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FEATURE ARTICLE

Falls in Hospitalized Patients

Can Nursing Information Systems Data Predict Falls?

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Falls among inpatients are the most frequently reported critical incidents in hospitals and can have tragic consequences that affect morbidity and mortality. The present study aimed to determine whether certain nursing units of care identified on patient care plans can be used to predict falls among hospitalized inpatients. A retrospective analysis of 7167 inpatient admissions in the 2002 calendar year was conducted. Faller status was ascertained from the hospital's accident and incident monitoring system, and nursing units of care activated in the hospital's nursing information system were identified. Twelve nursing units of care predicted falls. Logistic regression analyses showed that nursing units of care related to patient safety, confusion, incontinence, medication, mobility, and sleep were significant risk factors for falls among inpatients. The number of nursing units of care activated also predicted falls. Data collected from nursing information systems can be used to identify patients at high risk of falls.

KEY WORDS

Accidental falls • Hospital information systems • Risk factors

Falls among inpatients are the most frequently reported critical incident in the hospital setting.[1] Falls in hospital can have tragic consequences, such as hip fracture, which can dramatically affect a patient's morbidity and mortality. Hospital fall rates are often used as an indicator of nursing outcomes and processes[2] and are a frequent target for continuous quality improvement.[3]

There is a paucity of randomized controlled trials to guide practice in the prevention of falls in a hospital setting. Many hospitals either screen for falls risk and intervene on the high-risk patient[4] or use incident analysis (South Australian Patient Safety framework) to refine identification and management of patients in the ward. Both methods rely heavily on the identification of at-risk patients. Two studies that have evaluated falls risk screening found a reduction in falls after use of falls risk screening,[4,5] although a third study reported failure to reduce falls through the use of a screening tool.[6] Some authors have found that the failure of falls risk screening programs relates to poor compliance with the documentation necessary for screening.[7,8]

The lack of compliance identified in the literature does not relate to the lack of availability of validated tools.[9] Indeed, the risk profile of patients who fall in hospital is well known, including patients with cognitive impairment,[10–13] Parkinson's disease,[14] medications,[11] and incontinence,[12,13,15] and these are included on most validated tools used in clinical practice. Furthermore, the interrater reliability of falls risk assessment is often not tested in clinical practice, unless as part of a research

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study.[9] Poor compliance with screening may be related to the extra time and paperwork required to complete a falls risk assessment at the time of admission. Therefore, the unanswered challenge is to ensure widespread and reliable screening of the risk factors for falls for all older patients in hospital.

A system that identifies at-risk patients without the need for extra paperwork would be attractive. Computerized nursing information systems (NISs) are used in most hospitals to identify and enumerate nursing care needs. The Repatriation General Hospital's NIS, "Excelcare," records an individualized care plan for each patient and is updated by nursing staff on a shift-by-shift basis. Each plan consists of units of care (UOCs) that are the specific tasks required to address the patient's care needs. After the assessment of a patient by a registered nurse, appropriate UOCs that reflect the identified nursing needs of that patient are activated and placed on an electronic care plan using Excelcare. Thus, UOCs do not merely describe the need for linen changes or intravenous drug administrations; they describe the clinical state of the patient who is being nursed and encourage both planning of, and reflection on, clinical activities for a given patient.

More than 1100 UOCs are included in the Excelcare system. Several processes exist at both the South Australian Department of Health and at the local hospital level to ensure quality and standardization of each UOC. A robust, evidence-based, and consultative process is engaged in before adding and activating a new UOC in the Excelcare system. The Excelcare system is thus dynamic and adapts to the changing needs of patients and nursing staff.

There are several advantages in using an NIS such as Excelcare to develop a risk screening instrument for falls prevention. These include the following: (1) standardized definitions of UOCs are used; (2) data are already collected for Excelcare and so a risk screening instrument based on this system does not add to the existing workload for nursing staff; and (3) offers the possibility of using the system to develop electronic decision support tools to identify inpatients at risk of falling.

A group of Swiss researchers previously attempted to use routinely collected case-mix data to develop a predictive model for falls.[16] These authors showed that age, gender, diagnosis-related groups, and length of stay could be used satisfactorily to predict falls in the hospital setting. However, no previous studies that use routinely collected NIS data to prospectively identify patients at high risk of a fall during their inpatient stay were identified in a literature search.

The aim of the present project was to determine if the UOC data entered into the Excelcare system by nursing staff during a patient stay could be used to identify those patients at high risk of a hospital-related fall. A retrospective analysis that contrasted UOCs for inpatient fallers and nonfallers was carried out to identify a set of risk factors for falling in the hospital setting.

METHODS

The setting for this study was the Repatriation General Hospital, a 250-bed acute care public hospital that provides a range of general medical and surgical services to people living in Adelaide, South Australia. It is also the hospital of choice for war veterans and war widows. The Repatriation General Hospital offers high-quality integrated care from the acute stages to rehabilitation. The hospital primarily caters to patients aged 65 years or older. Pediatric and obstetric services are not available at the Repatriation General Hospital.

Three hospital databases from the 2002 calendar year were used in this study, namely, (1) the patient management system "Homer," (2) the Advanced Incident Monitoring System, and (3) the NIS "Excelcare."

The South Australian Department of Health mandates the collection of information in these databases. Each hospital in South Australia collects details concerning all patient admissions and separations, which is entered into the Homer database. The Advanced Incident Monitoring System records details of falls and all other critical incidents in the public hospital system. As outlined previously, the Excelcare database is used by all hospital nursing staff to record patients' care needs on a shift-by-shift basis.

All 7167 patients identified as having a 2002 admission date to the Repatriation General Hospital were included in this study. Patient demographic data and length of hospital stay were extracted from Homer. Falls occurrence and date of occurrence were extracted from Advanced Incident Monitoring System. Units of care were extracted from the Excelcare database.

Because there are in excess of 1100 UOCs that can be activated, we used a test data set from 2001 to identify a set of fallers and extracted the UOCs for these fallers. A total of 30723 UOC activations was available for these fallers. The frequency with which each UOC was activated was then derived. Some UOCs were very rarely activated and were not investigated further in this study. We considered the 100 UOCs that were most frequently activated; the frequency of activation ranged from 76 to 913 times. An expert panel of senior nursing staff, independent of the current project, was convened to reduce the list to plausible UOCs that may predict a fall. This process ultimately led to the identification of 28 UOCs of interest as potential risk factors for falls, and these are described in Table 1.

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Table 1

Summary of Univariate Logistic Regression Analyses of UOCs as Predictors of First Fall in Hospital

		UOC Activated					
		Nonfaller		Faller			
UOC ID	Description	n	%	n	%	OR	95% CI
u7	Toileting—use of commode	596	8.8	65	16.7	2.08	1.57–2.75
u8	Toileting—use of pan/bottle (all shifts)	3160	46.6	228	58.6	1.62	1.32–1.99
u15	Potential for injury—safety level 0	1194	17.6	19	4.9	0.24	0.15–0.38
u16	Safety level 1	3375	49.8	118	30.3	0.44	0.35–0.55
u17	Safety level 2	1950	28.8	193	49.6	2.44	1.98–2.99
u18	Safety level 3	1036	15.3	201	51.7	5.93	4.81–7.31
u20	Confused patient (assess each shift)	659	9.7	135	34.7	4.94	3.95–6.17
u23	Risk management—potential for falls	1450	21.4	267	68.6	8.04	6.44–10.04
u26	Confused patient (duration of admission)	455	6.7	103	26.5	5.00	3.92–6.39
u63	Toileting—use of pan/bottle (nighttime only)	193	2.8	10	2.6	0.90	0.47–1.71
u64	Mobility and toileting—1 nurse assist	1797	26.5	111	28.5	1.11	0.88–1.39
u65	Mobility and toileting—2 nurse assist	373	5.5	61	15.7	3.19	2.38–4.28
u358	Oral meds—4–6 AM shift	2840	41.9	217	55.8	1.75	1.42–2.15
u359	Oral meds—more than 6 AM shift	1379	20.3	127	32.6	1.90	1.52–2.36
u361	Oral meds—4–6 PM shift	1662	24.5	154	39.6	2.02	1.63–2.49
u362	Oral meds—more than 6 PM shift	364	5.4	28	7.2	1.37	0.92–2.04
u604	Urinary incontinence—includes linen change	871	12.9	168	43.2	5.16	4.17–6.38
u654	Care of patient with indwelling catheter	1200	17.7	72	18.5	1.06	0.81–1.37
u725	Sleep disturbance	635	9.4	80	20.6	2.50	1.93–3.25
u840	Communication deficit (deafness)	503	7.4	57	14.7	2.14	1.59–2.88
u2105	Fecal incontinence (includes linen change)	612	9.0	114	29.3	4.18	3.31–5.28
u2111	Care of the patient with impulsive behavior	68	1.0	27	6.9	7.36	4.65–11.64
u2115	Disorientation (memory loss)	140	2.1	26	6.7	3.40	2.21–5.23
u2118	Showering—1 nurse assist	3972	58.6	261	67.1	1.44	1.16–1.79
u2218	Rehab—Urinary incontinence management	53	0.8	22	5.7	7.61	4.58–12.64
u2240	Rehab—mobility and toileting—use of wheelchair	99	1.5	33	8.5	6.25	4.16–9.41
u2260	Rehab—mobility and toileting—1 nurse assist	166	2.4	20	5.1	2.16	1.34–3.47
u2261	Rehab—mobility and toileting—2 nurse assist	51	0.8	12	3.1	4.20	2.22–7.94

Percent values show the % of nonfallers and fallers, respectively, with given UOC activated.

Statistical Analyses

Units of care may be activated and deactivated many times for inpatients during a hospital stay. For patients who fell at least once during an admission, the activation of the UOCs of interest was considered only up until the time of the first fall. Units of care activated after a fall may be in response to the fall rather than potential predictors of the fall. Variables that indicated if a particular UOC was activated before the first fall were then created. For patients who did not fall during an admission, these indicator variables classified whether a UOC of interest was activated at any time during the hospital stay.

In keeping with the study aim of identifying patients at high risk of a fall while in hospital, logistic regression analyses were conducted to assess each of the 28 UOCs as a risk factor for faller status. If a UOC had a corresponding *P* value in the univariate analysis of less than .2, then that UOC was retained and included in the starting set of potential risk factors in a multiple logistic regression analysis. This was done to ensure UOCs were not prematurely discarded from the analysis. Several UOCs that differentiated if they were activated on a rehabilitation or medical ward were combined for the multiple logistic regression analyses. For example, "Mobility—2 nurse assist" and "Rehab—mobility 2 nurse assist" were merged to create one variable. Groups of UOCs that related to continence, mobility, confusion, and medications, respectively, were combined in this way.

The total number of activated UOCs per admission was also calculated and considered in a separate logistic regression analysis.

Stata version 8 (StataCorp, College Station, TX) was used in all analyses.[17] Because patients could be admitted more than once, Huber-White[18,19] estimates of variance were used to adjust for the effect of clustering by patient.

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Ethical approval for this study was obtained from the Repatriation General Hospital Research and Ethics Committee.

RESULTS

There were 7167 admissions to the hospital in 2002. Falls were recorded in a total of 389 admissions, with an average of 1.7 falls (range 1–25) per admission in which one or more falls occurred. The demographic profile of the fallers and nonfallers was similar. The mean age of nonfallers was 75.9 years (SD = 12.2), and fallers 79.8 years (SD = 7.9). A total of 64% of the nonfallers were male; whereas 66% of the fallers were male. The median length of stay among nonfallers was 5 days (interquartile range 2–11 days), and the median time to the first fall among fallers was 5 days (interquartile range 2–15 days).

As shown in Table 1, most UOCs had odds ratios (ORs) that differed significantly from 1. One medication UOC and several toileting UOCs were not significant predictors of falls, although other UOCs that encompassed medication and continence issues were significant. The UOCs "safety level 0" (no safety risks) and "safety level 1" (minimal safety risks) were protective against falling.

The results from the multiple logistic regression are presented in Table 2. As this demonstrates, UOCs related to patient safety, confusion, continence, medication, mobility, and sleep were significant risk factors for inpatient falls.

A separate analysis also showed that the total number of UOCs identified on the patient's care plan was also a significant predictor of falls. A gradient of fall risk with increasing number of UOCs was evident, with more UOCs markedly increasing the risk of a fall (see Figure 1).

Table 2

Summary of Multiple Logistic Regression

UOC	OR	95% CI	*P*
Potential for injury			
Safety level 0	0.58	0.35–0.95	.029
Safety level 2	1.60	1.26–2.02	<.001
Safety level 3	2.00	1.52–2.61	<.001
Confusion	1.79	1.37–2.35	<.001
Care of the patient with impulsive behavior	2.15	1.24–3.71	.006
Urinary incontinence management	6.63	3.63–12.11	<.001
Mobility 2 nurse assist	1.30	0.94–1.81	.113
Risk management potential for falls	3.64	2.80–4.74	<.001
Medications 4–6	1.31	1.03–1.66	.030
Medications 6+	1.31	1.03–1.68	.029
Urinary incontinence (includes linen change)	1.54	1.18–2.01	.001
Sleep disturbance	1.37	1.03–1.83	.030

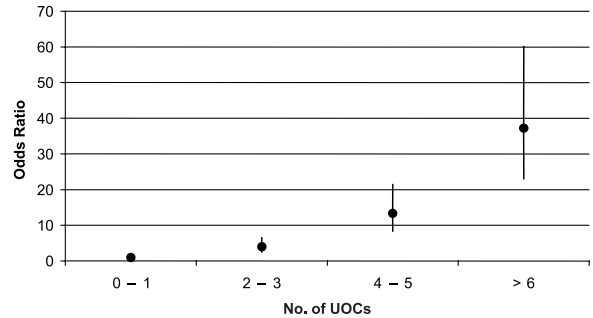

FIGURE 1. Summary of logistic regression for number of UOCs as predictor of falls. Odds ratio and 95% confidence intervals are presented.

DISCUSSION

As a result of this study of a large sample of patients admitted to hospital, UOCs were identified that can now potentially be used to identify at-risk patients for falls prevention strategies. Another important application of the findings of this study is their adaptability to any other hospital that uses similar UOCs in their NIS. Furthermore, it is conceivable that these data could be used to develop an electronic decision support tool for falls prevention.

The use of an NIS to actively guide clinical interventions is attractive. The present study has shown that UOCs, which are essentially standardized nursing assessments and observations, carry significant predictive value for an important clinical outcome. The hospital's NIS, Excelcare, is closely monitored and audited in the study hospital because of its importance in patient care planning. This serves to strengthen its clinical utility. The UOC data are already stored in electronic format and require no additional resources to collect.

The data collected in this study compare favorably with other risks for falling identified in the literature. Incontinence and confusion[12,13] are commonly identified as risks for falling in hospital populations. Estimates of poor balance are also common in falls risk assessment tools. However, in this study, the only significant mobility item described patients who were severely impaired with inability to stand unaided. Patients who could walk with only one assistant were not found to be at significantly higher risk of falling than patients who did not require this assistance. This is different from the risk factors identified in studies with community-dwelling participants[20] and many of the

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items that are included in screening tools for falls risk.[13] In one study of hospital patients, the highest risk for falling was associated with being unable to stand without assistance.[21] Similarly, a study concerning falls risk among nursing home residents showed that the highest falls risk was in those who could rise from a chair but could not stand unaided.[22] This possibly explains the high risk in the study's more dependent patients who may have similar mobility to those in the nursing home study.

The present study has also highlighted that the risk profile for patients who fall in hospital is quite different from those who fall in the community. The hospital environment is very different from the home environment, and those in hospital are generally more frail due to the reason for their admission; therefore, interventions to reduce falls need to be targeted differently for hospitalized participants than those for community-dwelling participants.

Although this work has been a useful first step, further consideration needs to be given as to how these data could be used to drive a falls intervention program. Quality improvement programs rely on available evidence to guide practice improvement. Many of these projects will screen for falls risk and then intervene with a set of generic nursing interventions.[3,23] These interventions are targeted to the risk factors in an individual who is at high risk.[24] However, the evidence base supporting these generic nursing interventions is weak,[25] and the screening instruments may have poor sensitivity.[13] It is possible that the UOCs identified in the present study could be used as basis for a "screening instrument." However, the data collected in the present study would suggest that, like many other instruments, one based on the UOCs would not be sensitive or specific enough to be classified as a screening test. Nonetheless, the UOCs do identify risk factors for a population, and these could be intervened upon in the same way as treating blood pressure is treating a risk factor for stroke.

The results suggest that a new approach to preventing falls in hospitals is required. Delirium, an adverse event of hospitalization, has been prevented by screening all patients for risk factors for delirium and then intervening on all patients with risk factors.[26] A similar approach is needed for falls, with an intervention for all patients with significant cognitive impairment, incontinence, or poor mobility targeted to manage the falls risk associated with these particular risk factors. Units of care could be the basis of an intervention program for falls prevention in acute wards as the method of identifying risk factors. For example, it would be feasible to provide a continence strategy to the 11% of inpatients who were identified as incontinent in the present study. Future work is planned that will develop a continence management strategy based on regular toileting to improve continence *and* the falls risk associated with this for all patients who have this UOC activated. Strategies for patients with the mobility UOCs and confusion UOCs activated are also under development.

There are several limitations in the present study. Although stringent monitoring and auditing of the UOCs is carried out, the possibility of some inaccuracies in the entry of UOC data by nursing staff remains. Despite this, the falls risk identified in the present study has high clinical relevance. The "risk management potential for falls" UOC is also potentially problematic, in that not all hospitals have a corresponding UOC for this item. This UOC does not fit particularly well within the proposed paradigm of identifying and managing specific risk factors. However, the relationship between falling and the other UOCs persisted if the risk management UOC was excluded and analyses were rerun. More work to validate these findings in another hospital is both needed and planned. This will also confirm whether the "risk management potential for falls" UOC is a robust predictor of falls in the hospital setting, as well as assess the procedure using other databases. The difference in the length of exposure to different UOCs between the two groups may have affected the data collected. However, certain UOCs are undoubtedly activated after a fall, and including these would have made interpretation of the model impossible. The large proportion of males in this study was due to the high number of war veterans admitted to this hospital. It is unknown if this gender bias may have had an influence on the results, making the findings reported here less applicable to other hospitals.

In summary, this analysis has identified a robust technique for identifying falls risk factors and patients at risk of falling in an acute hospital environment without creating extra paperwork. This could form the basis for a new direction in managing the challenging problem of falls in hospitalized inpatients.

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