.g., education and training, stress management) levels. This study also identified the evaluation of risk control effectiveness as a critical need to support the healthcare sector in monitoring progress towards reducing or eliminating the risks associated with patient handling tasks (Fray and Hignett, 2013).

The factors contributing to worker injuries due to patient handling are themselves complex and multi-faceted (Hignett et al., 2003). To best understand this extent of this complexity, it is essential to establish a learning culture (Stemn et al., 2017) that is supported through the development of investigation methods that optimise the quality of learning from incidents (Littlejohjn et al., 2017), particularly those that adopt an integrated approach that captures that multiplicity of factors contributing to incidents (Rollenhagen et al., 2017). However, a critical gap in practice is a tool that would allow Occupational Health and Safety (OHS) practitioners in the healthcare industry to identify these factors to prevent future injuries (Goode et al., 2018a).

Research conducted by the authors (see Goode et al., 2018b) found that most healthcare services in Australia currently do not have any

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https://doi.org/10.1016/j.ssci.2020.104844
Received 17 October 2019; Received in revised form 22 March 2020; Accepted 12 May 2020

standardised systems in place for reviewing risk controls following an injury to staff. Furthermore, most investigations focus on gaps in training and equipment and ignore the broader system of factors likely to contribute to incidents (Goode et al., 2018a). This reductionist-focused approach also creates challenges in making changes to higher order processes and structures (e.g., management systems); a finding consistent within high-risk industries such as nuclear power plants (Rollenhagen et al., 2017). Thus, the current investigative environment within healthcare is inhibiting learning as well as providing limited opportunities to review and revise risk controls in place to prevent injury incidents.

In response to this gap in practice, research is being conducted to develop a standardised process for investigating MSDs to staff due to patient handling, underpinned by systems thinking. This study presents the first steps in the development and evaluation of a toolkit, the Patient Handling Injuries Review of Systems (PHIRES), which focuses specifically on the patient handling task. The aim of the paper is to describe development of the PHIRES Toolkit and present the results of a usability evaluation conducted with three health services in Victoria.

2. Systems thinking

There is now significant evidence demonstrating the use of systems-thinking methods for understanding incident causation in many domains (Hulme et al., 2019). An example of systems-thinking in healthcare being the Systems Engineering Initiative for Patient Safety (SEIPS; Carayon, 2006) model which has been used to frame the design and analysis of research across multiple healthcare settings. This research has established that incidents are caused a complex sytem of factors, with risk influenced by a diverse set of interacting individual, work-related and societal factors, in addition to the physical risks typically associated with the work task. Despite this being widely accepted for over almost three decades, it has not translated well into safety practice to prevent injury to healthcare workers; with this limitation labelled as the research-practice gap (Chung and Shorrock, 2011; Underwood and Waterson, 2014). This gap is characterised by discrepancies in the methodologies that safety researchers and Occupational Health and Safety (OHS) practitioners are applying in response to the same issues, and raises concerns relating to the extent to which the methods being applied in practice reflect the theoretical and methodological advances being made in academia (Salmon, 2016).

Underwood and Waterson (2013) identified a number of barriers preventing the adoption and usage of system-thinking accident analysis methods by practitioners, including a lack of awareness, lack of training opportunities, accessibility and lack communication of information, usability, resource constraints, and questions around the reliability and validity of the methods. In addition, the literature provides little guidance for the practitioner wishing to apply systems thinking methods to investigate or follow-up on workplace injuries. Significant work is required to translate these methods into tools for safety practitioners, including those in the healthcare setting (Goode et al., 2018a). A goal of the PHIRES project is to address this gap through development of a system-thinking incident investigation Toolkit.

An important step in developing a system-thinking incident investigation Toolkit is the adoption of an appropriate accident causation model. One model that has been frequenty used across multiple safety-critical domains is Rasmussen's (1997) risk management framework (see, Salmon et al., 2017a). The popularity of this framework is partly attributed to its generic structure which allows researchers and practioners to apply it in any domain. Rasmussen's (1997) framework represents work systems as hierarchies comprising multiple levels including: government policy and budgeting; regulatory bodies and associations; local area government planning & budgeting; technical and operational management; physical processes and actor activities; and equipment and surroundings. The framework is based around the idea of vertical integration, which argues that for safe system performance the decisions and actions made at higher levels of the system (e.g. by governments, regulators, and managers) should propagate down and be reflected in the decisions and actions occurring at the lower levels (e.g. supervisors and frontline staff). Further, information about the status of safety at the lower levels needs to be communicated back up the hierarchy to inform the decisions and actions made at the higher levels.

A second reason for the popularity of Rasmussen's risk management framework is the related Accimap technique which is used to support the use of the framework in incident analysis (Rasmussen, 1997; Svedung & Rasmussen, 2002). Accimap is used to graphically represent how the conditions, and decisions and actions of various actors within the system interact with one another to create the incident under analysis. Factors at each of the levels are identified and linked together based on cause-effect relationships. The Accimap technique has been applied to describe and represent large-scale organisational accidents in multiple domains, as well as multiple incident datasets (Goode et al., 2018b; Hulme et al., 2019; Salmon et al., 2014, 2020). In addition, Accimap has been used to support the analysis of workplace injury incidents (Goode et al., 2014; Newnam and Goode, 2015; Newnam et al., 2017). Thus, there is substantial evidence to support Accimap as an ideal method for the collection and analysis of data in PHIRES.

3. PHIRES

The PHIRES Toolkit was designed to provide a standardized process for reviewing and revising risk controls following the report of an injury to staff in a hospital setting. The Toolkit was developed to meet four primary purposes:

1. improve compliance with Regulation 28(1)(c) of the Occupational Health and Safety Regulations in Victoria, Australia, which requires workplaces to review and revise risk controls following the report of an MSD;
2. optimise risk controls to prevent future patient handling injuries;
3. optimise the allocation of resources to control the risks associated with patient handling; and
4. improve collaboration across all levels of the healthcare system (e.g. patients, staff, health service management, regulators and government departments) in the prevention of patient handling injuries.

The Toolkit is underpinned by core systems thinking principles and uses Rasmussen's Accimap technique to guide OHS practitioners in mapping the factors contributing to patient handling injuries. It also aligns with similar approaches (e.g., PreventiMap technique; Goode et al., 2016) through using the Accimap technique to prompt practitioners to use systems thinking principles to generate recommendations based on their analysis of the incident. The key principles underpinning PHIRES are presented in Table 1. These principles were adapted from a set of predictions arising from Rasmussen's framework (Cassano-Piche et al., 2009).

This paper presents the key findings from the initial development and evaluation of the PHIRES Toolkit. The overall aim of the pilot was to evaluate the usability of the PHIRES Toolkit within three health services in Victoria, Australia. A usability evaluation was conducted to assess if practitioners could use a system thinking toolkit to generate goals capable of creating systemic change in the healthcare industry. The findings were used to refine the PHIRES Toolkit for a larger scale pilot.

4. Methods

4.1. Research design

Co-design was integral in the development of the PHIRES Toolkit and in the evaluation of its usability. The research collaboration

Table 1
Key principles underpinning PHIRES.

Principle	Description
Patient handling injuries are caused by multiple, interacting factors.	Injuries resulting from the decisions and actions of people at all levels of the system, not just frontline staff (e.g., nurses) performing the task. Information from frontline staff needs to inform the decisions at the higher levels. The decisions at the higher levels then needs to be effectively implemented at the frontline.
The healthcare environment is constantly changing due to multiple pressures.	These changes will inevitably impact on patient handling tasks, so safety and performance needs to be constantly monitored.
Focussing solely on administrative controls (eg: training in policies and procedures) is likely to be ineffective.	Effective strategies for reducing patient handling injuries involve: • Introducing controls at higher levels of the system (e.g. staff numbers, equipment selection process); • Improving the flow of information up and down levels of the system; • Ensuring work planning decisions do not unintentionally increase the risk of patient handling injuries (e.g. rostering, approval process); • Mitigating against pressures through effective and targeted work design and planning (e.g. safety margins); and • Increasing choice and flexibility for frontline staff (e.g., nurses) performing patient handling tasks

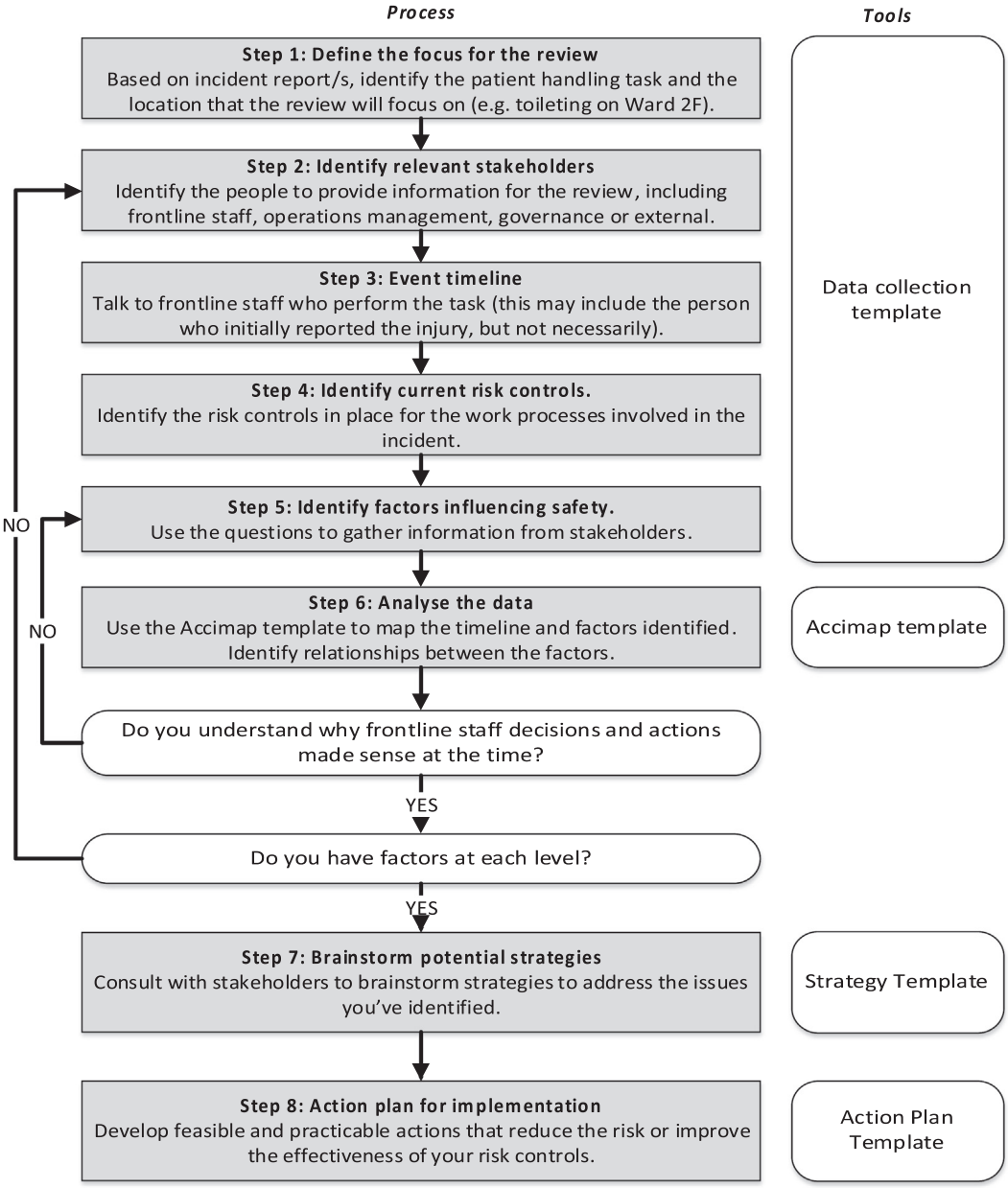

Fig. 1. Overview of the pilot version of the PHIRES process and supporting tools.

consisted of two Universities (Monash University and the University of the Sunshine Coast), a workplace safety regulator (WorkSafe Victoria) and three health services in Victoria, Australia. An Expert Reference Group (ERG) of OHS practitioners was established from the outset of the project to provide context-specific guidance on the design of PHIRES. This group (five OHS practitioners) had an average of 15 years' experience in healthcare and were engaged on two occasions to provide input into the design of the toolkit prior to the pilot.

4.2. Participant profile

Four OHS Officers (three females, one male) from three Health Services participated in the pilot of the PHIRES Toolkit. Two Health Services were metropolitan-based (i.e., Health Service 1 and 3) and one was regional (i.e., Health Service 2). In the regional health service, two OHS Officers were recruited and collaborated in the completion of their reports using the PHIRES Toolkit. Only those OHS Officers recruited for this project (and were trained on using the PHIRES) completed investigations using the PHIRES Toolkit.

OHS Officers were defined as individuals with current responsibilities for investigating or following-up on reports of patient handling injuries. Each participant had between 1 and 15 years' experience in their role. All participants had experience in conducting reviews of worker injuries and three out of four participants reported they were familiar with the regulation requiring the review and revision of risk controls following the report of a musculoskeletal disorder.

Recruitment was facilitated by presentations of the project at key conferences and industry forums and through the ERG. Ethics approval was granted to undertake the project and consent was provided by the OHS Officers prior to their participation.

4.3. Procedure

Several stages were involved in the development and evaluation of the PHIRES Toolkit. The first stage involved engagement with the ERG. This group identified that OHS Officers would be the ideal participants for PHIRES given they are responsible for reporting and investigating incidents involving injury to a staff member with Health Services, and also have the relevant background knowledge about safety management systems. This group also provided feedback on factors to consider in the implementation of PHIRES and collection of data (e.g., development of facilitation guides and prompt questions for OHS Officers).

The second stage involved developing and delivering training materials for OHS Officers. The training materials included a series of videos on systems thinking and an overview of the PHIRES Toolkit with a worked example based on an incident where a worker was injured due to handling a bariatric (seriously overweight) patient.

Following the training (stage three), the OHS Officers were asked to use the PHIRES Toolkit to analyse a minimum of five injury events over a three month period and use this data to generate strategies that align with system thinking principles. Fig. 1 describes the steps in the PHIRES process and the associated materials. This figure outlines the eight steps in the PHIRES process including the tasks required by OHS Officers in the pilot. As illustrated in Fig. 1, the Toolkit incorporates four key tools, in the form of templates that were developed using Word documents (that could be populated electronically or in hardcopy). These templates describe what types of incidents to review, who should be involved in reviews and guidance material to assist in the collection of information related to the incident.

The data analysis tools included the Accimap framework and taxonomy of contributing factors for analysing the data (i.e, classification scheme). The classification scheme was developed through a review of the literature relevant to patient handling and injury and through consultation with the ERG. Fig. 2 shows the classification scheme used to help the OHS practitioners identify factors contributing to worker injuries due to patient handling.

Participants were given instructions on how to create an Accimap using the software program, Lucid Chart. Instructions were also provided to assist OHS practitioners in generating strategies to address the key issues requied to identify new or revised risk control strategies (i.e., Strategy and Action Plan templates).

The final stage of the pilot involved follow-up and consultation. Following their first review, an in-person coaching visit was provided by the research team to ensure the OHS Officers were using the PHIRES effectively and to offer any technical support in using Lucid Chart to develop the Accimap. A research team member was also available throughout the pilot via telephone and email to answer questions, identify issues and resolution.

4.4. Usability evaluation

The International Standards Organization (ISO) definition of usability was adopted in this study, which defines usability as *effectiveness, efficiency and satisfaction* with which specified end users are able to achieve goals in a particular environment (ISO/IEC, 2016).

Effectiveness was evaluated by assessing the number of sections within the PHIRES Toolkit that OHS Officers completed correctly (i.e., task completion) and the quality of the actions generated from the reviews. Task completion was measured by assessing the number of sections within the PHIRES Toolkit that OHS Officers completed (i.e., task completion). The quality of actions generated from the reviews were assessed through measuring if participants identified factors at each level of the framework. Quality was also evaluated against the systems thinking principles, as identified in Table 1. These principles were operationalized in this study to assess if each action (i) identified only training of staff to prevent future patient handling injuries, (ii) identified only changes to equipment to prevent future patient handling injuries, (iii) involved only change to procedures or manual handling procedures, (iv) intended to improve the flow of information up and down levels of the system, (iii) intended to mitigate against pressures (e.g. time pressure) through work design and planning. Two authors (SN, NG) assessed the measures of effectiveness independently, with all disagreement resolved at a consensus meeting.

Efficiency was evaluated by assessing the estimated time to complete the PHIRES Toolkit. This measure was assessed by asking OHS Officers the time taken to complete a review of a patient handling injury using the PHIRES Toolkit following the completion of the pilot. This question was asked using an on-line survey.

Satisfaction was evaluated through assessing perceived usability, leanability and acceptability. The System Usability Scale (SUS: Brooke, 1996) was used to measure usability and learnability (i.e., Lewis & Sauro, 2009). The usability scale is measured with 8 items and the learnability scale is measured with 2 items. An example statement to measure usability included "I thought the system [PHIRES] was easy to use" and a statement to measure learnability included "I needed to learn a lot of things before I could get going with the system [PHIRES]". These scales are measured on a 5-point Likert scale, ranging from Strongly Disagree (1) to Strongly Agree (5). This scale was administered on-line at completion of the pilot.

The NoMad scale (Rapley et al., 2018) was used to assess acceptability. This scale was measured with three items including "When you use the PHIRES Toolkit, how familiar does it feel?" measured on a 5-point Likert scale, ranging from Not familiar at all (1) to Very Familiar (5), "Do you feel the PHIRES Toolkit is currently a normal part of your work?" and "Do you feel the PHIRES Toolkit will become a normal part of your work?" (measured on a 5-point Likert scale, ranging from Definitely Not (1) to Definitely Yes (5). This scale was administered on-line at completion of the pilot.

Qualitative feedback was also gathered from OHS Officers following completion of the trial in a half-day workshop, facilitated by two of the authors (SN & NG). Semi-structured questions were developed to gain understanding of the OHS Officers perceptions of (i) using the

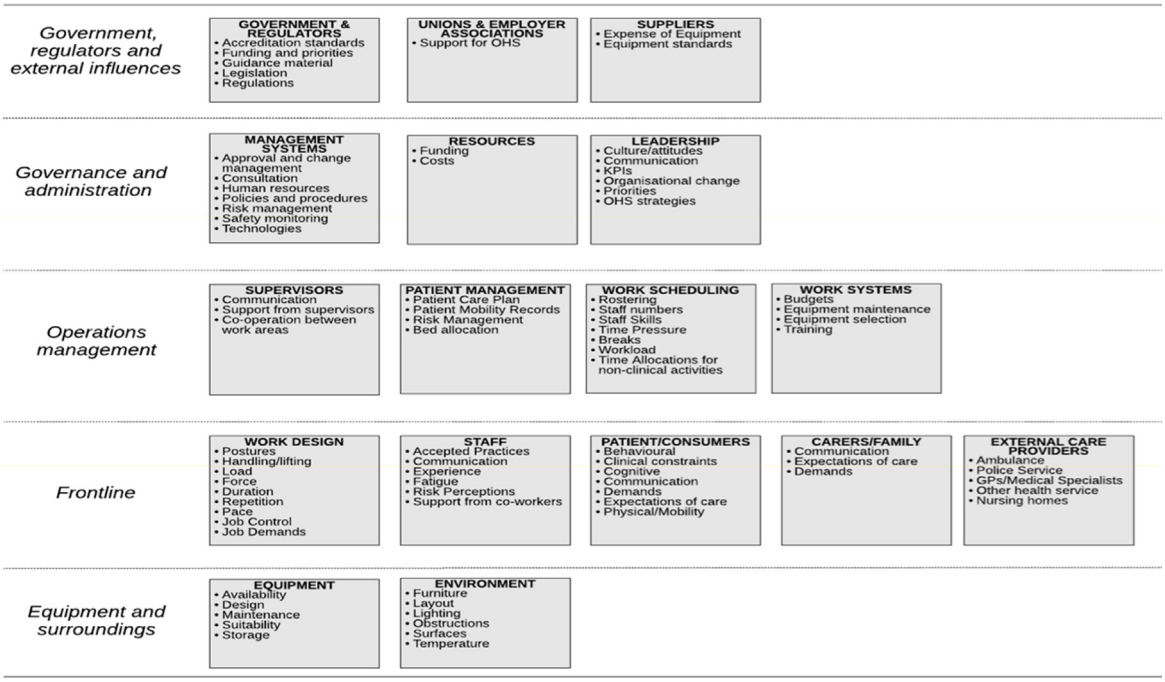

Fig. 2. PHIRES classification scheme.

PHIRES Toolkit (ii) the factors that supported use of the PHIRES Toolkit, (iii) the barriers to using the PHIRES Toolkit, (iv) the strengths and weaknesses of the PHIRES Toolkit (v) suggestions to improve the PHIRES Toolkit for future implementation. The data collected from this stage provided a basis for further planning and revision of the PHIRES Toolkit.

4.5. Data analysis

The data from each report was transcribed into an excel spreadsheet. The spreadsheet summarized the number of factors identified at each level of the Accimap framework. The spreadsheet also synthesized the actions generated by OHS Officers in each of their reviews as well as the feedback gained by participants in the workshop at completion of the trial. Descriptive analysis was undertaken to summarise the the SUS and NOMAD data (i.e., satisfaction).

5. Results

5.1. Usability assessment

Over the three month period of the pilot, Health Service 1 completed six reviews, Health Service 2 completed four reviews and Health Service 3 completed five reviews. The data collected from these reports and the surveys were used in the usability evaluation.

5.2. Effectiveness

The results demonstrated that participants were able to complete most steps of the PHIRES Toolkit, without assistance from the research team. Table 2 provides a summary of the number and percentage of factors identified at each level of the aggregated Accimap framework. The results demonstrate that participants were able to identify factors at each level of the framework and that the Accimap method is appropriate for this domain.

The results showed that the Health Services successfully completed Step 1 through to Step 4 successfully and without assistance from the research team. These steps involved: Defining the scope of the review (Step 1); Identifying relevant stakeholders (Step 2); Creating an Event Timeline (Step 3) and; Identifying current risk controls (Step 4). Step 5 was also completed successful without assistance from the research team. This step required participants to identify factors influencing safety at each level of the framework.

Table 2
Number and percentage of factors identified at each level of aggregated Accimap for each Health Service.

Level	Health Service 1	Health Service 2	Health Service 3	Total
Government, Regulators & External Influencers	6 (7%)	9 (12%)	4 (5%)	21
Governance & Administration	10 (11%)	23 (29%)	11 (14%)	44
Operations Management	23 (25%)	10 (13%)	21 (27%)	54
Front-Line Staff	44 (48%)	26 (33%)	27 (35%)	97
Equipment & Surroundings	8 (9%)	10 (14%)	15 (19%)	33

Step 6 prompted participants to populate the Accimap. Health Service 1 completed this step in all reports without any assistance from the research team while Health Service 2 and 3 required assistance from the research team in populating the Accimap in all their reports. The reason for the participants from Health Service 2 and 3 needing assistance from the research team was due to the extra time needed to create the Accimaps in Lucidcharts.

Step 7 required participants to brainstorm potential strategies to address the issues identified in the reviews. Health Service 1 successfully identified strategies in all reports with assistance from the research team. Health Service 2 required assistance in identifying strategies in one report, while no strategies were reported in the remaining reports. Health Service 3 successfully identified strategies in one report while strategies were identified in the remaining reports with assistance of the research team. Step 8, which prompted participants to identify actions to revise their risk controls, was completed successfully by all three Health Services.

All reviews resulted in the identification of revisions to risk controls; thus, this allowed us to evaluate the quality of the data against the systems thinking principles. Table 3 shows that the highest number of actions identified in reviews focused on actions involving equipment and very few reviews identified training needs. However, all of the

Table 3
Actions evaluated against the system-thinking principles.

	Health Service 1	Health Service 2	Health Service 3
# of reviews with actions	6 reviews	4 reviews	5 reviews
Mean # of actions per review	4 actions	4 actions	2 actions
# of reviews with actions involving only training	2 out of 6 reviews	2 out of 4 reviews	1 out of 5 reviews
# of reviews with actions involving only equipment	5 out of 6 reviews	4 out of 4 reviews	4 out of 5 reviews
# of reviews with actions involving changing procedures or manual handling procedure	3 out of 6 reviews	0 out of 4 reviews	3 out of 5 reviews
# of reviews with actions to improve consultation	5 out of 6 reviews	3 out of 4 reviews	3 out of 5 reviews
# of reviews with actions to mitigate against pressure	5 out of 6 reviews	4 out of 4 reviews	5 out of 5 reviews

reviews that identified an action involving equipment also identified an action that aligned with at least one of the three systems thinking principles. This result shows that PHIRES supported participants to apply system thinking during reviews: the majority of reviews across the three Health Services identified actions to improve consultation and mitigate against pressures in the system.

Examples of actions identified that illustrated system-thinking principles include:

> *"Explore resource strategies with the disability working party to ensure that patients with special needs &/or disabilities have appropriate levels of care" (Health Service 1)*
>
> *"Interdisciplinary scenarios/drills between birth centre and theatre" (Health Service 2)*
>
> *"Conduct audit of facility to identify number of rubberised hoist hangers." (Health Service 3)*

Efficiency: The participants reported that the time to complete a review of a patient handling injury using the PHIRES Toolkit was approximately two hours and this ranged between 1.5 and 4 h, depending on the complexity of the report (i.e, number of consultations with key stakeholders). Similarily, a review of an injury using the traditional methods of data collection was reported to take approximately two hours.

Satisfaction: All four OHS Officers reported strong and positive agreement that the PHIRES Toolkit was user friendly (M = 4.5; SUS scale). The participants also reported strong and positive agreement regarding its learnability (M = 4.7; SUS scale). That is, participants did not need a high degree of technical skill to adapt the Toolkit within normal work duties. The participants also reported a high degree of acceptance of the PHIRES Toolkit (i.e., NoMAD scale). OHS Officers reported high level of familiarity (M = 4.7) or with using the Toolkit. All four participants also felt that the PHIRES Toolkit was somewhat part of their current work duties (M = 3.5) but would certainly (M = 4.5) become part of their future work duties.

Feedback: The participants identified several strengths and opportunities for improving the PHIRES Toolkit. All participants stated that the PHIRES Tookit is comprehensive and helped guide a more thorough investigation and that the comprehensiveness of the Toolkit justified the additional time to conduct a review. The participants reported that the guidance material helped to tailor the prompt questions (i.e., Step 4) to the different stakeholder groups and that the Toolkit prompted more extensive and comprehensive conversations with the stakeholders. It was also reported that the PHIRES Toolkit helped participants to identify factors at higher-levels of the system and to think about work processes contributing to the incident at each level (i.e., Step 5).

The resulting Accimaps (i.e., Step 6) were reported by participants to (i) facilitate the process for identifying appropriate revision to the risk controls, (ii) allow participants to assess the incident in summary form and provide an opportunity to reflect on the system of factors influencing the event and, (iii) provide an excellent summary of the event to support discussions with senior management.

The participants also identified opportunities to improve the usability of PHIRES. First, PHIRES could be reduced in length through deleting some of the instructions and repetition of information. In particular, participants stated that Steps 1 to 5 are essential but could be simplified through reducing the instruction. Second, more guidance is needed in conducting Steps 6 to 8, particularly in creating relationships between factors in the Accimap and developing actions based on the key issues. Third, participants reported that it was challenging to create the Accimap using the online tool, Lucid chart. They felt this replicated work they had already completed during Step 5. Fourth, OHS Officers reported that one-on-one coaching is needed to identify factors at higher levels of the system. It was suggested that scenario-based training could be integrated within the training package to help identify factors at higher-levels of the system. They stated that this could be completed within the initial training and in the one-on-one training sessions. A final recommendation was to incorporate examples of completed PHIRES Toolkit within the training materials.

6. Conclusion

The aim of this paper was to present the development a system-thinking incident investigation Toolkit designed for patient-handling injuries and present the results from a usability evaluation. The PHIRES Toolkit was developed in response to an identified gap in investigating and preventing MSDs from a systems thinking perspective. The Toolkit overcomes this gap through providing a standardized process for examining the work system following the report of a patient handling injury. The unique contribution of the PHIRES Toolkit is that it addresses many of the challenges identified in current approaches to learning from incidents (i.e., Goode et al., 2018b; Lukic et al., 2012; Maragaryan et al., 2017; Salmon et al., 2012, 2017b). First, the PHIRES Toolkit is underpinned by systems thinking; thus, it provides a comprehensive approach for identifying the complex system of factors contributing to the risk of MSDs sustained through patient handling. Furthermore, the classification scheme underpinning the PHIRES Toolkit identifies factors relevant to MSDs; thus, the actions generated from the reviews are targeted to MSD processes and procedures.

Second, its conceptual development was undertaken in consultation with academic and non-academic stakeholders (i.e., healthcare professionals). This approach ensured a shared understanding of its intended purpose and the anticipated learnings. Third, the useability evaluation conducted in this study allowed us to identify the barriers and enablers associated with implementation of the PHIRES Toolkit. The information gained from this study allows the review and revision of the Toolkit to optimize learning in its future implementation. Finally, development of the PHIRES Toolkit (and its training) focused on ensuring its feasibility and practicability for the end-user (i.e., healthcare practitioners), as well as optimizing its translational value to other key stakeholders (e.g., senior management, regulators, government bodies).

This study identified several key learnings. First, the results showed that the end-users of the PHIRES Toolkit (i.e., OHS Officers) were able to successfully complete the majority of steps without assistance of the research team. Furthermore, they were able to identify factors at each level of the Accimap framework. This result not only supports the usability of the PHIRES Toolkit but confirms that Accimap is an appropriate method for the healthcare context and the review of patient

handling injuries (Hulme et al., 2019).

Second, the actions generated from the reviews were aligned with system thinking principles. In fact, the majority of reviews across the three health services identified actions to improve consultation and mitigate against pressures in the system. This finding provides evidence to suggest that systems thinking models can be effectively translated into tools to help practitioners drive systemic change in healthcare (Goode et al., 2018a, 2018b). That is, the PHIRES Toolkit addresses an existing capability gap in knowledge about MSD causation and incident investigation systems. The power in collecting data on the systemic issues influencing MSD injuries is in creating the evidence-based to inform the review and revision of higher-order risk controls such as staff-patient ratios and budgetary allocations.

Third, the OHS Officers reported a positive experience in using the PHIRES Toolkit and that it was a useful and comprehensive method for reviewing and revising risk controls. The Accimaps, in particular, were reported to provide an ideal discussion point with senior management and in the development of action plans; this being key to initating systemic change in healthcare.

6.1. Study limitations and future research

The limitations of this study need to be acknowledged. This research included a small sample size and a small number of overall incidents analysed using the PHIRES Toolkit. Future research is already addressing this limitation as the results from this usability evaluation have been integrated into the PHIRES Toolkit and guidance material for Stage 2 of the project. Based on the feedback from OHS Officers, the PHIRES Toolkit has been reduced in length to avoid repetition of information, laminated sheets have been developed to provide instructions on Step 4 (prompt questions), Step 7 (development of system-based actions) and Step 8 (development of actions) to reduce the length of the Toolkit. One-on-one coaching has also been integrated to help OHS Officers identify more factors at higher-levels of the system, as well as actions that go beyond training.

Further actions have been identified to drive further translation of systems thinking in practice. The research team have identified that an on-line tool is required to analyse the system of factors identified in the review of injuries and review and revise associated risk controls at an individual-incident and aggregate level; the intention of the latter goal is to create systemic change in the healthcare industry. As identified by the OHS Officers, such a tool would simplify the creation of Accimaps and reduce the workload associated with using the PHIRES Toolkit to review and revise risk controls. Development of this on-line tool will enhance the uptake and sustainability of the use of the PHIRES Toolkit within health services.

Future implementation of the PHIRES Toolkit will be accompanied by a rigorous evaluation plan. The aim of this evaluation will be to quantify the cultural (i.e., safety values), safety (e.g., % of actions implemented, number and rate of accepted compensation claims) and financial (e.g., cost of claims, duration of compensated time loss) benefits for healthcare services who apply the Toolkit to review and revise their risk controls following the report of a MSD injury. Funding has already been secured to conduct a pre-post evaluation using these outcomes. This evaluation will allow us to assess sustainability and learnings from the implementation of actions identified in the reviews; this being a challenge identified in bridging the research-practice gap (Littlejohjn et al., 2017).

Acknowledgement

This project is funded by WorkSafe Victoria, through the Institute for Safety, Compensation and Recovery Research.

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