Cognitive work analysis to evaluate the problem of patient falls in an inpatient setting

Karen Dunn Lopez,1 Gregory J Gerling,2 Michael P Cary,3 Mary F Kanak4

ABSTRACT
Objective To identify factors in the nursing work domain that contribute to the problem of inpatient falls, aside from patient risk, using cognitive work analysis.
Design A mix of qualitative and quantitative methods were used to identify work constraints imposed on nurses, which may underlie patient falls.
Measurements Data collection was done on a neurology unit staffed by 27 registered nurses and utilized field observations, focus groups, time-motion studies and written surveys (AHRQ Hospital Survey on Patient Culture, NASA-TLX, and custom Nursing Knowledge of Fall Prevention Subscale).
Results Four major constraints were identified that inhibit nurses’ ability to prevent patient falls. All constraints relate to work processes and the physical work environment, opposed to safety culture or nursing knowledge, as currently emphasized. The constraints were: cognitive ‘head data’, temporal workload, inconsistencies in written and verbal transfer of patient data, and limitations in the physical environment. To deal with these constraints, the nurses tend to employ four workarounds: written and mental chunking schemas, bed alarms, informal querying of the previous care nurse, and informal video and audio surveillance. These workarounds reflect systemic design flaws and may only be minimally effective in decreasing risk to patients.
Conclusion Cognitive engineering techniques helped identify seemingly hidden constraints in the work domain that impact the problem of patient falls. System redesign strategies aimed at improving work processes and environmental limitations hold promise for decreasing the incidence of falls in inpatient nursing units.

INTRODUCTION
The greatest number of non-fatal injuries in the acute care setting are caused by patient falls.1 2 In addition to causing injuries, patient falls can lead to increased healthcare expenditures, and are a major motive behind lawsuits.3 The direct financial burden to hospitals increased in October 2008 when the US Center of Medicare and Medicaid Services began to disallow reimbursement charges associated with falls that incurred injuries during a hospitalization.3 Others speculate that private insurers will institute similar ‘no pay for bad performance’ policies in the future.5

Patient falls are adverse events that are largely preventable.6 8 The magnitude of adverse events in US hospitals was described in the Institute of Medicine’s (IOM) report of healthcare errors, which estimated that 48 000 to 98 000 patient deaths occur yearly due to preventable medical errors.9 Since the release of this landmark report, many experts have advocated the application of systems engineering tools to transform a complex and often error-laden health system into a safer healthcare system.10 12 Although systems engineering approaches have addressed other adverse events in healthcare,12 14 research is needed that explores the problem of patient falls.

BACKGROUND
The true impact of patient falls in the inpatient setting is unknown as current reporting mechanisms significantly underestimate the incidence of patient falls.5 However, research over the last decade underscores the significance of the problem. Reports estimate between 4 and 12 falls per 1000 patient days in US hospitals.6 15 17 It is estimated that 15–30% of patient falls cause fractures requiring a cast, traction or surgery, but these estimates do not include other serious injuries and, in some cases, death related to falls.1

Most patient falls are predictable and simple patient risk assessment tools can predict over 70%.2 4 Identified risk factors include poor health status, gait instability, balance problems, age, agitation, confusion, urinary frequency and incontinence, patient history of falls, and certain sedative and hypnotic drugs.5 12 While many of these risk factors are well known and documented by nursing staff, the assessment tools and prevention strategies have made little headway in reducing the incidence of falls.5 7 23

In addition to patient-related factors, three elements of the system—nurse staffing, nurse knowledge, and safety culture—are emphasized in the adverse event literature. Studies of nurse staffing (nurse-to-patient ratios) and skill mix (higher percentage of Bachelor of Science prepared and registered nurses than nursing assistants and licensed practical nurses)16 17 18 and the expansion of nursing knowledge in risk assessment for falls25 27 have found mixed results on fall rates. Although the relationship between fall prevention and safety culture has not been rigorously studied, safety culture is often cited in the safety literature as being an important component of error prevention.9 20 22 A culture of safety acknowledges the error-prone nature of hospital work, establishes a blame-free environment, and dedicates resources to safety promotion.30 32 In recent studies, staff perception of a blame-free, safety culture and the emphasis on safety promotion has been shown to be associated with improved falls reporting.22 29 33 Increases in fall reporting offer opportunities for system improvements that may prevent falls which would not exist if the falls went unreported. Despite considerable research, patients continue to fall at unacceptable rates. Therefore, research is needed to uncover other
factors that could help prevent falls within the acute care environment, but which are poorly understood at present.

SPECIFIC AIMS
The specific aims of this research were to identify constraints in work processes and the work environment (physical, organizational systems and culture, individual, and technical) imposed on acute care nurses that may increase the likelihood of patient falls, and to identify workarounds employed by nurses to deal with these constraints.

OVERVIEW OF COGNITIVE WORK ANALYSIS
Cognitive work analysis (CWA) is a formal approach in systems and cognitive engineering for examining the functional structure of the work domain, including tasks performed, processes followed, environmental constraints, and information followed available. Such analysis helps system designers, managers, re-designers, and accident investigators understand how workers interact with their environment and how modifications might create more productive work or reduce errors. In this study we used CWA as an umbrella approach for data collection and analysis. Data were collected both by observation of workers and time motion studies to identify constraints placed on the workers, and by surveys and focus groups to attain input from workers to identify workarounds.

METHODS
Setting
The study took place at a 572-bed academic medical center on the east coast. The center is recognized by the American Nurses Credentialing Center as a magnet organization for excellence in nursing service. The specific unit studied was a 26-bed, general neurological unit that treated stroke and epileptic patients, with an average daily census of 25 patients. The unit nursing staff consisted of 27 full-time equivalent (FTE) registered nurses (RNs), 15 FTE nursing assistants (NA), and 4 FTE nursing unit clerks. The nurse to patient ratio was 1:4 for the stroke population and 1:5 for other patients. Figure 1 shows the unit layout.

Data sources
1. Structured field observations (two total, 4.5 h each) of RNs, NAs, and unit clerks in their normal routines were conducted separately by nursing and cognitive engineering investigators. These observations explored workflow, communication, the physical environment, equipment, and nursing documentation. Greater focus was placed on RNs.
2. Focus groups (n=3) were conducted by investigators with a mix of RNs, NAs, and unit clerks in a semi-structured discussion format.
3. Written surveys (n=3) were administered to RNs.
   a. The Hospital Survey on Patient Culture is a 44-item Likert scale survey designed to measure staff perception about patient safety, medical error, and event reporting for inpatient hospital settings. Items are grouped into 14 dimensions: frequency of event reporting, overall safety perception, safety grade, number of events reported, organizational learning, teamwork within-unit, teamwork across-units, openness of communication, error communication, non-punitive response to error, staffing, manager actions, management support, and hand-offs. The instrument has undergone psychometric testing with acceptable to high reliability per dimension (Cronbach’s alpha range from 0.65 to 0.84). The Agency for Healthcare Research and Quality (AHRQ) maintains a comparative database to allow for national benchmarking of survey results. In addition to its favorable psychometrics and ability to benchmark results, this...
survey was chosen because of its inclusion of key areas within the concept safety culture possibly related to patient falls, including reporting, hand-offs, staffing, non-punitive response, and management response.

b. Nursing Knowledge of Fall Prevention Subscale (see supplementary material online) is a subset of knowledge-related questions from the Fall Prevention Survey currently in development that seeks to identify factors extrinsic to patient risk that may increase the likelihood of patient falls. In this analysis, we include the 13-item subscale that assesses nurse perception of knowledge of fall prevention and protocols, as this is an important initial step in determining if worker knowledge is a constraint. While existing surveys assess the overall safety of the internal culture and peer relationships, there is a void of psychometrically validated surveys to assess fall prevention knowledge. The subscale contains eleven 4-point Likert item questions ranging from strongly agree to strongly disagree; two items were dichotomous (yes/no) questions. Content validity of the complete survey was assessed by advanced practice nurses (N=5) and cognitive engineering experts (N=2). While additional psychometric testing is in progress, full reliability and validity testing of this survey has not been done and is a limitation addressed in the study limitations section.

c. The NASA-TLX Workload Instrument\(^37\)\(^38\) is a measure of worker perception of workload. It was administered to the RNs to shed light on specific areas (assessing, determining, performing, documenting) of work constraint in their fall prevention activities. The survey ranks six areas (1–100 visual analog scale).\(^37\) The survey has been shown to be sensitive in situations, like fall prevention, that require vigilance\(^39\); it performs well psychometrically\(^38\) and has been used extensively to study workload in the aviation and other complex industries\(^40\)–\(^42\) but has been used to a lesser extent in the healthcare domain.\(^43\)\(^44\)

4. Four time–motion studies measured the duration that nurses spent performing various tasks over a 4 h period. Four randomly selected RNs were ‘shadowed’ by one of two investigators (from advanced care nursing and cognitive engineering). Tasks in progress were reported every 5 min. It was possible to code in smaller blocks of time; however, this practice rarely was necessary. During these studies, each nurse cared for 4–5 ‘moderate to acutely ill’ patients.

5. Three key informant interviews (each 30 min) with the nurse manager were used to acquire background information on expected work processes and tools, as pertains fall prevention. This input helped to familiarize the researchers with the unit but did not generate results.

Demographics

Table 1 presents focus group and survey demographic data. Data were collected in categorical form to protect the identity of each participant. The majority of respondents (74%) in the Hospital Survey on Patient Culture reported working 40–59 h per week. Although the survey did not include questions on shift length, the nurse manager reported that the majority of nurses work a combination of 12 and 8 h shifts (full-time nurses are scheduled for two 12 h shifts and two 8 h shifts each week).

<table>
<thead>
<tr>
<th>Focus group (%)</th>
<th>Surveys (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td></td>
</tr>
<tr>
<td>18–30</td>
<td>25</td>
</tr>
<tr>
<td>31–40</td>
<td>25</td>
</tr>
<tr>
<td>41–50</td>
<td>44</td>
</tr>
<tr>
<td>&gt;50</td>
<td>6</td>
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<table>
<thead>
<tr>
<th>Years of experience</th>
<th>Focus group (%)</th>
<th>Surveys (%)</th>
</tr>
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<tbody>
<tr>
<td>&lt;1</td>
<td>13</td>
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<tr>
<td>1–3</td>
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<td>5–7</td>
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<tr>
<td>4–7</td>
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</tr>
<tr>
<td>&gt;12</td>
<td>44</td>
<td>16–20</td>
</tr>
<tr>
<td>N/A</td>
<td>0</td>
<td>&gt;21</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Years of experience on nursing unit</th>
<th>Focus group (%)</th>
<th>Surveys (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td>1–3</td>
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<tr>
<td>&gt;12</td>
<td>30</td>
<td>16–20</td>
</tr>
<tr>
<td>N/A</td>
<td>0</td>
<td>&gt;21</td>
</tr>
</tbody>
</table>

**Analysis methods**

A different method of analysis was used for each data source. Focus group discussion notes were summarized during the session by investigators. Included in the analysis were major points confirmed by participant consensus. Single or minority opinion points and points with minor relation to patient falls were not included. The Hospital Survey on Patient Culture was analyzed by computing composite frequencies of the positive responses for items within the 14 safety culture dimensions using Likert response categories (‘neutral’ responses were omitted). The number of annual events reported was averaged by individual respondent. NASA-TLX survey scores were derived from ‘X’ marks on a visual analog scale (0–100) and individual scores were averaged. Likert items on the Nursing Knowledge of Falls Prevention Subscale were also averaged per item (1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree). Field observations findings were discussed between the two observers, following their separate observations. A comparison of notes was used to reach a consensus regarding relevant data to include. Time–motion data were added by category, across the four data collection periods.

All data analysis was conducted iteratively with the data collection process. Preliminary conclusions from the data sources were synthesized into the abstraction–decomposition (A–D) hierarchy (figure 2), to help uncover relationships between disparate components and sub-components of the work domain. The A–D hierarchy is a cognitive engineering model that describes the work domain in a single representation and serves to focus on identifying constraints and workarounds.

**RESULTS**

Overall, 33 of the 46 (71.7%) members of the nursing unit personnel, including registered nurses (N=27), nurse assistants...
(N=15), and unit clerks (N=4) participated in at least one phase of the study. There were 25 h of direct work observation. RNs and NAs present were observed in two field observations (9 total hours, 4.5 h per shift); four RNs were more intimately shadowed in the time-motion studies (4 h each). Nineteen of 27 RNs completed the surveys (70.4% response rate). Sixteen of the 46 RNs, NAs, and unit clerks participated in the focus groups. Table 2 summarizes focus group data.

Field observations: typical procedures

Data from field observation were used to understand how the RNs operationalized fall prevention in their daily work flow. The typical procedure an RN followed to assess and communicate the fall risk for each patient is detailed below.

1. RN to RN hand-off occurred at shift change whereby the outgoing nurse verbally conveyed the patient status to the incoming nurse who took written notes. Fall risk was rarely verbally communicated at shift change report, unless a near-miss or injury had occurred recently.

2. The RN obtained written patient information from the medical information system (MIS) and paper chart, as detailed in figure 2. Data from the MIS (eg, medical orders, scheduled medications, etc) were printed out per patient and used by nurses as a reference to carry out nursing tasks. Fall risk status or measures to prevent falls are not a separate entry in the MIS.

3. ‘Pink packet’ fall prevention measure was initiated if the patient was assessed as a falls risk by the admitting RN. Pink dots, armbands, and paper notices were placed in the paper chart and the nursing station board, on the patient, and over the bed. Also, a list of fall prevention interventions was placed in the patient’s chart.

4. Early in his or her shift (and then at intervals thereafter), the RN greeted each patient and informally assessed the patient’s falls risk, keeping this information in his or her head.

5. The paper chart contained the Schmid Fall Risk Assessment Tool and preventive interventions. This tool was completed on patient admission to the unit, though the paperwork was not updated at points thereafter.

6. RNs employed devices such as bed alarms and informal video feeds available from some rooms based on assessment performed in (4).

Time—motion

The time—motion study found that 55% of time was spent on indirect patient care (16% of overall time on clerical duties, 15% communication with unit staff, 9% shift report, 9% using MIS, 6% equipment gathering), with 45% on direct patient care (33% time in patient room, 12% preparing and administering medication).

Nursing knowledge of fall prevention subscale

Table 3 shows results of the survey subscale. In addition to items reported in table 3, 100% of respondents also reported that they were aware of fall prevention protocols at the medical center. All but 2 of the 19 participants reported having had a patient of theirs fall during their shift.

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**Figure 2** Abstraction—decomposition hierarchy for domain, shown in part. Gray blocks represent key constraints for discussion and are detailed at the level of physical function.
The nurses reported their perceptions of subtypes of work demands (mental demand, physical demand, temporal demand, perception of own performance, effort, and frustration level) related to fall prevention, using a 1–100 visual analog scale.\textsuperscript{37} The average of the nurses’ responses is shown on the y-axis. While ‘high’ and ‘low’ appear on the y-axis for brevity, the anchors used in the survey were: frustration (very low, very high), temporal demand (very leisurely, very frantic), effort (very low, very high), physical activity (very easy, very strenuous), mental demand (very simple, very complex), and view of success.

### Table 2: Major constraints with associated workarounds

<table>
<thead>
<tr>
<th>Constraint</th>
<th>Evidence of constraint</th>
<th>Workaround</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive head-data</td>
<td>FG: Nurse cognitive capacity is tested by the demands inherent in multiple, simultaneous nursing activities. FG/FD: Once too many tasks accumulate, nurses focus on higher-level tasks or primary jobs (eg, medication administration, patient assessments), with the price of neglecting lower-level or secondary jobs (eg, updating patient record, adjusting bed to lowest position, routinely evaluating bed alarms, frequent rounding to assess patient). NASA-TLX: Temporal workload, frustration, and effort score high, whereas thinking (mental workload) scores low. FPS: Issues with ‘head data’ contrast with knowledge acquisition, where RNs and nurse assistants are comfortable with their knowledge of prevention measures, whereby FPS scores are greater than 3.5 of 4.</td>
<td>Written and mental chunking schemas</td>
</tr>
<tr>
<td>Workload</td>
<td>FG/TMS: Nurse workload is impacted by patient acuity, inadequate staffing, indirect care tasks, and rapid patient turnover. FG: Fall prevention takes a lower priority amid more acute and immediate problems. FG: Some nurses do not place ‘borderline’ patients on fall precautions due an already heavy workload. FPS: Nurses report that timed voids, ambulation assistance, and use of restraints are difficult. FG/FPS: Perception of inadequate number of sitters and inadequate family involvement. HSPSC: 57% of nurses report work in ‘crisis mode’, trying to do too much, too quickly. HSPSC: 93% report that when pressure builds up the manager wants them to work faster, even if that means taking shortcuts. HSPSC: 66% feel there is not enough nursing staff to handle unit workload. NASA-TLX: High levels of effort, temporal demand, frustration.</td>
<td>Need for bed alarms</td>
</tr>
<tr>
<td>Verbal communication</td>
<td>FG/FD: No formal exchange of information between RNs and nurse assistants at shift change. FG/FD: No formal exchange of information (hand-off) between nurse assistants at shift change. FG: Inadequate exchange of fall risk information between RNs at shift change. FG/FPS: Nurse assistants not informed of RN fall prevention interventions, they rely on visual cues for fall prevention (ie, bracelets, slippers, stickers). FG/FPS: Inadequate exchange of fall prevention information between nurses, patients, and family members has led family members to ‘undo’ interventions. Patients and families do not adequately understand fall prevention activities. FG: Unit clerks do not staff evening and night shifts, therefore alarms and patient calls for help are not communicated to RNs. TMS: 9% of time was spent on status at shift change and another 15% in communication with unit staff.</td>
<td>Informal querying of the previous care nurse about fall status</td>
</tr>
<tr>
<td>Medical information system and paper chart [linked with constraint above]</td>
<td>TMS/FG: Poor design of medical information systems leads to their underutilization (used 9% of time in TMS). Specifically, the appropriate fields for entering falls data are not forced, prompted, or provided in the MIS. If a nurse chooses to comment on fall prevention in the MIS, this information would be somewhat hidden in free text data and therefore not easy for subsequent nurses to find and incorporate into their activities. FO: Data in the MIS is seldom updated and did not reflect the nurse opinion of the fall risk of patients. Therefore, the MIS is seldom relied on. FO: While the ‘pink packet’ is utilized, it often was ineffective because nearly every patient on the neurological unit had the necessary conditions to warrant inclusion. FPS: Nearly 60% of nurses acknowledge moderate to significant loss of information, both during shift change and across hospital units. FO: Due to issues of workload, nurses seldom accessed the patient’s chart for details, instead relying on shift report to highlight the most pertinent patient information. Shift report was often very superficial so that it could be efficient, with little communication of fall risk or potential. [Linked with the above]. Informal querying of the previous care nurse about fall status</td>
<td></td>
</tr>
<tr>
<td>The physical environment</td>
<td>FO: Nursing unit layout does not facilitate ongoing surveillance of patients. FO: While patient diagnosis, disease severity, and infection control are factors, bed availability more than often dictates room assignment with fall risk as a secondary consideration. FPS/FG: Patient rooms do not address the limitations of the elderly and disabled, including inadequate lighting, uneven floor surfaces, and limited grab bars. FG/FD/TMS: Bed alarms were infrequently employed, non-intuitive to use, not audible at distances, and often deactivated and not reactivated. Bed alarms were defective in some limited cases. FO: Physical restraints in patient rooms do not accommodate this population and provided little flexibility to permit safety considerations.</td>
<td>Informal audio and video surveillance</td>
</tr>
</tbody>
</table>

FO, field observation; FG, focus group; FPS, Nursing Knowledge of Fall Prevention Subscale; TMS, time—motion study; HSPSC, Hospital Survey on Patient Safety Culture.
Hospital survey on patient safety culture

Table 4 reports the results, which were compared with 518 hospitals that voluntarily shared their results with the AHRQ in 2008. The unit met or surpassed benchmarks from a national sample in seven of the 12 comparable dimensions. In one dimension, non-punitive response to error, this unit exceeded the maximum reported in the AHRQ database. The nursing unit had four additional scores at or above the 75th percentile of all reporting hospitals (teamwork within unit, teamwork across units, manager actions, and organizational learning). Manager actions included the staff’s perception that their nurse manager seriously considered staff suggestions for safety improvement, did not pressure nurses to work faster or take short cuts, and did not overlook safety problems. Organizational learning included the staff’s perception that they were actively working toward improving safety, mistakes led to positive change, and improvements to safety were evaluated. Within-unit teamwork included the perception that the nurses work together when the unit is busy. In contrast, the prominent weaknesses were perceptions of staffing adequacy (<10th percentile) and overall perception of safety (<10th percentile). The low perception of staffing adequacy may relate to greater demand in temporal and effort areas found in the results of the NASA-TLX assessment.

DISCUSSION

Currently, promoting a safety culture, nurse staffing, and expanding nursing knowledge are the primary system factors emphasized for fall prevention in the nursing literature. Somewhat surprisingly, our findings suggest that these extrinsic system factors were not major causes for concern. The nurses perceived a favorable safety culture in the majority dimensions of the Hospital Survey on Patient Safety Culture and their nurse-to-patient staffing ratios were within the range reported in other studies. In contrast, our findings indicated that work processes and the physical environment presented the major limitations for fall prevention on this nursing unit. We also found from the NASA-TLX workload assessment, that the nurses perceived a high level of frustration related to fall prevention. Specifically, they perceived that they were exerting a great deal of time, attention, and effort to complete fall prevention tasks that required little mental demand.

Using the CWA approach that integrated findings from all of the data sources, we identified four constraints that appeared to be inhibiting the nurses’ ability to prevent falls as well as nurse-developed workarounds for each constraint (table 2).

Cognitive head-data constraint leads to written and mental chunking schemas

The nurses tracked and executed several tasks in parallel, some with numerous sub-tasks, by mentally noting their checklist. This notion, which we call ‘head-data’ here, has been described elsewhere. The paths toward completion were generally straightforward. However, the challenge was in remembering the list of tasks, the number of sub-tasks remaining, the temporal timeframe (s) remaining, and dealing with new entries into the list. The nurses viewed the activities related to fall prevention as imposing a high temporal demand, but low mental demand.

The nurses’ workaround to this constraint was to develop written and mental chunking strategies. For example, several experienced RNs had developed schemas to permit them to retain relatively more information and to bypass limitations on short-term, working memory. Strategies used were visual reminders (eg, lists written on pocket cards) to outline planned tasks and patient assessment to be completed and means of chunking (eg, in their mind enumerating the overall tasks, ordering the list, and then trying to complete one block of sub-tasks before moving to another task). Given a lack of formal training in these strategies, some nurses appear to have greater skill in developing these schemas than others.

Workload constraint leads to the need for bed alarms

Table 3 Results from Nursing Knowledge of Falls Prevention Subscale, where anchors are 1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean (SD) scale range from 1 to 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>The prevention of patient falls is a high priority for me in the provision of patient care</td>
<td>3.85 (0.35)</td>
</tr>
<tr>
<td>I am knowledgeable of fall risk factors</td>
<td>3.78 (0.41)</td>
</tr>
<tr>
<td>I am confident that risk assessment will identify patients at risk for falling</td>
<td>3.28 (0.62)</td>
</tr>
<tr>
<td>I know how to use the medical information system to include fall prevention in the care plan</td>
<td>3.68 (0.59)</td>
</tr>
<tr>
<td>I am knowledgeable of nursing interventions to reduce falls</td>
<td>3.63 (0.49)</td>
</tr>
<tr>
<td>I am knowledgeable of nursing documentation of fall prevention</td>
<td>3.63 (0.49)</td>
</tr>
<tr>
<td>I am knowledgeable of nursing documentation after a fall (incident report, patient charting)</td>
<td>3.70 (0.49)</td>
</tr>
<tr>
<td>I understand how to use the Schmid Falls Risk Assessment Tool</td>
<td>3.78 (0.41)</td>
</tr>
<tr>
<td>I feel that I could benefit from educational information on fall prevention</td>
<td>2.37 (0.64)</td>
</tr>
<tr>
<td>I feel my nursing colleagues could benefit from educational information on fall prevention</td>
<td>2.67 (0.59)</td>
</tr>
<tr>
<td>There is more that the [unit] nursing staff could do to prevent falls</td>
<td>2.25 (0.83)</td>
</tr>
</tbody>
</table>

Throughout this study the nurses reported high levels of temporal demand, effort, and frustration in their workload. One component of workload is staffing. While the evidence base on nurse staffing does not call for standard nurse to patient ratios, the staffing ratios on the studies unit falls within the range mandated in the State of California (1 RN to 5 patients) and the range studied by healthcare analysts and economists for non-ICU staffing (1 RN to 4–8 patients) in other studies. Another component of workload in this analysis is how and where the nurse spends her time. The majority of nurse time on this unit was consumed providing indirect care or medications (67%), which positions nurses in the proximity of the nursing station, away from patient rooms. The task of monitoring for patient falls, however, is one in which the nurse must be in intimate proximity of the patient to predict, detect, and intervene an impending fall. Under a heavy workload with competing parallel demands and a large proportion of time away from the patient, the task of monitoring falls becomes increasingly difficult for the RN. An automation of the monitoring task may alleviate the perceived workload demands.

The nurses’ workaround to the workload constraint was to use bed alarms, but these were employed inconsistently and their success varied. Bed alarms are an automated means to address constant monitoring, by notification of patient movement which offers an opportunity to intervene. The bed alarms used on this unit included a monitor with user interface, a speaker built into
Inadequate written data and verbal communication lead to informal querying of previous nurse

As a result of inadequate written data (lack of capability in the MIS and paper chart) and verbal communication (between RNs and NAs), the fall risk status of a patient was often communicated only via RN verbal report at shift change, and not consistently done. This lack of structure in the verbal report introduces the possibility for additional human error, in this case inconsistent reporting of fall risk status. We found there to be inconsistency between the MIS data and the nursing care plan that had been compiled from the paper chart, shift change information, and patient assessment. Fall risk status and other pertinent patient information in the MIS were rarely updated. The MIS does not have a field or prompt to complete falls data, and therefore was not conducive to falls tracking. Nurses can enter a general comment, but this information is not readily displayed to the subsequent nurses. The paper chart was the source of more reliable data, but it was not always read at the beginning of the shift, as the nurse would first receive shift report and begin to meet with patients. Therefore, typically only those nurses who had worked the previous day, who were assigned the same patient, could rapidly and readily appreciate the patient’s level of risk for falls and be able to select appropriate fall prevention interventions. In most incidences, however, nurses only had consistent patient assignments for two consecutive days.

A second issue surrounds the lack of formal, verbal communication between RNs and NAs and between RNs and the patient/family. While RNs implement fall prevention protocols, the NAs conduct the routine monitoring that ensures their effectiveness.

There was an overwhelming consensus in the focus group that the RN—NA partnership was vital to preventing falls, but a lack of communication hindered its effectiveness. The observation data (shadowing and time motion) also showed that in contrast to RNs, the NAs were not involved in the formal exchange of information between RNs at hand-off or with a prior NA. As they were not informed of patient fall risk or RN fall prevention interventions, they relied instead on visual cues (eg, bracelets, slippers, stickers) to determine fall risk.

The nurses’ workaround to decipher patient fall risk was to rely on informal querying of the previous care nurse about fall status. This reliance was evident in the TMS, where 24% of time was spent in communication either between nurses at shift change (9%) or with unit staff (15%). Conversely, only 9% of time was spent interacting with the MIS. It is possible than an

Table 4  Results of Hospital Survey on Patient Safety Culture compared to Agency for Healthcare Research and Quality (AHRQ) 2008 database

<table>
<thead>
<tr>
<th>14 item dimensions</th>
<th>% Positive ratings</th>
<th>AHRQ average</th>
<th>Percentile scores*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teamwork (within-unit)</td>
<td>91</td>
<td>79</td>
<td>90th</td>
</tr>
<tr>
<td>Safety grade (acceptable—excellent)</td>
<td>86</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td>Manager actions</td>
<td>80</td>
<td>75</td>
<td>75th</td>
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<tr>
<td>Organizational learning</td>
<td>77</td>
<td>70</td>
<td>75th</td>
</tr>
<tr>
<td>Non-punitive response to error</td>
<td>70</td>
<td>44</td>
<td>&gt; max reported</td>
</tr>
<tr>
<td>Management support for patient safety</td>
<td>67</td>
<td>70</td>
<td>25th</td>
</tr>
<tr>
<td>Teamwork (across units)</td>
<td>67</td>
<td>57</td>
<td>75th</td>
</tr>
<tr>
<td>Openness of communication</td>
<td>62</td>
<td>62</td>
<td>50th</td>
</tr>
<tr>
<td>Error communication</td>
<td>58</td>
<td>62</td>
<td>25th</td>
</tr>
<tr>
<td>Frequency of event reporting</td>
<td>49</td>
<td>60</td>
<td>10th</td>
</tr>
<tr>
<td>Overall perception of safety</td>
<td>48</td>
<td>64</td>
<td>&lt;10th</td>
</tr>
<tr>
<td>Hand-offs</td>
<td>45</td>
<td>45</td>
<td>50th</td>
</tr>
<tr>
<td>Staffing</td>
<td>34</td>
<td>55</td>
<td>&lt;10th</td>
</tr>
<tr>
<td>Number of events reported by respondents annually</td>
<td>2.6 (ave)</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

*Percentile scores reflect the 10th, 25th, 50th, 75th, and 90th percentile scores for the survey dimensions from the AHRQ Comparative Database Report.45 A 90th percentile score indicates that the unit studied scored higher than at least 90% of the hospitals in the database.
inadequate understanding of or lack of confidence in the current MIS may have led to its underutilization. It is also important to note that informal querying contributes to human error; formalized documentation systems would better inform fall risk while decreasing the time spent obtaining a patient’s status.

Limitations in the physical environment constraint lead to informal surveillance

The physical layout of the unit removed nurses from physical proximity to their patients and did not permit direct patient visibility. It is quite difficult for a nurse to prevent a fall when positioned far from the patient—while at the nursing station, for example, to mix medication, access equipment, or update documentation. In this study, it was found that nurses spent only 33% of time in the patient rooms, divided among four to five patients. There were no means of formal surveillance to deal with this constraint. In particular, from the location of the nursing station (figure 1) there was a direct viewing angle into only 3 of 17 patient rooms.

The nurses’ work-around was to add informal video and audio surveillance to improve patient visibility. Many nurses sought to monitor patients by using closed-circuit video (or relying on video assistants to watch the monitors) to patient rooms. However, most cases where an impending fall might be detected would be caught essentially by chance when a nurse happened to be in position near the camera. Also, video cameras were used only in those rooms (five in total, apart from the three with direct visual angles) where epileptic patients were assigned. Other nurses relied on reports from the unit clerk, the person to whom patients in all rooms could call over the audio intercom. In one observed case, a nurse was able to use this means to talk a patient back into bed, but this likely is a rare occurrence. In the focus group, several nurses reported that more surveillance was necessary via sitters and/or cameras.

While increased audio and video surveillance of patients may alert nurses to an impending fall, the knowledge often occurs too late to prevent it. Patients at risk for falling benefit from having nearby people who can quickly respond to an impending fall. Some redesign strategies to overcome this constraint include relocating nurses’ indirect care tasks to be in close physical proximity to the patients’ bedside and to allow more space for patient family members to stay overnight.

STUDY LIMITATIONS

The study methodology yields a few limitations. First, as with all single-site research, the findings are unlikely to generalize completely to all inpatient nursing units. The similarity of the other nursing units and their work processes to the one studied must be considered before applying the results of this research. Second, a convenience sample of nursing unit volunteers was used and as such the potential for bias exists. Third, there is a potential for the ‘halo effect’ (to perform with greater vigilance when being observed) in the observed nurses who were aware that the study focused on the prevention of patient falls. Fourth, there are some inconsistencies in the data from different data sources. For example, respondents rated themselves highly on the Nursing Knowledge of Fall Prevention Subscale while in focus groups, and they discussed inadequate understanding of how to use the MIS for fall prevention. Perhaps part of the reason nurses reported this constraint is because there are no prompts or fields related to fall prevention in the MIS. Additional reasons for differences between data sources are likely due to the differences between open ended (focus group) and closed response (survey) forms of questioning. Fifth, there is a possible ‘Lake Wobegon effect’ in the survey data, such that nurses may have inflated their individual above average knowledge base for fall prevention techniques, while also reporting that others had a low overall concern for safety. The surveys used in this study did not directly assess nursing knowledge, and self-report data of this nature can have systematic self-report bias. Finally, the void of psychometrically validated tools for extrinsic systems factors led us to develop the Fall Prevention Survey. While its face validity was assessed by cognitive engineers and advanced practice nurses, there is a need for full psychometric testing.

CONCLUSION

This study indicates that constraints in the acute care environment may lead to increased patient falls. Traditionally, extrinsic work system factors, such as nurse staffing, knowledge of fall prevention, and safety culture, have been emphasized along with intrinsic patient risk factors. Despite the emphasis in these areas, patients continue to fall. This study sheds greater light on how nursing work processes and the physical work environment contribute to the risk of patient falls. Some of the factors identified can be rectified rather simply, as in the case of standardizing hand-offs between nurses and nurse assistants. Other factors—such as limitations in the physical environment, lack of capability in the MIS, ineffective bed alarms, and unique aspects of nursing workload—are more systemic and require complex solutions. Solutions must consider the low mental but high temporal demands of the work domain, that nurses track and execute numerous tasks in parallel, and are often physically separated from individual patients for large chunks of time. Moving forward, when nursing work processes and the physical work environment are considered together with traditional factors, broader solutions can be developed with greater potential for preventing patient falls.

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REFERENCES


