Nurses respond to fallers’ call lights more quickly than they do to lights initiated by non-fallers. The nurses’ responsiveness to call lights could be a compensatory mechanism in responding to the fall prevalence on the unit.

Full prevention programs for hospitalized patients have had limited success because patients have increasingly complex disorders and functional deficits and staff members often fail to consider pertinent risks such as a patient’s tendency to overstep physical limitations (Jeske et al., 2006). Human errors are common and have a negative impact on patient safety. For example, Hicks, Bandiera, and Denny (2008) concluded the majority of physician and nurse participants believe human factors are more important in determining emergency department patient outcomes than medical knowledge or procedural skills. However, the importance of content knowledge and procedural skills for determining resuscitation outcomes are not in dispute. Because resuscitation requires the coordinated efforts of an interdisciplinary team, formal team training education and structured performance feedback were identified as effective ways to improve team dynamics.

Human factors seem to dominate the impact of fall prevention efforts that address risk factors related to the environment (e.g., patient room design and equipment) (Tzeng & Yin, 2008). However, human factors (e.g., adherence to a fall prevention protocol) rarely were studied and quantified. For example, Tzeng and Yin (2009a) conceptualized nurses’ response time to call lights as a process indicator that predicts patients’ overall hospital experience because when the average call light response time was longer, patients were less satisfied with hospital nursing care. Both patients and nurses perceived a long call light response time was an extrinsic risk factor for falling (Tzeng & Yin, 2008; 2009b). Consequently, it was proposed nurses’ responsiveness to call lights could be an objective, nursing-sensitive, human factor-related indicator that may determine the effectiveness of any fall prevention program and predict fall occurrence.

Purpose

This exploratory study evaluated a putative model of nurses’ response time to call lights in discriminating non-fallers from fallers in an acute inpatient rehabilitation unit (see Figure 1 and Table 1). Authors proposed longer nurses’ call light response time would lead to a higher probability of falling before a fall actually occurred. After a fall occurred, nurses would respond to fallers’ call lights more quickly than to the lights initiated by non-fallers.

The research question of this study was, “What are the differences in nurses’ average call light response times between fallers and non-fallers?” The research hypotheses were as follows: (a) Longer nurs-
Figure 1.
The Conceptual Model of Nurses’ Response Time to Call Lights in Discriminating Non-Fallers from Fallers in an Acute Inpatient Rehabilitation Unit

**Independent Variable: Extrinsic Risk Factor for Falls**
Nurses’ response time to call lights

**Intrinsic Risk Factors for Falls**
18 Functional Independent Measures of severity of disability at admission:
- Self-care (6 measures): (1) eating, (2) grooming, (3) bathing, (4) dressing-upper, (5) dressing-lower, and (6) toileting
- Sphincter control (2 measures): (1) bladder and (2) bowel
- Transfers (3 measures): (1) bed/chair/wheelchair, (2) toilet, and (3) tub/shower
- Locomotion (2 measures): (1) walk/wheelchair and (2) stairs
- Communication (2 measures): (1) comprehension and (2) expression
- Social cognition (3 measures): (1) social interaction, (2) problem solving, and (3) memory

**Dependent Variables**
- Fall occurrence
- Patients’ call light usage

### Table 1.
Study Variables and Definitions

<table>
<thead>
<tr>
<th>Variables and Data Source</th>
<th>Conceptual Definition</th>
<th>Operational Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall occurrence Source: The fall incident report database and the prospective payment system (PPS) database</td>
<td>A fall is conceptualized as unintentionally coming to rest on the ground, floor, or other lower level. If the patient lost balance and was lowered to the ground by a helper or was found on the ground, both the attended and unattended situations are considered a fall (American Nurses Association, 2008; Buchner et al., 1993).</td>
<td>One binary response variable, Faller, was created (1=Faller, 0=Non-faller). Only the first fall during the entire hospital stay was included.</td>
</tr>
<tr>
<td>Nurses’ average response time to call lights Source: Responder® IV call light tracking system</td>
<td>The calls made from the pillow speaker or call cord are categorized as normal calls. The response time is defined as the duration from the time a normal call was activated to the time this call was cancelled from the patient room. The time for “Staff Response” on the Responder IV reports was used. The average response time for each subject was calculated for the calls made in the defined 24-hour window before and after the shift during which each included fall incidence occurred.</td>
<td>This variable was calculated as (call light response time in seconds for all the calls made)/total number of calls in the defined 24-hour window).</td>
</tr>
<tr>
<td>Patients’ call light usage Source: Responder® IV call light tracking system</td>
<td>The normal call count included all the calls either cancelled at the console or at the station of origin – the patient room in the identified 24-hour window before and after the shift during which each included fall incidence occurred.</td>
<td>The count of normal calls in the identified 24-hour window before and after each included fall incidence occurred.</td>
</tr>
<tr>
<td>Functional Independent Measures (FIM) Source: The PPS database</td>
<td>The FIM instrument is a measure of disability. It measures what the person with the disability actually does, not what the person ought to be able to do or might be able to do under different circumstances. The FIM has 18 measures: (1) eating, (2) grooming, (3) bathing, (4) dressing-upper, (5) dressing-lower, (6) toileting, (7) bladder, (8) bowel, (9) bed/chair/wheelchair, (10) toilet, (11) tub/shower, (12) walk/wheelchair, (13) stairs, (14) comprehension, (15) expression, (16) social interaction, (17) problem solving, and (18) memory. The FIM scores are documented for reimbursement purposes (UB Foundation Activities, 2004).</td>
<td>The actual scores at admission were used. All 18 FIM measures were scaled from 1 (total assistance) to 7 (complete independence).</td>
</tr>
<tr>
<td>Age Source: The PPS database</td>
<td>Patient age refers to the number of years from the birth date to the time of being discharged from the study hospital.</td>
<td>This variable was abstracted from the PPS database as recorded.</td>
</tr>
</tbody>
</table>

**Note:** The information on gender and diagnoses was recorded in the PPS database.
es’ response time to call lights would lead to higher probability of falling; and (b) Once a fall occurred, nurses would respond to the faller’s call lights more quickly than to lights initiated by a non-faller.

Based on the evidence-based Morse Fall Risk Scale cutoff score of 45 to determine high risk (Morse, 2006), 75%-90% of the acute rehabilitation inpatients in the United States were thereby designated as being at high risk for falls. Fall rates for inpatient rehabilitation can be as high as 16 falls per 1,000 patient days (Gilewski, Roberts, Hirata, & Riggs, 2007). Consequently, an acute rehabilitation unit within an academic medical center was selected as the study unit.

Developed to guide this study, the model in Figure 1 shows nurses’ call light response time, patients’ call light usage, and 18 Functional Independent Measures (FIMs) of severity of disability at admission during acute rehabilitation stays. The 18 FIMs were mandated by all health insurance companies for all acute rehabilitation inpatients and were readily available to clinicians; however, nurses seldom used FIMs for clinical decision making (UB Foundation Activities, 2004). In this study, the focus was on the relationship between nurses’ call light responsiveness and fall occurrence. Patient falls have a multifactorial nature, and falls have many causes other than the variables included in the model.

Background

Falls are one type of crisis occurring in clinical settings. Estimates of inpatient falls during hospital stays have been constant over time, ranking from 2.2 to 7/1,000 patient days. Among fallers, about 30% sustain physical injury leading to longer lengths of stay and higher costs to hospitals (Hitcho et al., 2004; Nadkarni, Iyengar, Dussa, Watwe, & Vishwanath, 2005; Rizzo et al., 1998). A crisis, such as a fall occurring in an inpatient care setting, could be a turning point for a positive form of staff change for a short or extended period of time. However, fall-related human factors and crisis management training for nurses rarely have been studied. Falls are multifactorial in nature, with multiple medical, functional, and cognitive factors associated with a higher risk of falling (Gilewski et al., 2007; Joint Commission, 2005a; Schwendimann, Bühler, De Geest, & Milisen, 2006).

Understanding risk factors for falls. Individual risk factors for falls can be intrinsic or extrinsic for each patient (Joint Commission, 2005a). Intrinsic risk factors are integral to each individual and may be associated with mental status deficits, reduced vision, previous falls, and unsteady gait. Extrinsic risk factors are external to each individual and may be associated with the physical environment and call lights not being answered in a timely manner (Quigley et al., 2009; Tzeng & Yin, 2008). In reviewing sentinel patient fall events between 1995 and 2004, The Joint Commission (2005b) found one of the primary causes of fatal falls was unavailable or delayed care.

Recent studies (Gilewski et al., 2007; Lee & Stokic, 2008) found admission mobility and problem-solving FIM scores at admission accounted for 17% of the variance in whether a fall occurred in acute rehabilitation settings. Age between 41 and 50, lower social cognitive FIM scores at admission, diagnosis of stroke and amputation, and presence of nine or more medical co-morbidities were associated with a high risk for falling among fallers during inpatient rehabilitation. A retrospective review of 22 injurious falls (Quigley et al., 2009) identified fall risk factors as toileting needs (68.2%), impaired mobility (68.2%), history of previous falls (81.8%), altered mental status (36.4%), and use of medications that increase the risk for falls (36.4%).

Falls among people ages 65-74 are more likely to be due to extrinsic factors, whereas the intrinsic factors are more important among those over age 80 (Hignett & Masud, 2006). A retrospective electronic chart review of 252 patients who fell during their hospital stay (Lakatos et al., 2009) found 96% of them had evidence of delirium. Falls in the general hospital were related to both diagnosed and undiagnosed delirium and advanced age (Lakatos et al., 2009). Except for medication use, all the aforementioned risk factors for falls are intrinsic.

Call light response time and usage. The nurse call light is a vital patient communication link during hospital stays. When patients use the call light, it is usually to summon the nurse for information or assistance. Patients expect when they push the call light button, a nursing staff member will answer or come to them. However, the statement that call lights are perceived as noise and interruptions to nursing is true according to some nurses (Deitrick, Bokovoy, Stern, & Panik, 2006; Meade, Bursell, & Ketelsen, 2006).

The assumed disparity between patient and nurse perceptions of call light usage may be at the core of patient safety problems, particularly because patients become impatient when a prompt response is not made and they attempt activities that threaten their safety. Frustration over delays in answering call lights is one of the most frequent comments patients make. The problems associated with answering call lights also may affect nurse-patient communication and relationships. Nurses must recognize call lights are rightful ways for patients to test the responsiveness of the inpatient care system toward their needs (e.g., in the hospital, skilled nursing facility, and the observation/extended stay area in the emergency department) (Deitrick et al., 2006).
Methods

Design and data sources. The site for this study was a 32-bed adult acute rehabilitation inpatient unit in an academic medical center located in Michigan. This exploratory study used a case-control method for subject sampling. It was a secondary data analysis, where the information was abstracted from the archived hospital data for the period January 2007 to March 2009 (see Table 1 for data source details). Only the acute rehabilitation patients admitted into the study unit during this period were included in the subject pool. This project was approved by the study hospital’s institutional review board to ensure confidentiality.

During the study period, no call light responsiveness-related interventions were performed beyond the hospital-wide fall prevention plan. When a fall occurs, the responsible nurse must complete an incident report, which will be reviewed by the risk management department and administrators. The fall incident report will not be included in the patient’s medical record. The responsible nurse also must complete an inpatient SOAP note after the fall, which will be included in the medical record. This form and related policy were finalized and implemented in July 2008. Based on the purpose of this study, no time factor was included in the analysis.

Participants. The inclusion criteria were: (a) patients had a primary diagnosis of admission for rehabilitation, multiple types (V57.89 as used in 2009 ICD-9-CM); (b) patients were age 21 or older when admitted to the study unit; (c) only the fall incident that occurred 72 hours after the faller was admitted to the study unit was included; and (d) only the first falls since admission were included in the analysis. The exclusion criterion was that patients did not have a completed FIM document at the time of admission.

Data collection procedures. For each data source, a protocol for data collection was developed and examined to ensure the materials did not contain any information that could compromise confidentiality and ensure consistent data processing. Two trained research associates performed data retrieval, entry, and management. The values of the study variables were abstracted from multiple data sources and entered into the Statistical Package for the Social Sciences (SPSS) dataset (more details follow).

Patients were first classified into two groups: (a) those who experienced a fall during their hospital stay (fallers) and (b) those who did not (non-fallers). From a total of 1,100 admissions during the study period, 1,001 patients had no falls, 82 had one fall, 13 had two falls, and four had three falls during the entire hospital stay. For patients with more than one fall during their hospital stay, only the first fall was included in the analysis (n=82).

At the inception of the project, 82 individual fallers were matched with non-fallers. Medical information of fallers and non-fallers was matched for (a) the primary diagnosis (V57.89) and related secondary diagnosis, (b) gender, and (c) age (within 10 years), in that order or as closely as possible. First, all fallers were matched with non-fallers according to gender and age. Non-fallers who were the same gender and within 10 years of the faller’s age were considered viable possible matches. Second, the fallers were matched according to their primary and secondary diagnoses. When identical secondary diagnoses were not found between a faller and non-faller, related diagnoses were considered. For 11 fallers, no corresponding non-faller fit the three inclusion criteria (same gender, close age, and related secondary diagnoses); these patients then were excluded. On completion of the matching phase of the project, 71 matches were identified.

The period of interest for retrieval of call light use data was the 48-hour period consisting of the 24-hour period immediately preceding and the 24-hour period immediately following the patient’s fall. For fallers, the call light data were collected for this period. Non-fallers were assigned “false” incident times that were identical to the incident times of their corresponding matched fallers. These false incident times were based on the number of days between the date of admission and the date the fall incident occurred in the matched fallers (abbreviated as the number of days to the fall incident). For two fallers, there was an unknown error in the date the fall incident occurred; these two matches were excluded from analysis. Following this exclusion, 69 matches remained. For 30 matches, the non-faller’s length of stay was not as long as the matched faller’s number of days to the fall incident. To resolve this issue, the 30 corresponding matched fallers re-entered the matching process to be assigned new non-faller matches. Ten of these fallers did not have any viable match possibilities and were excluded.

Finally, 59 matches (118 patients) were identified. Twenty-eight fallers made at least one call, and call light usage and responsiveness data were retrieved; 34 non-fallers made at least one call and call light usage and responsiveness data were retrieved. Thus, 62 patients had valid call light response time data. The other 56 patients had no call light response time data available because no call lights were made; missing values were indicated for these subjects.

Data analysis. The SPSS 16.0 Windows version (Chicago, IL) was used. Fifty-nine fallers and 59 non-fallers were included in the analysis. The unit of analysis was the individual patient. Descriptive analyses were performed. Independ-
ent t tests were used to answer the research question and test the hypotheses. Alpha was set at 0.05. The differences between the fallers and non-fallers in their ages, the scores of all 18 FIMs at admission, and patients’ call light usage also were examined using independent t tests to validate the comparability between the characteristics of fallers and non-fallers.

**Results**

The study included 118 patients; among the 59 fallers, 48 had no injury and 11 acquired injuries. The independent t tests showed no differences in the means between the groups of fallers and non-fallers in age, length of stay, and all 18 FIMs (see Table 2). Thus, the characteristics of the fallers and non-fallers were comparable.

No differences were found in the means of the call light usage 24 hours before the fall incident occurred. However, for the 24-hour window after the fall incident occurred, nurses’ average response time to the fallers’ call lights (2 minutes 49 seconds) was significantly shorter than the response time when the call was initiated by non-fallers (4 minutes 12 seconds; p=0.01) (see Table 2).

Additional one-way ANOVA analyses and Tukey significant difference tests were conducted to explore any differences in the mean values of the study variables among the non-fallers (n=59), fallers without injury (n=48), and fallers with injuries (n=11). Only two study variables had statistically significant findings. First, statistically significant differences were found in the mean values across three groups on the call light usage 24 hours after the fall occurred (F=3.25, p=0.04; mean value: non-fallers = 4 minutes 11.6 seconds, fallers without injury = 2 minutes 48.1 seconds, fallers with injuries = 2 minutes and 50 seconds). The mean difference in the call light responsiveness between non-fallers and fallers without injury was statistically significant (p<0.05).

**Discussion**

This study found a difference in nurses’ average call light response time between fallers and non-fallers, but only after a fall occurred. The first hypothesis (longer nurses’ response time to call lights would lead to higher probability of falling) was rejected. The second hypothesis (once a fall occurred, nurses would respond to the faller’s call lights more quickly than to those initiated by the non-faller) was accepted. In other words, after a fall occurs, nurses respond to a faller’s call light more quickly than to one initiated by a non-faller. The one-way ANOVA analyses provided additional evidence that fallers with injuries would increase their call light usage.

### Table 2.

Descriptive Characteristics of the Selected Study Variables and the Result Summary of the Independent t Tests on the Means Between the Groups of Fallers and Non-Fallers

<table>
<thead>
<tr>
<th>Variable</th>
<th>Groups</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t-Test Value (Significance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Call light usage in counts: 24 hours before</td>
<td>Non-fallers</td>
<td>59</td>
<td>5.53</td>
<td>7.54</td>
<td>t = 1.16 (p = 0.25)</td>
</tr>
<tr>
<td>the fall</td>
<td>Fallers</td>
<td>59</td>
<td>4.03</td>
<td>6.36</td>
<td></td>
</tr>
<tr>
<td>Call light usage in counts: 24 hours after</td>
<td>Non-fallers</td>
<td>59</td>
<td>5.05</td>
<td>7.09</td>
<td>t = -0.68 (p = 0.50)</td>
</tr>
<tr>
<td>the fall</td>
<td>Fallers</td>
<td>59</td>
<td>6.12</td>
<td>9.86</td>
<td></td>
</tr>
<tr>
<td>Average call light response time in seconds:</td>
<td>Non-fallers</td>
<td>31</td>
<td>210.13</td>
<td>102.39</td>
<td>t = 0.31 (p = 0.76)</td>
</tr>
<tr>
<td>24 hours before the fall</td>
<td>Fallers</td>
<td>26</td>
<td>201.97</td>
<td>94.33</td>
<td></td>
</tr>
<tr>
<td>Average call light response time in seconds:</td>
<td>Non-fallers</td>
<td>30</td>
<td>251.60</td>
<td>153.11</td>
<td>t = 2.64* (p = 0.01)</td>
</tr>
<tr>
<td>24 hours after the fall</td>
<td>Fallers</td>
<td>28</td>
<td>168.57</td>
<td>68.13</td>
<td></td>
</tr>
<tr>
<td>Age in years</td>
<td>Non-fallers</td>
<td>59</td>
<td>53.56</td>
<td>15.94</td>
<td>t = -0.20 (p = 0.84)</td>
</tr>
<tr>
<td></td>
<td>Fallers</td>
<td>59</td>
<td>54.15</td>
<td>15.69</td>
<td></td>
</tr>
<tr>
<td>Length of stay in days</td>
<td>Non-fallers</td>
<td>59</td>
<td>25.54</td>
<td>14.54</td>
<td>t = -0.70 (p = 0.49)</td>
</tr>
<tr>
<td></td>
<td>Fallers</td>
<td>59</td>
<td>27.58</td>
<td>16.95</td>
<td></td>
</tr>
</tbody>
</table>

* p < 0.05.

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SERIES

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Nurses’ Response Time to Call Lights and Fall Occurrences
This study found a difference in nurses’ average call light response time between fallers and non-fallers, but only after a fall occurred.

usage after their fall incidents occurred. Nurses respond to these call lights initiated by fallers with injuries faster than the ones initiated by non-fallers.

In previous research that used archived call light tracking data by inpatient care units and by month or week (Tzeng & Yin, 2009a; 2009c), more calls for assistance were associated with fewer fall-related patient injuries per 1,000 patient days. It is arguable the increased call light usage by fallers could be a consequence of their fall incidences (e.g., fear of falling again, more willing to call for assistance for toileting needs). If this is true, nurses’ call light responsiveness could be the compensatory mechanism in responding to fall incidents on the unit.

Previous studies also found more calls for assistance were associated with longer call light response times and fewer fall-related patient injuries per 1,000 patient days (Tzeng & Yin, 2009a; 2009c). It is arguable the injurious fall and fall rates, patients’ call light usage, and nurses’ call light responsiveness could have close feedback loops into each other. If so, patients’ call light usage should be observed simultaneously when investigating the relationship between nurses’ call light responsiveness and fall prevalence with and without injury, especially in quality improvement efforts associated with hospital fall prevention.

Limitations. This study was conducted in only one acute rehabilitation unit within an academic medical center. As a case-control method, only 59 matches for a total of 118 subjects were included in the analysis. A call light may be answered by an RN, a nurse aide, or other health care provider (e.g., unit clerks, physical therapists). Obviously, a nurse cannot physically attend to more than one patient’s call at a time. Nurses’ priority among their assigned tasks, as a human factor-related phenomenon, could be a critical aspect of their responsiveness to call lights (Tzeng & Yin, 2008). However, these issues were not addressed and were not able to be controlled as study limitations.

Conclusions. A crisis, such as a fall occurrence in an inpatient care setting, could be a turning point for a positive form of staff change for a short or extended period of time. A long-term change may involve (a) redefining the roles of RNs versus nurse aides, (b) revising hospital-wide or unit-specific fall prevention policies and protocols, (c) responding to the faller’s call lights in a more timely manner, and (d) being more proactive in addressing the faller’s toileting needs. For illustration purposes, a high level of fidelity to a fall prevention protocol in an inpatient care unit could have an average call light response time within 1 minute for an extended period of time. Regardless, a short- or long-term change in nurses’ levels of fidelity to and adherence to a fall prevention protocol could depend on the maturity of their attitudes toward crisis awareness of fall occurrences and injuries resulting from falls.

Clinical relevance. Yee and associates (2005) claimed nontechnical skills (task management, team working, situation awareness, decision-making) in clinical practice-related crisis management are not acquired necessarily through clinical experience and may need to be taught specifically. They found a single exposure to anesthesia crises using a high-fidelity patient simulator can improve the nontechnical skills of anesthesia residents. However, an additional simulation session may present little or no additional benefit.

As a result, based on the study findings of Yee and associates (2005), authors suggest fall prevention on-the-job training should be extensive and comprehensive. Such training could be taught as a fall crisis management skill development program (e.g., using a high-fidelity patient simulator with a scenario involving the consequences of delayed response times to call lights). Training programs need not be offered more than once a year because repeated in-service sessions may confer little or no additional benefit in fall prevention.

Future research. Future research should focus on exploring how nurses prioritize their assigned tasks. It is necessary to identify and quantify human factors that contribute to nurses’ decision-making regarding when to respond to the call lights initiated by recent fallers versus non-fallers. For example, future research may investigate changes in nurses’ attitudes toward responding to call lights after a crisis (a fall incident with or without injury) occurred with one of their patients during their own shift. Longitudinal hospital archived data could be used to understand the closed-loop feedback relationship among nurses’ call light responsiveness, patients’ call light usage, and fall/injurious fall prevalence.

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