FEATURE

Predicting and Assessing Fall Risk in an Acute Inpatient Rehabilitation Facility

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Abstract

Purpose: Unintentional falls account for 70% of all hospital accidents. The objective of this study was to identify risk factors for falls and develop an assessment tool specific for an inpatient rehabilitation facility setting.
Design/Method: Diagnosis and Functional Independence Measure (FIM) scores were collected for 174 patients to assess predictors for fall risk. Independent *t*-tests, chi-square, and logistic regression analysis were conducted to examine differences between fallers and nonfallers.
Findings: We identified several risk factors for falls including 4 FIM items: toileting, bed transfer, tub/shower transfer, and stairs; and three diagnoses: right stroke, traumatic brain injury, and amputation. From these findings, we completed initial development of a risk assessment tool.
Conclusions: Evaluation of the tool suggests good specificity with 20%–30% of the patient population identified as high risk and good sensitivity by correctly predicting nearly 90% of patient falls.
Clinical Relevance: Continued evaluation of this assessment tool is needed to identify effectiveness in predicting patients who are at high risk for falling.

Introduction

Unintentional falls account for 70% of all hospital accidents. The fall rate for inpatient hospitals varies from 1.4 to 17.9 falls per 1000 patient days (Morse, 1996; Vassallo, Sharma, Briggs, & Allen, 2003; Vlahov, Myersz, & al-Ibrahim, 1990). Falls during hospitalization pose a significant health risk to the patient, as up to 33% of these falls may result in injury (Bates, Pruess, Souney, & Platt, 1995; Fischer et al., 2005; Morgan, Mathison, Rice, & Clemmer, 1985). Injuries resulting from falls include serious complications such as fractures, cranial and soft tissue injuries as well as anxiety, depression, and a loss of confidence resulting in a decrease in independence, and impact on patients' perceptions of safety (Fischer et al., 2005; Schwendimann, Buhler, De Geest, & Milisen, 2006). This psychosocial impact of a fall has been reported to have an enduring effect (Adkin, Frank, Carpenter, & Peysar, 2002; Kressig et al., 2001; Legters, 2002; McKee et al., 2002). In addition to these complications, falls during hospitalization present potential financial implications with an estimated $28 billion in annual direct costs related to falls, a number expected to increase to $54.9 billion by 2020 (Englander, Hodson, & Terregrossa, 1996; Stevens, Corso, Finkelstein, & Miller, 2006).

The reasons for patient falls are multifactorial, with age, mental state, drug use, and reduced mobility all contributing to an individual's risk for falling. In line with these factors are specific diagnoses, including stroke, brain injuries, and other orthopedic conditions, which have been shown to increase the likelihood of falls. Risk factors for falls may vary greatly in different settings. Patients in acute rehabilitation represent one of the most at risk populations for falls during hospitalization (Rabadi, Rabadi, & Peterson, 2008). This may be due to a combination of factors including the

primary goal of inpatient rehabilitation, which is to increase patient mobility with a population that has significant cognitive impairments in a short length of stay to facilitate return home (Nakai, Akeda, & Kawabata, 2006). Previous studies investigating risk factors for falls specific to inpatient rehabilitation facilities found that patients with the highest risk for falling had a stroke or amputation, were between 41–50 years of age, and had lower cognitive and physical abilities (Lee & Stokic, 2008). History of previous falls has also shown to be a good predictor for falling in addition to other factors such as balance, gender, and overall functional abilities (Morrison et al., 2011). The Functional Independence Measure (FIM) instrument, used in all inpatient rehabilitation settings, has been investigated for its ability to accurately predict falls. Specifically, fallers have been shown to have lower cognitive, motor, and total FIM scores at admission (Gilewski, Roberts, Hirata, & Riggs, 2007; Kwan, Kaplan, Hudson-McKinney, Redman-Bentley, & Rosario, 2012; Saverino, Benevolo, Ottonello, Zsirai, & Sessarego, 2006).

Despite the research identifying differences in fall risk in different settings, currently no assessment tool has been developed specifically for use in an acute inpatient rehabilitation facility. Most fall risk assessment tools were developed and tested for acute hospital settings like the Morse Fall Scale, Hendrich II, STRATIFY, and the Downton index. When these existing tools are used in inpatient rehabilitation facilities, the majority of patients will be identified as high risk. Several studies have evaluated these risk assessment tools in inpatient rehabilitation facilities but found that they are not effective (Gilewski et al., 2007; Kwan et al., 2012). In a previous study completed at this facility, the Morse Falls Scale was assessed and found to routinely place nearly 100% of patients at high fall risk, which was defined as a score of 25 or greater (Kwan et al., 2012). This makes it difficult to establish interventions targeted at a smaller population of actual high-risk patients. Understanding the risk factors for falls specific for the inpatient rehabilitation facility population is essential to being able to accurately predict patient falls. The goal of this study was to identify risk factors for falls at an inpatient rehabilitation facility and to use these risk factors to develop a tool specific for assessing fall risk in an inpatient rehabilitation facility.

Methods

The initial study sample consisted of 174 patients who were consecutively admitted to an inpatient rehabilitation facility in southern California between July and November in 2010. All patients admitted during this time received normal and customary care under an existing falls prevention plan including use of the Morse fall scale to assess fall risk. To assess predictors for fall risk, age, gender, length of stay, diagnosis, and admission, FIM scores were collected for all patients in the study population. The FIM instrument is widely used in inpatient rehabilitation settings to assess an individual's level of functioning and disability. There are 18 items under two major categories (motor and cognition) that comprise the FIM with each item being scored on an ordinal scale from 1 to 7. The score is based on the level of assistance needed to perform activities of everyday living. A score of 1 dictates that the patient requires full assistance while a 7 indicates total independence; a score of 0 is given when the activity does not occur at admission, for example, if it is unsafe to do the task. This tool has been shown to have good reliability and prognostic potential at admission (Heinemann, Linacre, Wright, Hamilton, & Granger, 1993; Oczkowski & Barreca, 1993). For example, the FIM tool has been used to predict functional outcome at discharge, length of stay, and discharge location (Oczkowski & Barreca, 1993; Sebastia et al., 2006). The FIM is completed for all patients admitted to an inpatient rehabilitation facility by nursing, physical, occupational, and speech therapy between 24 and 72 hours of admission. All falls that occurred within this population were also documented according to hospital policy. A fall was defined as unintentionally coming to rest on the ground including slips, assisted, attended, and unattended falls. To identify risk factors for falls, independent *t*-tests and chi-square analysis were conducted for FIM scores, diagnosis, and other variables to examine differences between fallers and nonfallers. Logistic regression and chi-square analysis were used to determine the relative risk score associated with each predictive factor. The risk scores were used to develop a risk assessment tool and Chi-square analysis was used to set standard and high-risk level cut offs. The specificity and sensitivity of this measure were assessed using a separate retrospective cohort, which was composed of a completely independent population from the initial data set. Specifically, this new population consisted of 60 patients and was assessed using the new risk assessment. Fallers and nonfallers were compared based on the level of risk assigned by the new assessment tool. JMP statistical software (SAS Institute, Cary, NC) was used for all analyses. The level of significance was set at 0.05 for all analyses. All analyses were performed using a de-identified data set.

Table 1 Diagnosis

	Fallers (n = 30)	Nonfallers (n = 144)	ChiSq
CVA R	7	15	0.05*
CVA L	2	13	0.74
Traumatic brain injury	6	7	0.003*
Ortho hip fracture	1	11	0.4
Ortho total knee replacement	2	8	0.7
Ortho total hip replacement	0	12	0.3
Amputation	4	1	0.001*
Anoxic brain Injury	2	4	0.28
Spinal cord Injury	2	5	0.38
Ortho – Other (not hip FX, or TJR)	1	3	0.63
Debility	2	10	0.93
Other	0	58	N/A

*denotes significant effect, $p < .05$.

Results

The study population included 174 patients over 5 months; during this time, 30 falls occurred. Approximately 22% of the total population had a diagnosis of stroke, 25% had an orthopedic diagnosis, and 7% had a diagnosis of traumatic brain injury. Of the 30 patients who fell, 30% had a diagnosis of stroke, 20% had a diagnosis of traumatic brain injury, 13% had an orthopedic diagnosis, and 13% had an amputation. The average age for the total population was 67 years ranging from 18 to 96. There was no difference in age between the fallers (65 years) and nonfallers (67 years). 72% of falls were unattended while only 28% were attended. The average time between admission and when falls occurred was 11 days, but this ranged from 3 days to 37 days after admission.

Risk factors for falls and creation of a risk assessment tool

The Pearson's chi-square test was used to analyze differences in diagnoses between fallers and nonfallers. Patients with a right-hemisphere stroke represented the largest population of patients who fell. In addition to right-hemisphere strokes, we found that patients with a traumatic brain injury and an amputation were also at a significantly increased risk for falling (Table 1). Other fallers had diagnoses of spinal cord injury, anoxic brain injury, a fracture of the humerus, and debility. The Pearson's chi-square test and Student's t-test were used to analyze FIM data in fallers and nonfallers (Table 2). Four

Table 2 FIM scores

	Fallers (n = 30)	Nonfallers (n = 144)	t-test p-Value	ChiSq p-Value
Eating	4.8	4.8	.99	.79
Grooming	4.3	4.3	.80	.28
Bathing	2.7	2.9	.34	.36
Dressing – upper extremity	3.7	3.6	.70	.60
Dressing – lower extremity	2.1	2.1	.74	.2
Toileting	1.5	1.9	.04*	.03*
Bladder control	2.8	2.8	.96	.59
Bowel control	4.4	3.8	.15	.30
Bed transfer	1.9	2.6	.0032*	.003*
Toilet transfer	2.7	2.3	.08	.13
Tub/shower transfer	0.8	1.8	.0002*	.0001*
Walk/wheelchair	1.6	1.3	.17	.32
Stairs	0.6	1.2	.0001*	.0001*
Comprehension	4.8	4.4	.18	.16
Expression	4.8	4.4	.18	.28
Social interaction	4.9	4.3	.08	.07
Problem solving	4.3	3.8	.16	.16
Memory	4.3	3.8	.18	.18

*Denotes significant effect, $p < .05$

Table 3 Casa Colina Falls Assessment Scale

Diagnosis	Odds Ratio	Relative Risk	If Yes, Patient Receives the Following Score
RCVA	2.6 (0.96–7.1)	2.24	20
TBI	5.56 (1.5–20.6)	4.9	50
Ortho – amputation (not FX, THR, or TKR)	4.89 (1.5–15.8)	4.11	40
FIM score			
Toileting score 1,2	3.2 (0.89–11.4)	3.1	30
Bed transfer 1,2	2.4 (1.0–5.58)	1.5	20
Tub/shower transfer 0,1	2.42 (0.8–5.9)	1.3	20
Stairs 0	14.9 (4.7–47.5)	6.9	60

FIM items were identified as potential risk factors for falling, toileting, bed transfer, tub/shower transfer, and stairs. From these data, logistic regressions were run to predict the FIM scores associated with increased risk for falling

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CASA COLINA FALL RISK ASSESSMENT SCALE

Diagnosis	If yes, patient receives the following score	Admit Scores Date _____	Team Conference Date _____	Team Conference Date _____	Team Conference Date _____	Team Conference Date _____	Team Conference Date_____
RCVA	20						
TBI	50						
Amputation	40						
FIM Score							
Toileting score 1,2	30						
Bed transfer 1,2	20						
Tub/shower transfer 0,1	20						
Stairs 0	60						
Total							
	Staff initials						

If 80 or > patient is HIGH RISK

Figure 1 Casa Colina Fall Risk Assessment Scale.

(Table 3). The FIM scores significantly associated with risk of falling were 1 or 2 for toileting ($\chi^2 = 4.7$, Receiver Operating Characteristic (ROC) curve = 0.61, $p < .05$), 1 or 2 for bed transfers ($\chi^2 = 8.7$, ROC = 0.67, $p < .01$), 0 or 1 for tub/shower transfers ($\chi^2 = 17.3$, ROC = 0.74, $p < .0001$), and a 0 for stairs ($\chi^2 = 22.0$, ROC = 0.71, $p < .0001$). Following chi-square analysis for all factors associated with risk of falling, the odds ratio and relative risk score were determined. The relative risk scores were rounded up and multiplied by 10 for ease of use in a risk assessment tool (Table 3). A patient will receive 20, 50, or 40 points if they have a diagnosis of a CVA (right side), TBI, or amputation. In addition to the diagnosis, a patient will receive 30 points if they have a toileting FIM score of 1 or 2; 20 points for a bed transfer FIM score of 1 or 2; 20 points for a tub/shower transfer FIM score of 0 or 1; and 60 points for a stairs FIM score of 0 (Figure 1). When added up, risk is determined according to the following designations; standard risk <80, High Risk ≥80 based on a logistic regression analysis ($\chi^2 = 46.9$, ROC = 0.85, $p < .0001$).

Risk assessment tool sensitivity

The specificity and sensitivity of this assessment tool was tested using a 100% new patient population to avoid serial correlations with the data set used to create this measure. The demographics of this retrospective data set were similar to the original patient population used to create this tool. The average age was 68.8 years with 20% of the population diagnosed with a stroke, 25% with an orthopedic condition, and 15% with a TBI. Using the Morse fall scale, nearly 75%–90% of patients are identified as high risk (Gilewski et al., 2007; Kwan et al., 2012). In this retrospective cohort using the newly developed assessment tool, which included 60 patients, the risk assessment identified 37% as high risk. In this cohort eight patients fell during their inpatient stay; seven of the eight patients were correctly identified as high risk (87.5%, $\chi^2 = 0.0013$*). From this initial evaluation, our new risk assessment tool has a sensitivity of 0.88 and a specificity of 0.72.

Discussion

The goal of this study was to identify risk factors for falling and create a risk assessment tool specific for people in an inpatient rehabilitation facility. Although there are a number of risk assessment tools, such as the Morse Fall Scale, which has been validated for acute hospital settings (Morse, 1996), and other measures of functional ability, which have been shown to be useful in community dwelling individuals (Scott, Votova, Scanlan, & Close, 2007), the validity of these measures does not necessarily extend to acute rehabilitation (Morrison et al., 2011). The standard practice for acute rehabilitation hospitals has been to use existing measures from other levels of care to predict fall risk (Gilewski et al., 2007; Nyberg & Gustafson,

1996). These measures do not provide the specificity needed to detect patients at risk. As these tools were created and tested in acute care settings, they are overly sensitive for postacute rehabilitation settings, placing the majority of patients at high risk (Gilewski et al., 2007; Kwan et al., 2012). For these reasons, an assessment tool specific for inpatient rehabilitation facilities was needed. In this study, we identified that people with a diagnosis of TBI, amputation, and stroke were at an increased risk for falling. In addition, 4 of the 18 FIM items, toileting, bed transfer, tub/shower transfer, and stairs, were significantly lower in those who fell than in nonfallers. Further analysis identified which scores for these FIM items correlated with increased risk for falling. Taking the diagnoses and FIM items that were identified as predictors or risk factors for falling, we then developed a new risk assessment tool specific for inpatient rehabilitation facilities.

Reliability and validity studies have been completed on a number of fall risk assessment tools with promising results (Gates, Smith, Fisher, & Lamb, 2008; Haines, Hill, Walsh, & Osborne, 2007; Hendrich, Bender, & Nyhuis, 2003; Kim, Mordiffi, Bee, Devi, & Evans, 2007; Scott et al., 2007). However, most of these tools have been tested in only one setting out of the number of health service delivery areas (Kim et al., 2007; Scott et al., 2007). The consensus from this research is that there is not a single tool that can be used across all settings (Scott et al., 2007). Underlying this finding is the fact that risk factors for falls vary across settings (Morrison et al., 2011). There is ample research identifying risk factors for falls both across hospital settings and in other at risk populations such as aging community-dwelling people (Oliver, 2007; Oliver, Daly, Martin, & McMurdo, 2004; Rapport et al., 1993; Scott et al., 2007). Although some factors remain constant regardless of the setting, such as advancing age and cognitive impairments, other factors are applicable only at certain levels of care (Scott et al., 2007). In community settings, mobility status, vestibular (balance) impairments, environmental hazards, and risk-taking behaviors represent the greatest risk factors for falling (King & Tinetti, 1995; Tinetti, Speechley, & Ginter, 1988). For these reasons, assessments of physical function like the Berg Balance Scale, the Timed Up and Go (TUG), and the Dynamic Gait Index work well to help predict people at risk for falling (Gates et al., 2008; Medley, Thompson, & French, 2006). In an acute hospital setting, the Morse Fall Scale, St Thomas Risk Assessment Tool in Falling Elderly Inpatients (STRATIFY), and Heindrich II Fall Risk Model (HFRM) have all been found to be effective in predicting falls due in part to their focus on history of falling, mobility status, and mental state (Haines et al., 2007; Kim et al., 2007; Oliver et al., 2004). As the majority of patients admitted to an inpatient rehabilitation facility already have significant limitations in cognition and mobility, which is the focus of many of the community dwelling or acute care assessment scales, this level of care is in need of a specific tool that can assess these limitations more specifically.

Studies that have focused on rehabilitation populations have found a number of risk factors including stroke, being an amputee, cognitive impairment, previous falls, sleep disturbances, medications including tranquilizers, anticonvulsants, and antihypertensives, advancing age, vertigo, physical impairments, urinary incontinence, and visual and/or hearing impairment (for review see Vieira, Freund-Heritage, & da Costa, 2011). The diagnostic risk factors identified in this study were consistent with the previous literature (Lee & Stokic, 2008; Morrison et al., 2011; Rabadi et al., 2008; Rapport et al., 1993; Teasell, McRae, Foley, & Bhardwaj, 2002). Stroke patients represented the highest population of fallers; however, as they also represent one of our highest patient populations, overall, the relationship between stroke and risk of falls did not reach significance. We did look at patients with right- and left-hemisphere strokes separately and as previously reported (Rapport et al., 1993), we found those with right-hemisphere strokes to be the more at risk population. Behavioral impulsivity and visual-spatial impairments have been previously reported to underlie this effect (Rapport et al., 1993). Due to this previous literature and the trend identified in our findings, we included right-hemisphere stroke as a risk factor in our assessment tool. In addition to right-hemisphere strokes, traumatic brain injuries and amputees constituted the three major diagnostic risk factors in the assessment tool. These diagnoses encompass other previously identified risk factors including physical and cognitive functional abilities (for review see Vieira et al., 2011). Admission FIM scores have also been previously identified as risk factors for falls in inpatient rehabilitation facilities (Gilewski et al., 2007; Kwan et al., 2012; Lee & Stokic, 2008). Total FIM and cumulated motor and cognitive FIM scores have been found to be lower in fallers as compared with nonfallers (Gilewski et al., 2007; Kwan et al., 2012; Lee & Stokic, 2008). In addition, individual items such as mobility, problem solving, grooming, bathing, upper extremity dressing, stairs, and comprehension have also been

shown to be significantly lower in fallers as compared with nonfallers (Gilewski et al., 2007; Kwan et al., 2012). In this study, we identified lower scores on toileting, bed transfer, tub/shower transfer, and stairs as risk factors. Logistic regression analysis of these four FIM items identified the scores with which increased risk of falling was associated. Differences in the patient population and acuity of patients in this rehabilitation hospital versus other settings may account for the small differences in FIM items identified as risk factors. This result highlights the major limitation of this study, which is the ability to generalize the findings to other patient populations or hospital settings. Although we predict that this tool will be helpful for all settings with similar populations, it remains unclear how well this will generalize to other like facilities, as it was created by a single inpatient rehabilitation facility. In addition, the potential risk factors identified in this study and used to create this assessment tool are not exhaustive, for example, we did not include previous falls or medications, both of which have been shown to be risk factors for falls (Mayo, Korner-Bitensky, Becker, & Georges, 1989; Morrison et al., 2011; Rabadi et al., 2008; Rapport, Hanks, Millis, & Deshpande, 1998). Furthermore, due to our limited sample size for some diagnoses, we were not able to examine all impairment groups, but rather looked at the top diagnoses for which falls occurred.

Conclusions

On the basis of the results of this study, we predict that this measure may prove to be more sensitive in identifying patients at high fall risk at an inpatient rehabilitation facility and lead to more focused fall prevention. Thus far, results have been promising in terms of the sensitivity and specificity of this new tool for this population. Currently, the efficacy of this measure in reducing patient falls is being investigated in our facility. However, future research at other inpatient rehabilitation facilities will be needed to clearly establish the ability of this tool to work at different settings.

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The authors have no financial conflicts of interest to declare.

Key Practice Points

- Unintentional falls are a huge problem in hospitals and pose both financial and health risks.
- There are several different risk factors for falls in an inpatient rehabilitation facility.
- Despite the research identifying differences in fall risk in different settings, currently no assessment tool has been developed specifically for use in an inpatient rehabilitation facility.
- A fall risk assessment tools sensitive for inpatient rehabilitation facilities should help reduce patient falls.

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