

Falls Risk Factors in an Acute-Care Setting: A Retrospective Study

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Les résultats des études sur les risques de chute en milieu de soins intensifs se contredisent. Or, cerner les facteurs qui accroissent les risques de chute demeure une priorité à cause du taux élevé de morbidité et de mortalité qui en résulte et des coûts plus élevés en soins de santé qui en découlent. La présente étude visait à élargir les connaissances sur les facteurs de risque, au-delà des facteurs connus que sont l'âge et le diagnostic médical; on a comparé les caractéristiques de 301 adultes ayant été victimes d'une chute au cours d'un séjour à l'hôpital avec un échantillon correspondant d'adultes qui n'ont pas fait de chute. Un modèle descriptif, rétrospectif et comparatif a été utilisé pour cette recherche. Des correspondances ont été établies entre les membres de chaque groupe selon l'âge et le diagnostic principal à la sortie de l'hôpital. Les données ont été recueillies à partir des rapports d'incident effectués à l'hôpital et des dossiers médicaux. L'analyse de régression des groupes correspondants a permis d'identifier les cinq facteurs de risque suivants:

- *L'incontinence.* Les probabilités de chute étaient de 11,3 fois supérieures pour les personnes incontinentes (IC=3,85, 33,05).
- *La durée prolongée du séjour à l'hôpital.* Les probabilités de chute étaient de 9,9 fois supérieures pour les patients hospitalisés depuis 19 jours ou plus (IC=4,89, 19,88).
- *La mobilité.* Les probabilités de chute étaient 6 fois plus élevées pour les personnes ambulatoires avec assistance par rapport à celles qui sont ambulatoires (IC=2,83, 12,84).
- *L'hygiène.* Les probabilités de chute étaient 2,5 fois plus élevées pour les personnes qui pouvaient faire elles-mêmes leur toilette que pour celles qui avaient besoin d'aide (IC=1,23, 4,88).
- *Le manque d'exercice physique régulier.* Les probabilités de chute étaient deux fois plus élevées pour les personnes qui ne faisaient pas régulièrement de l'exercice (IC=1,00, 3,82).

Ces résultats suggèrent qu'il faudrait peut-être accorder plus de poids à l'évaluation continue qu'à l'évaluation effectuée à l'admission quand il s'agit de cerner les facteurs de risque de chute en milieu de soins intensifs. Il n'existe pas d'études ayant identifié exacte-

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ment les mêmes ensembles de facteurs de risque, bien qu'on observe que certains résultats se répètent d'une étude à l'autre. Ceci suggère que les facteurs de risque récurrents pourraient permettre d'identifier les personnes étant plus à risque d'être victimes d'une chute, tandis que les facteurs de risque non récurrents pourraient être associés à des populations spécifiques de patientes et de patients.

Research findings have been contradictory regarding risk factors for falls in the acute-care setting. Identification of factors that place individuals at risk of falling in this setting are a priority because falls result in high morbidity and mortality and thus increased health-care costs. The purpose of this study was to extend knowledge beyond the known risk factors of age and medical diagnosis by comparing the characteristics of 301 adults who fell while hospitalized with a matched sample of adults who did not fall while hospitalized. A descriptive, retrospective, comparative design was used. The fall and non-fall group were matched on age and primary medical diagnosis at the time of discharge. Data were collected from hospital incident reports and medical records. Logistic regression for matched groups identified 5 risk factors, as follows.

- *Incontinence.* The odds of falling were 11.3 (CI = 3.85, 33.05) times greater for those who were incontinent than for those who were not incontinent.
- *Long hospital stay.* The odds of falling were 9.9 (CI = 4.89, 19.88) times greater for those hospitalized 19 days or longer than for those hospitalized less than 19 days.
- *Dependency for ambulation.* The odds of falling were 6 (CI = 2.83, 12.84) times greater for those who were dependent for ambulation than for those who were independent.
- *Independency for hygiene.* The odds of falling were 2.5 (CI = 1.23, 4.88) times greater for those who were independent for hygiene than for those who were dependent.
- *Lack of regular exercise.* The odds of falling were twice as high (CI = 1.00, 3.82) for those who did not exercise regularly as for those who exercised regularly.

These findings suggest that ongoing assessment may be more important than the admission assessment in identifying risk factors for falls in the acute-care setting. No 2 studies have found exactly the same set of risk factors, although some findings are consistent across studies. This suggests that those risk factors that are consistent across studies may identify persons who are at the greatest risk for falls and that other risk factors for falls are specific to a patient population.

A major safety issue for patients is the high incidence of falls during hospitalization. Although there is no United States national database for falls in the acute-care setting, Morse and Morse (1988) found a fall rate of 2.9 per 1,000 bed days in acute care. Falls are the most frequent cause of accidents in the hospital setting (Catchen, 1983), extend the length of stay (Andrews, 1986; Uden, 1985), and may be a primary reason for placement in a nursing home (Buchner et al., 1993; Dunn, Furner, & Miles, 1993). The effects of falling range from no physical injury to a major fracture. The proportion of falls resulting in fracture is low (5%) (Gryfe, Amies, & Ashley, 1977; Tinetti, Speechley, & Ginter, 1988), but the costs of the additional medical treatment can be high.

Several studies have identified risk factors associated with falls in acute-care settings (Hendrich, Nyhuis, Kippenbrock, & Soja, 1995;

Janken, Reynolds, & Swiech, 1986; Johnson, 1985; Llewellyn, Martin, Shekleton, & Firlits, 1988; Lund & Sheafor, 1985; Morgan, Mathison, Rice, & Clemmer, 1985; Morse, Tylko, & Dixon, 1985, 1987). Risk factors found to be significant across several studies, regardless of setting, are age (Barbieri, 1983; Johnson; Llewellyn et al.; Morse et al., 1987), gait (Morse et al., 1985; Wolfson, Whipple, Amerman, Kaplan, & Kleinberg, 1985), balance (Maki, Holliday, & Topper, 1994), muscle weakness in the lower extremities (Hendrich et al.; Janken et al.; Lord, Clark, & Webster, 1991; Whipple, Wolfson, & Amerman, 1987), recent history of falling (Janken et al.; Johnson; Lund & Sheafor; MacAvoy, Skinner, & Hines, 1996; Morse et al., 1987; Schmid, 1990), medical diagnosis of cardiovascular disease, cancer, neurological problems, or altered cognition (Hendrich et al.; Janken et al.; Lund & Sheafor; MacAvoy et al.; Morse et al., 1987), and altered continence (Hendrich et al.; Janken et al.).

A few studies have evaluated fall risk models, and the factors in these scales are not identical (Hendrich et al., 1995; MacAvoy et al., 1996; McCollam, 1995; Tinetti, Doucette, Claus, & Marottoli, 1995). McCollam used the Morse Fall Scale (MFS), which included the risk factors of history of falling, secondary diagnosis, use of ambulatory aids, IV or Heparin Lock, gait, and mental status. McCollam found that the MFS did identify those most at risk of fall, but also found that the cut-off score for risk of fall had to be modified for different types of patient-care units. MacAvoy and colleagues matched fallers with a random sample of non-fallers on two variables: age and length of hospital stay. Other variables in their Fall Risk Assessment Tool (FRAT) were mental status, elimination, history of falling, sensory impairment, activity, and medications. The sensitivity of this tool was reported as 43%; the specificity was 70%. Further analysis revealed that the factor that was the most valid predictor of falls was history of falls. MacAvoy and colleagues also found that history of falls in combination with age, confusion, and elimination was a predictor.

The literature review consistently identified age and medical diagnosis as risk factors for falls; therefore these risk factors did not merit further study. Most researchers only examined characteristics associated with fallers and did not compare the characteristics of fallers and non-fallers. The purpose of this study was to extend knowledge beyond the known risk factors of age and medical diagnosis, by comparing the characteristics of a group of adults who fell while hospitalized in an acute-care setting with characteristics of a group matched on age and primary medical diagnosis who did not fall while hospitalized in an acute-care setting.

Method

Design

A retrospective, descriptive, comparative design was used. Non-fallers ($n = 301$) were matched as closely as possible with fallers on the variables of age and primary medical diagnosis at discharge. A coding system identified the faller and non-faller as a pair.

Setting

The setting was an urban acute-care centre in the American Midwest. The hospital is an 811-bed regional referral specialty facility, and is designated as a Level I Emergency and Trauma Center with 24-hour air-ambulance service, critical-care support, and comprehensive maternity care.

Population and Sample

Approval for the study was obtained from the appropriate institutional review boards. Sampling criteria included all individuals 18 years or older hospitalized between November 1993 and August 1994; 15% of the sample were younger than 40 years of age, 29% were between 40 and 64, and the remaining 56% were 65 or older. During the study time frame, 25,441 patients were admitted, 63% of whom were female and 37% male. All individuals who fell and whose fall was reported via an incident report during the specified period ($n = 301$) were included in the fall group. The non-fall comparison group was randomly selected from all matches available during the month in which the fall occurred.

The advantages and disadvantages of matched studies are well documented. In the event that a given factor is a well-documented risk factor, matching removes confounder bias (Selvin, 1991) and increases the statistical efficiency or precision of the estimate (Kelesy, Thompson, & Evans, 1986; Kleinbaum, Kupper, & Morgenstern, 1982; Selvin). Essentially, matching on known risk factors improves the assessment of differences in the two groups because of other potential risk factors. The only disadvantage of matching in the present study is that matching resulted in a sample that is not representative of the population. This sample is older and characterized by a subset of the diagnoses found in the hospital population.

Instrument. The investigators developed a data-collection form reflecting the variables reported in the literature as being associated with individuals who fall. Content validity was supported by having

the medical-surgical nursing research interest group (MSRIG) review the instrument for a comprehensive listing of fall risk factors reported in the literature. The MSRIG comprised clinical nurse specialists, unit-based nurse educators, staff nurses, and nursing faculty from two state-supported universities. See Table 1 for the list of variables and their definitions. For ease of data collection, the items on the instrument were ordered similarly to the record system used at the study hospital. One risk factor found to be important by other researchers, *history of falls*, was excluded because the information was not available in hospital records at the time of the study.

Procedure. The data-collection form was placed on a spreadsheet and data were entered directly into a portable computer. Data were first retrospectively collected from incident reports of those patients who fell during the study period. The medical records of the fallers were then accessed to obtain data from the nursing assessment on admission and data from the nursing flow sheet and medication-administration record on the day of the fall. Finally, data were obtained from the medical records of the non-fallers, based, as far as possible, on the day of the fall for the matched subject. For example, if the subject fell on hospital day five, the data for the non-faller were collected for hospital day five.

Data analysis. Logistic regression was selected to develop the model, because it allows the use of several independent variables (continuous or discrete) and a dichotomous outcome variable, in this case fall or non-fall. Logistic regression for a one-to-one matched study is based on the differences between values of the variables for each pair (Hosmer & Lemeshow, 1989). Matched analysis removes the effects of the confounding risk factors, age and medical diagnosis, and increases the precision of parameter estimates (Kleinbaum, 1994). Logistic regression provides estimates of odds ratios that are helpful in interpreting the findings (Munro, 1993). In this study, the odds ratios compare the odds of falling for two levels of a discrete independent variable or a one-unit increase of a continuous independent variable.

Multicollinearity among the independent variables was assessed as recommended by Menard (1995) using SAS Proc Reg with the VIF and COLLIN options. Collinearity diagnostics were interpreted using the guidelines suggested by Myers (1986). No evidence of collinearity was found among the independent variables. *SAS for Windows* Version 6.08 (SAS Institute, SAS Circle, Box 8000, Cary, NC) was used for analysis. Stepwise selection was used for model-building (SAS Institute, Inc., 1990). Independent variables with a significance level of ≤ 0.05 were retained in the model.

Table 1 *Variables and Definitions*

Variable	Definition
Length of stay	Number of days in hospital
Gender	Male or female
Systolic blood pressure	On admission to hospital
Diastolic blood pressure	On admission to hospital
Drugs/alcohol	Self-report on nursing admission sheet on use of recreational drugs and/or alcohol
Exercise routine	Self-report of a regular exercise program
Assistive devices	Use of orthopedic shoes, walker, cane, crutches, or prosthesis
Visual impairment	Patient wears glasses or contacts
Cognitive impairment	Any deficit in time, place, person, or change in memory
Dizziness/vertigo/syncope	Self-reported history
Convulsions/seizures	Self-reported history
Altered elimination	Urinary urgency, urinary frequency, or diarrhea
Incontinence	Nurses' notes on day of fall or match day
Restraints	From nurses' notes or incident report on day of fall for fallers; from nurses' notes on match day for non-fallers
Turn/position	Ability to turn or position self in bed
Hygiene	Ability to administer self-hygiene
Ambulation	Ability to walk without assistance
Gait	Unsteady or stable
Medications	Number of systemic medications taken in the 24 hours preceding the fall for fallers and match day for non-fallers

Findings

The sample consisted of 301 fallers and 301 non-fallers. Of these, 328 (54%) were female, 274 (46%) male. Females and males were equally represented in the fall group: 153 females, 148 males. The age of the sample ranged from 18 to 93 years ($M = 61.8$, $SD = 17.7$). Medical diagnoses were grouped into categories for ease of reporting. Cardiac patients formed the

largest group, 23.2% having a cardiac-related primary diagnosis. Other diagnostic categories were psychiatric (14%), rehabilitation (9.8%), gastrointestinal (8.8%), cancer (8.1%), orthopedic (6.9%), pulmonary (6.2%), neurologic (3.9%), and miscellaneous others (19%).

The stepwise selection procedure identified length of stay, exercise, incontinence, ambulation, and hygiene as important variables in the model. Further analysis of the continuous independent variable — length of stay — revealed a lack of linearity in the logit. Following the advice of Hosmer and Lemeshow (1989), the investigators determined that this variable should be dichotomized (1–18 days, 19 or more days). Risk factors for falling are a stay of 19 or more days, lack of regular exercise, incontinence, a need for assistance with ambulation, and independence for hygiene (Table 2). Fit was assessed by examining plots of deviance and chi-square residuals (Hosmer & Lemeshow; SAS Institute, Inc., 1995). Deviance residuals greater than four indicate poorly fitting subject pairs. In this model, seven pairs out of 301 had a deviance score greater than four. However, none of these pairs appears as a high influence point in the chi-square residual plot. Therefore, it is concluded that this logistic regression model fits these data well.

The odds of falling (Table 2) were found to be 11.3 times greater for subjects who were incontinent than for those who were not; 9.9 times greater for those hospitalized 19 or more days than those with a short stay; six times greater for those who were dependent for ambulation than those who were independent; 2.5 times greater for those who were independent for hygiene than those who were dependent; and twice as great for those who did not exercise regularly over those who did. Logistic regression of matched studies cannot be used for prediction (David Hosmer, personal communication, 1995); therefore observed outcomes could not be compared to predicted outcomes.

Table 2 *Primary Risk Factors Associated with Falls*

Level of Risk	Wald Chi-Square	Odds Ratio	Wald Confidence Limits
Incontinence	19.5405**	11.266	3.854, 33.054
Length of stay >18 Days	40.8414**	9.855	4.886, 19.880
Dependent for ambulation	21.7195**	6.031	2.833, 12.841
Independent for hygiene	6.4736*	2.445	1.228, 4.878
Lack of regular exercise	3.8662*	1.956	1.002, 3.818
* $p < .05$ ** $p < .01$			

Discussion

The adults who fell were predominately elderly — 56% were 65 years of age or older. Other researchers have also found that it is the elderly who fall most in the hospital setting (Barbieri, 1983; Kilpack, Boehm, Smith, & Mudge, 1991; Llewellyn et al., 1988; Morgan et al., 1985).

Fallers in this sample were almost equally divided along gender lines with only five more women than men falling. Gender was not significantly associated with falling in the model. Tinetti, Doucette, and colleagues (1995) also found that gender was not a factor in predicting fallers, but they found that women fallers were more likely to suffer serious injury. Other research findings have been contradictory on whether falls are more common among men (Catchen, 1983; Kilpack et al., 1991; Morgan et al., 1985) or women (Llewellyn et al., 1988; Sehested & Severin-Nielsen, 1977).

In addition to age, subjects were matched on their primary medical diagnosis at discharge. Cardiovascular disease was the most common medical diagnosis among fallers in this study. Other investigators also found cardiovascular disease to be the leading diagnosis of fallers (Fife, Solomon, & Stanton, 1984; Morgan et al., 1985). Barbieri (1983) reported that 48% of fallers had a primary or secondary cardiovascular diagnosis. The question that arises is whether cardiovascular disease in some way relates to falls, or whether it is the most common diagnosis among fallers because it is a predominant diagnosis among adults. During the study time frame, maternal-newborn diagnoses were the most prevalent at the study site, followed by psychiatric and then cardiac problems. In contrast to the findings in this study, Hendrich and colleagues (1995) found cancer to be the most prevalent diagnosis and a significant risk factor for falls. Although cancer was found to be the second-highest-rating diagnosis associated with fallers in the present study, it was not among the top 15 diagnoses of patients, leading to the conclusion that a high proportion of cancer patients fell.

Logistic regression for matched groups identified five factors associated with subjects who fell: long hospital stay, incontinence, dependence for ambulation, independence for hygiene, and lack of regular exercise. Each of these factors will now be discussed.

Long hospital stay. A greater number of falls were found among subjects hospitalized for 19 or more days. One explanation for falls among patients with longer stays may be deconditioning resulting from extended bed rest. Visual inspection of these data did not reveal any clear pattern between day of fall and length of stay. Further examina-

tion of fallers with a length of stay of ≥ 19 days showed that 45% fell after the 18th day.

Incontinence. Persons who have difficulty controlling bowel and bladder have been identified as at risk for falls (Hendrich et al., 1995; Janken et al., 1986). Lund and Sheafor (1985) report that 12% of fallers were in the act of toileting when they fell but do not indicate whether incontinence or another factor was the most likely precipitating factor. Lack of bladder control could result in a patient rushing to the bathroom too quickly to avoid objects in the way, or perhaps leaking urine that results in a slippery floor. In the present study, urinary urgency and frequency and diarrhea were combined into one variable labelled *altered elimination*, and this variable was not found to be significant. Hospital procedure calls for data on altered elimination to be routinely collected on admission but not specifically at the time of a fall.

Dependence for ambulation. This finding is supported by those of other researchers, who have found that fallers experienced general weakness, mobility deficits, and disability of the lower extremities (Hendrich et al., 1995; Janken et al., 1986; Kilpack et al., 1991; Tack, Ulrich, & Kehr, 1987; Tinetti et al., 1988). Hendrich and colleagues found that persons with altered mobility were twice as likely to fall. Rainville (1984) notes that some subjects in her pilot study fell because they did not seek assistance even though they were listed as requiring assistance with ambulation. Persons who have been independent may not always be able to admit their need for assistance, thus attempt to walk on their own and fall.

Independence for hygiene as a risk factor is a particularly interesting one. This finding is not supported by other research and is not mentioned as a variable by other researchers. It is possible that subjects were incorrectly categorized as independent for hygiene in the medical record, or that communication of expectations was not made clear by the staff at the bedside. Patients will often indicate they can do something on their own when they actually cannot.

Lack of regular exercise, finally, is the only significant admission variable. While exercise did not provide as high an odds ratio as the other significant variables, this finding suggests that persons who do not exercise are more likely to fall. A lack of regular exercise, whether due to the level of pre-hospital illness or simply choice, affects factors known to relate to falls. Researchers have reported that fallers had less muscle strength and poorer balance than non-fallers (Lord et al., 1991; Tack et al., 1987). Additionally, research has found that exercise improves flexibility (Bassett, McClamrock, & Schmelzer, 1982; Mills,

1994), muscle strength (Fiatarone et al., 1993; Fisher, Pendergast, & Calkins, 1991), and balance (Roberts, 1989). In the present study, the variable of regular exercise was self-reported and was not well defined. Knowing more about the duration, intensity, and frequency of an individual's exercise program may provide further information about the relationship between lack of exercise and falling. Engagement in regular exercise has not been studied in fall research in the acute-care setting, and the findings of this study suggest that it should be.

The findings of this study suggest that admission assessment may be less important than ongoing assessment in identifying risks for falls. Although patients who reported engaging in regular exercise on admission were less likely to fall while hospitalized than those who did not, the other significant variables were not found at admission yet were present on the day of the fall. Nurses must be informed about risk factors for falls and must maintain constant vigilance for changes in status that increase risk for falling.

No two studies have found the same set of risk factors. The present investigation found the factor with the highest risk coefficient to be incontinence, followed in descending order by length of stay, dependence for ambulation, independence for hygiene, and lack of regular exercise. As discussed, all of the factors except independence for hygiene have been found to be risk factors by other researchers. However, the specific set of risk factors differs according to patient population, which suggests that risk models may identify only those persons who are at greatest risk of falling. Findings also suggest that lack of exercise as a predictor is present across patients regardless of medical diagnosis. However, the remaining factors may be more closely associated with the medical diagnosis or the effects of chronic illness.

The risk factors found significant in this study should provide guidance for a fall risk model to be evaluated in the acute-care setting where it was conducted. Based on the odds ratios, the proposed model would include *incontinence of bowel and bladder* and *physical mobility*, which includes the need for assistance with ambulation and the lack of recent exercise that would accompany a sedentary lifestyle or extended illness with a lengthy hospital stay. *Misperception of functional ability* — when individuals think they are able to, and try to, perform a function beyond their capabilities — may also be important to the model, but this can only be inferred from the findings of this study and requires further testing.

Tinetti, Inouye, Gill, and Doucette (1995) suggest that falls, incontinence, and functional dependence in elders may be caused by similar,

or "shared," risk factors. They label the shared risk factors of lower-extremity impairment, upper-extremity impairment, sensory impairment, and affective impairment as *geriatric syndromes*. These researchers found that as the number of impairments increased, the proportion of participants experiencing functional dependence, incontinence, or falls increased. The findings of the present study partially support and do not contradict those of Tinetti, Inouye, and colleagues. The need for assistance with ambulation and lack of exercise prior to admission are consistent with their findings concerning lower-extremity impairment. The present study addressed incontinence as a precursor of falls, but, in light of the findings of Tinetti, Inouye, and colleagues, a future study might examine incontinence along with falls as an outcome variable. Although they limit their theory to older adults, their findings might also apply to the chronically ill regardless of age.

Conclusion

This study compared the characteristics of a group of adults who fell while hospitalized to a matched group of adults who did not fall while hospitalized. A major limitation is that this retrospective study could include only data routinely collected and documented. Thus important characteristics, such as history of falls, may have been excluded. Non-fallers were matched with fallers on age and primary medical diagnosis at discharge, thereby eliminating these two variables from consideration as predictive factors in the model. Application of these results to the hospital population must be made with care. Because matching on age and diagnosis were part of the sampling procedure, the results are most important for older patients with cardiac and psychiatric problems. Nonetheless, matching on known factors increases the precision of the estimates of odds ratios and may have allowed the identification of a previously unknown risk factor, independence for hygiene.

Logistic regression for matched groups identified five variables in a risk model, most of which have been identified by other investigators. However, no two investigations found the same set of predictor variables. Therefore, findings suggest that risk factors for fall are specific to the patient population. Based on the lack of consistency in findings across studies, each agency should develop a model of falls risk factors specific to their setting. Agencies should evaluate the effectiveness of their identified risk factors as predictors of fall as part of a continuous quality improvement program. As Tinetti, Inouye, and colleagues (1995) suggest, a combination of factors may be more predictive of falls than specific factors taken individually. This merits further study.

The important task for which nurses must be accountable is identification of individuals who may be at risk of falling based on the presence of specific variables on admission to the acute-care setting and throughout their stay. Once a patient is determined to be at risk, interventions appropriate to that risk factor should be instituted. Nurses must not only clearly communicate to other caregivers that the patient is at risk, but also identify the specific interventions for the patient. Additionally, nurses must be made aware of how their own action, or inaction, can contribute to falls.

Research is required in how to enlist the cooperation of patients and their families in seeking assistance. Many patients either underestimate their personal degree of risk or do not want to bother anyone. A task for the discipline is to find ways to enlist the full participation of acute-care patients in their own recovery. Older patients feel very vulnerable and do not want anyone — especially members of their family — to think they might be incapable of self-care when they leave the acute-care setting. The challenge for nurses is to recognize and value the patient's need for independence while decreasing the patient's risk for falling. Thus research is needed on interventions such as environmental adaptations that might decrease fall-related injuries and allow the fall-prone patient to be more independent in the acute-care setting.

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