

Leveraging Event Reporting Through Knowledge Support: A Knowledge-Based Approach to Promoting Patient Fall Prevention

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Abstract

Patient falls are a common safety event type that impairs the healthcare quality. Strategies including solution tools and reporting systems for preventing patient falls have been developed and implemented in the U.S. However, the current strategies do not include timely knowledge support, which is in great need in bridging the gap between reporting and learning. In this study, we constructed a knowledge base of fall events by combining expert-reviewed fall prevention solutions and then integrating them into a reporting system. The knowledge base enables timely and tailored knowledge support and thus will serve as a prevailing fall prevention tool. This effort holds promise in making knowledge acquisition and management a routine process for enhancing the reporting and understanding of patient safety events.

Keywords:

Patient Safety; Risk Management; Accidental Falls

Introduction

Patient safety events are the most concerning issues in the improvement of healthcare quality. Patient falls, the most common safety events resulting in adverse patient outcomes and imposing significant costs, become a great burden to society. Patient safety organizations (PSOs) have listed patient falls as one of the top patient safety events [1]; 92% of in-hospital falls are preventable [2]. Efforts such as prevention and assessment tools as well as reporting systems have been developed to reduce the recurrence of patient falls in the U.S.

Prevention and assessment tools are designed to help healthcare providers assess fall risk and reduce the occurrence of fall events [3; 4]. They also provide protocols for fall prevention in terms of leadership, evaluation of fall risks (vital status, medication, environments, etc.), and patient education. However, fall prevention remains challenging due to the diversity of risk factors and localized vulnerabilities in patient risk management, which calls for tailored interventions regarding risk factors per patient [3].

Learning from reported events is critical for identifying vulnerabilities in patient safety management. Reporting systems have been implemented for collecting patient safety event data and conducting root cause analyses (RCA). Mandatory and voluntary reporting systems complementarily serve different levels and different purposes in patient safety events management [5]. To standardize reporting formats, AHRQ Common Formats (CFs) were developed and then became widely accepted and commonly used for reporting and analyzing patient safety events including falls in voluntary reporting systems [6]. The CFs fall-reporting form includes 13 structured questions which cover most contributing factors of

a fall event reporting and RCA, such as circumstances, outcome, fall risk assessment, preventions, medication, and assistant devices [7]. The reporting systems are intended to facilitate risk identification, event data collection, and RCA [8]. The ultimate aim is to advance strategies of preventing and mitigating patient safety events.

However, the success of the tools and reporting systems on patient safety has yet to be seen, since healthcare providers fail to receive timely feedback and customized knowledge support [9; 10]. The event reporting systems merely serve as data repositories if reporters can learn nothing from them [11]. Delayed and non-customized feedback may lead to a lack of incentives for providers to continuously and voluntarily report events, which in return results in the underreporting and low-quality reports [12]. This also leads to insufficient knowledge support for providers towards effective fall prevention. Consequently, a knowledge base is expected to provide the foundation for knowledge-based interventions, if one could be developed and integrated into the routine workflow of patient risk management [13]. In such a knowledge base, the solutions for patient fall should be included, and their logical connections to the specific cases should be well established to support learning and clinical decision making. Within the patient fall management circle, event reporting, retrospective analysis, and prospective analysis are chained to support each other [9]. To support the information flow from event reporting to retrospective analysis, reporting data-driven feedback is necessary. Therefore, a refined reporting system with a knowledge base that supports effective feedback has the potential to bridge the gap between the reporting process and knowledge support.

To develop the knowledge base, we identified and synthesized entry-based fall solutions from multiple resources, and established connections between the solutions and the CFs fall-reporting form through expert review. As a result, a fall prevention knowledge base including the reports, solutions, and the connections between the two datasets was established as a resource for timely tailored knowledge support in a patient fall reporting system.

Methods

We developed a framework for the knowledge base based on the CFs fall-reporting form. Fall prevention solutions gleaned from multiple resources were filtered, combined and adjusted to fit into the framework. Each solution is connected to a targeted answer option in the reporting form. Solutions and their connections to the framework were revised by expert review (Figure 1).

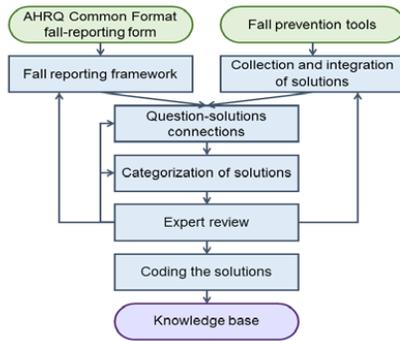


Figure 1 – Workflow of establishing the patient fall solutions knowledge base.

Establish a question-answer-solution framework for fall-reporting

To establish a network that links questions, answers, and solutions, we developed a framework of hierarchical questions for describing patient fall events based on AHRQ CFs reporting. These questions were adjusted from AHRQ CFs Hospital Version 1.2, released in April 2012 [7].

Collect solutions from multiple resources

We collected solutions from multiple tools for patient fall prevention, which were developed and distributed by Authentic Patient Safety Organizations. Two domain experts combined identical or similar solutions. Meanwhile, we searched Medline using “solutions” or “interventions” combined with “patient falls” as keywords, limited in abstracts and titles to identify additional resources containing information about patient fall solutions or interventions. The search, conducted in June 2016, resulted in 61 hits, which were integrated into the solution dataset. The following details the resources we used.

Pennsylvania Patient Safety Authority (PA PSA)

PA PSA [14] provides patient safety tools including solutions for fall prevention. The tools for falls prevention include prevention program tools and educational tools, which can serve as knowledge support for risk factors measurement and post-fall investigation. In particular, they include risk assessment tools for radiology and ambulatory surgical facilities. Pennsylvania Patient Safety Reporting System (PA-PSRS) Falls Event Type Decision Tree is provided for the determination of the fall event types in the PA-PSRS.

Joint Commission Center for Transforming Healthcare Targeted Solutions Tool (TST)

The Preventing Falls TST [15] is one of the four applications of Joint Commission TST aiming to improve the safety and quality of healthcare. It provides approaches for state evaluation, RCA, targeted solutions and strategies for sustaining patient safety management, including patient fall prevention.

Slip, Trip and Fall Prevention for Healthcare Workers

Slip, Trip and Fall Prevention for Healthcare Workers [16] was developed by Centers for Disease Control and Prevention The National Institute for Occupational Safety and Health (CDC-NIOSH). This tool listed top risk factors of patient falls, including indoor and outdoor environment conditions and improper use of equipment.

The third report from the Patient Safety Observatory. Slips, trips and falls in hospital

This is a summary of patient fall risk factors and recommended solutions based on “the slips, trips and falls in hospital, the third report from the National Patient Safety Agency’s (NPSA) Patient Safety Observatory” [1].

The “How to guide for reducing harm from falls”

This tool was developed by Patient Safety First [17], a California partnership for health. It provides fall prevention solutions for both leaders and frontline staff to implement interventions to reduce patient fall rates.

AHRQ WebM&M

AHRQ WebM&M [18] provides peer-reviewed patient safety cases and expert analysis, which can serve as a resource of patient safety event solutions. WebM&M is an example of case-specific knowledge support. Due to the store-and-forward method, the expert-reviewed case analysis is far from timely knowledge support and is merely for the purpose of case study.

AHRQ Patient Falls Prevention Toolkit

AHRQ Patient Fall Prevention Toolkit [19] contains a set of strategies and tools collected by experts from multiple sites. The toolkit provides a roadmap for stakeholders to engage in patient fall prevention. It also includes a collection of practical tools for reporters such as STRATIFY Risk Assessment Tool, Morse Fall Scale, Medication Fall Risk Score and Evaluation Tools, and other tools for mental and physical status evaluation.

Match the solutions to the Common Formats

We matched the solutions to the questions and answer options of the CFs based on the solution contents. The solutions that were successfully linked to single or multiple answer options were categorized as specific solutions. The others were categorized as general solutions. We further categorized the solutions into three different groups: Direct action, which consists of operational advice to the staff; Principle, which consists of principal guidance; Patients, which consists of knowledge support for patient education.

Expert review

An expert review was performed to ensure the solutions, connections between solutions and questions, and the categories of solutions were comprehensive for frontline practitioners. We constructed a survey to demonstrate the CF framework with relevant solutions listed below. Each solution was tagged with its category and mapping rule. Five patient safety experts working with a PSO participated in the survey. They revised the contents, categories and the mapping rules of each fall solution. Panel discussions were employed to establish consensuses.

Code the solution mapping rules

The mapping rules between solutions and answer options in CFs were coded into our knowledge base. Boolean logic connectors “AND”, “OR” and “NOT” were applied to form the preconditions for the activation of any solution in the feedback. In detail, the “AND” stands for a combination of two or multiple options need to be checked in the reporting to show the certain solutions. The “OR” requires either of the alternatives. The “NOT” means the solutions would be given in the feedback only if the certain options were not checked.

Develop a knowledge-based web server

A relational database was implemented on our server to accommodate the knowledge base containing reports,

solutions, and connections between reports and solutions. A web-based interface was developed in conjunction with the server and database.

Results

Develop a question-answer-solution framework

We set up a framework based on the 13 questions of CFs fall-reporting form. These structured questions are hierarchically organized with answer options for reporting and RCA (Table 1).

Table 1 – Questions from CFs fall-reporting form

No.	Question
1	Was the fall unassisted or assisted?
2	Was the fall observed?
3	Who observed the fall?
4	Did the patient sustain a physical injury as a result of the fall?
5	What type of injury was sustained?
6	Prior to the fall, what was the patient doing or trying to do?
7	Prior to the fall, was a fall risk assessment documented?
8	Was the patient determined to be at increased risk for a fall?
9	At the time of the fall, were any of the following risk factors present?
10	Which of the following were in place and being used to prevent falls for this patient?
11	At the time of the fall, was the patient on medication known to increase the risk of fall?
12	Was the medication considered to have contributed to the fall?
13	Did restraints, bedrails, or other physical device contribute to the fall (includes tripping over device electrical power cords)?

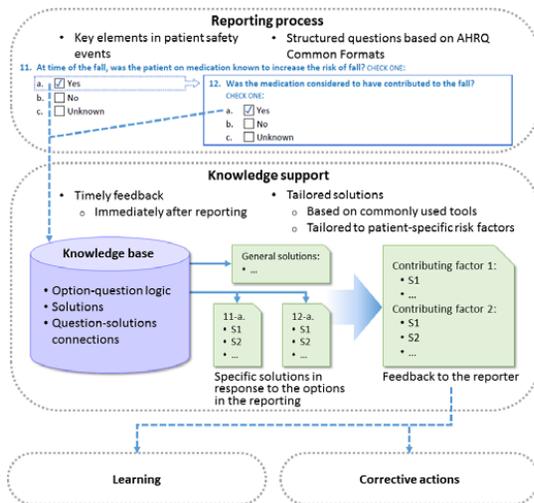


Figure 2 – The framework of the knowledge support strategy based on CFs fall reporting form.

These questions require documentation of the outcomes after fall events (Question 4-5). They further collect the risk factors (Question 6-13). The focuses of the questions can be described by 6 topics as shown in Table 1: Staff involved in the fall event (Question 1-3), outcomes of the fall (Question 4-5), circumstances of the fall (Question 6), fall risk assessment (Question 7-9, 13), fall prevention approaches (Question 10) and medication (Question 11-12). Common risk factors were included in the answer options such as medication, environment, equipment, and patient status. Logical links between options and questions were embedded to the framework. For instance, question 12 would be required

to answer if the reporter checked “Yes” for question 11 (Figure 2).

Collect and categorize fall solutions

The current tools have both overlapping and complementary contents. In general, the solutions cover the following aspects in fall prevention: assistive devices (including alarms, call lights, etc.), environment and equipment, fall event reporting, use of fall risk assessment tools, individual patient fall risks, medications, patient and family education, and rounding. As shown in Table 1, identified solutions were categorized into “general solutions” and “specific solutions” according to whether the solutions can be matched to certain answers of certain questions in the AHRQ CFs fall-reporting form. Twenty general solutions and 102 specific solutions were generated. The general solutions were categorized in 8 topics. The specific solutions were categorized in 6 topics according to the questions of CFs fall-reporting form (Table 2). In the topics of specific solutions, the count for Outcome of the fall is 0 because all of the current solutions that we collected were focused on the occurrence and recurrence of fall rather than the treatment of the outcomes which is a relatively independent process. The general solutions will be shown after all reports. Specific solutions will appear only when the corresponding answer options are chosen during the reporting. We also linked the commonly used risk factor assessment tools including Morse Scale, STRATIFY Scale and Medication Fall Risk Scale to the associated solutions, so that the reporters will be able to conduct assessments using those tools after reporting.

Table 2 – Solution categories in alphabetical order.

Contributing factors	General	Specific
Alarms	1	14
Assistive Devices	2	14
Call Lights	0	3
Environment and Equipment	7	14
Fall Event Report	1	2
Fall Risk Assessment Tool	2	8
Individual Patient Fall Risks	2	13
Medications	1	12
Patient and Family Education	2	4
Rounding	2	0
Showering/Toileting	0	10
Unassisted Ambulation	0	8
Sum	20	102

Assess recommended fall solutions

Experts’ comments from the survey were further categorized as follows:

Description improvement. Improving the description of solutions to eliminate ambiguities.

Detail specification. Adding specific terms to the solution description to provide practicable details.

New solutions. Supplementing with new solutions that were not included in the survey.

Generalization of target populations or application scopes. Expanding the target populations. For example, patient and family were included in the targets of “standardized education regarding the use of call lights” which targeted to the staff only before the expert review. The application scopes were also extended. For example, fall events without patient injuries were included in the reporting.

Workflow complementation. Implementing protocols to improve the workflow. For example, in the “Patient and family education” part, recommendation for conducting a “post-fall investigation” was added.

Solutions were improved according to the experts’ comments. Both general solutions and specific solutions were grouped by contributing factors, as shown in Table 2. By connecting the solutions with the answer options of questions in CFs fall-reporting form, a knowledge base for fall events was established. The knowledge base contains prevention solutions, connections between solutions and CFs questions, and the logical links of CFs questions (Figure 2).

Discussion

Making the reporting easy and meaningful

Though various reporting systems are available, healthcare providers face challenges using these systems. Extra training is required for providers to use the reporting systems. However, the effects of training may not live up to expectations, which makes the reporting process prone to mistakes [8]. Another problem in patient event reporting is repeated and under-qualified reports without useful information for RCA and corrective recommendations [8]. To solve these problems, we implemented the framework of AHRQ CFs fall-reporting form and integrated expert-reviewed patient fall solutions to develop a knowledge base, which provided an accessible and easy-to-use method for patient fall reporting. AHRQ CFs provided formats for structured information of patient safety events reports, which hold promise in unifying the reporting process and analysis. Based on the framework of AHRQ CFs, our system is expected to improve report quality and make reports more meaningful.

Learning from reporting

Research has been conducted to explore the proper use of fall event reports and to reduce the recurrence of patient falls [2; 3; 12]. However, traditional learning materials failed to provide effective and efficient interventions after reporting. Experienced reporters, such as expert physicians and senior nurses, may be familiar with the common solutions. However, continuous learning from practices is essential especially for novice caregivers [20].

Despite duplicate and incomplete data, current patient fall data from reporting provides rich information for reporters to learn from previous errors [21]. In the present study, we defined four levels of learning in patient safety events prevention as shown in Figure 3. National and local reporting systems collect and analyze patient safety events data, which may potentially contribute to learning on national and local scales. There are other resources for learning like guidelines, literature, and case note reviews [11]. Except for reporting systems, none of the methods is able to provide timely learning after events in individual or local level.

Therefore, a mechanism that integrates multiple solution resources and provides knowledge support after reporting is needed. In this study, we collected and integrated solutions from multiple resources for preventing patient falls. Based on the expert-reviewed solutions, we established a knowledge base that is available in a fall reporting system with timely feedback. By providing timely knowledge support after reporting, our research aims to bridge the gap between local reporting systems and local/individual learning levels (Figure 3), and to help healthcare settings identify vulnerabilities in patient risk management. As shown in Figure 3, the knowledge-based reporting system helps facilitate the

information flow from the reporting process to the learning process and then the process of identification and prevention of patient safety events (Figure 3).

The diversity of organizational weaknesses in patient safety management is a challenge for healthcare providers to apply prevention solutions. Therefore, it is essential for patient safety managers to identify local vulnerabilities in management and perform corrective measures. The feedback after reporting can provide not only immediate post-fall solutions to the reporters and help prevent the recurrence of similar patient fall events but also alerts patient safety managers about management system vulnerabilities.

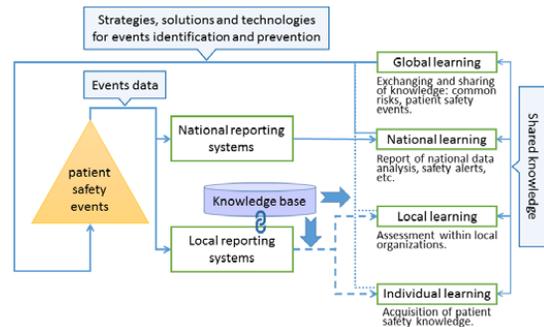


Figure 3 – Interactions between patient safety events reporting and learning in different levels. Reporting systems collect and analyze patient safety events data, provide information and knowledge for learning in different levels.

Bridging the gap in patient fall management

The three stages of the patient safety management circle (i.e., prospective analysis stage, surveillance stage, and retrospective analysis stage) overlap with each other. Correspondingly, an ideal pattern is integrating the reporting process and knowledge support into the existing workflow of patient fall management, which facilitates learning from reporting as well as the assessing and correcting processes. However, the gap between reporting and knowledge support appears to be a major barrier to establishing an integrated management mechanism for patient safety. A practical approach is to explore the potential connections between various usable tools of fall prevention and the reporting systems so that reporters will be able to gain timely feedbacks after reporting. Our approach provided a method to integrate expert-reviewed patient fall solutions into the reporting system and to offer timely knowledge support.

For other types of events, a specific knowledge base should be established within the corresponding domains to connect events and solutions. As a result, the strategy for establishing a knowledge base that was used here could be adapted accordingly. For example, pressure ulcers are an injury to the skin and underlying tissue, and are described in four stages according to severity. For each stage, solutions and mapping rules to reporting forms should be collected and evaluated separately to ensure the practicality of knowledge support. Establishing a knowledge base for medication reconciliation could also be considered. The knowledge base should consider the drug name, dosage, frequency, and route while archiving the solution entries. Moreover, physicians' admission, transfer, and/or discharge orders should also be considered while connecting medication events to solutions. Therefore, future patient safety reporting systems with timely knowledge support should be based on a group of knowledge bases in various domains.

Limitations

The solutions collected in this study may not have covered all aspects of patient falls. Additionally, there are still controversial opinions on the effectiveness and necessity of several solutions due to the lack of large-sample experiments. Further evaluation of such solutions is needed to mitigate such controversy. Although AHRQ CFs cover most key elements for event reporting and RCA, some aspects may be not included due to the diversity of healthcare settings.

The efficiency and effectiveness of our feedback mechanism also need to be further evaluated. Considering the time-consuming and multiple-step procedures of assessment and reporting, the risk factor assessment and knowledge support still call for collaborations from healthcare providers, patient safety experts, and informaticists.

Another challenge is developing and embedding a human-computer communication mechanism into the healthcare providers' workflow. A critical barrier for patient event reporting is the reluctance of providers to report because of a potentially discouraging environment and workflow interruption. In some cases, reporters were not the personnel relevant to the events who would most benefit from learning from reporting.

Future work

Future work should extend knowledge base development and management of patient falls to those of other event types. The mechanism of sharing and learning from safety events would enhance the reporting quality at all levels. In addition, maintaining and updating the knowledge base can be challenging and labor-intensive, but procedures maintain updated knowledge bases are necessary.

Conclusion

As more high-quality data is collected, stored and analyzed by reporting systems, patient falls can be an important use case for establishing an integrated and optimized workflow using informatics strategies. Our work explored the possibility of building connections between reporting and knowledge support via a knowledge base. This approach may be extensible to other fields of patient safety events, such as pressure ulcers, medication errors, health information technology (HIT) issues, surgical safety, hand hygiene, and medical device issues.

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