

Final report-2011/11/29 (limited to 20 pages)**AHRQ R03 Project Title:** Call Light Responsiveness and Effect on Inpatient Falls and Patient Perceptions**Principal Investigator (PI):** Huey-Ming Tzeng, PhD, RN, FAAN, Professor of Nursing and Associate Director of Nursing and Undergraduate Programs, Department of Nursing, School of Health Professions and Studies, University of Michigan-Flint, Flint, MI (humi@umich.edu; humi@umflint.edu; tzenghm@gmail.com), cell phone: (734) 358-0358**Co-Investigator:** Marita Titler, PhD, RN, FAAN, Associate Dean for Practice and Clinical Scholarship, Rhetaugh Dumas Endowed Chair, and Professor, School of Nursing, University of Michigan, Ann Arbor, MI**Co-Investigator and Biostatistician:** David Ronis, PhD, Research Scientist, School of Nursing, University of Michigan, Ann Arbor, MI**Organization:** The University of Michigan**Inclusive Dates of Project:** September 30, 2009-September 29, 2011**Federal Project Officer:** Dr. Judith Sangl**Acknowledgment of Agency Support:** This project was supported by grant R03HS018258 from the Agency for Healthcare Research and Quality. The content is solely the responsibility of the authors and does not necessarily represent the official views of the Agency for Healthcare Research and Quality. Sincerely, we thank the support from the Agency for Healthcare Research and Quality as well as Dr. Judy Sangl's guidance and helpful comments on the final report.**Grant Award Number:** 1 R03 HS018258-01

Abstract (250 words)

Purpose: This study examines the contribution of response time to call lights in predicting falls, injuries from falls, and patient perceptions about call light response time in adult noncritical care inpatient settings.

Scope: The specific aims of this study are to examine the unique contribution of *call light response time* in predicting 1) total fall rates, 2) injurious fall rates, and 3) patients' perceptions about timeliness of call light responsiveness and accessing toileting assistance.

Methods: This exploratory study analyzes data from 28 units from four Michigan hospitals (three teaching hospitals and one community hospital) and uses archived hospital data/reports from January 2004 to May 2009. The patient care unit-month is the unit of analysis (N = 1063). Multiple regression analyses were used.

Results: For **Aims 1 and 2**, multiple regression analyses showed that faster call light response time was associated with lower total fall and injurious fall rates. For **Aim 3**, multiple regression analyses showed that faster call light response time by staff would contribute to higher patient satisfaction of the timeliness of call light responsiveness but would not contribute to patient satisfaction about accessing toileting assistance. In short, this study verified the use of staff's call light response time in predicting total and injurious fall rates and patient satisfaction about timeliness of call light responsiveness. Hospital and nursing executives should consider strategizing fall and injurious fall prevention efforts by aiming for a decrease in staff response time to call lights. Regular monitoring of response time should be a priority.

Key Words: Falls; injurious falls; hospital-acquired injury; consumer satisfaction; quality of healthcare; patient; hospital; patient safety

FINAL REPORT NARRATIVE

Purpose

Hospital inpatient falls are among the most frequently reported incidents and are a significant cause of hospital-acquired injuries. Many inpatient falls cause little or no harm, but falls can sometimes lead to severe injuries (e.g., hip fractures, head traumas) [1]. Inpatient falls can lead to injury, prolonged stays, lack of patient independence, and additional resource expense. It is well recognized that falls have many causes and a multifactorial nature, including impaired cognition, history of falling, mobility, gait and balance, and dependence in activities of daily living [2]. The contribution of nurse response time to call lights has not been studied systematically as a contributor to falls in hospitals [3].

As a result, this study is proposed to examine the contribution of response time to call lights in predicting falls, injuries from falls, and patient perceptions about call light response time in adult noncritical care inpatient settings. The overall goal is to generate insights about call light responsiveness and its relationship with falls and patient satisfaction to develop and test interventions to reduce call light response time, fall rates, and injuries from falls.

As for policy relevance, the Partnership for Patients (launched by the Obama Administration) estimated that 25% of fall injuries can be prevented. The goal set by the Partnership for Patients for hospitals is to cut the number of preventable fall injuries in half by 2013 or 43,750 fall injuries over 3 years [1]. In addition, Centers for Medicare & Medicaid Services (CMS) announced that, beginning in fiscal 2013, the Hospital Value-based Purchasing Program will start applying to payments for discharges occurring on or after October 1, 2012. CMS will make value-based incentive payments to acute care hospitals. The payments will be based either on how well the hospitals perform on certain quality measures or how much the hospitals' performance improves on certain quality measures from their performance during a baseline period [4].

Scope

We address the following specific aims and hypotheses:

1. To examine the unique contribution of call light response time in predicting *fall rates*.
Hypothesis 1: Call light response time will contribute significantly to predicting fall rates, after controlling for covariates.
2. To examine the unique contribution of call light response time in predicting *fall-related injuries*.
Hypothesis 2: Call light response time will contribute significantly to predicting injurious fall rates, after controlling for covariates.
3. To examine the unique contribution of call light response time in predicting *patients' perceptions* about a) timeliness of call light responsiveness, and b) accessing toileting assistance.
Hypothesis 3: Call light response time will contribute significantly to predicting patients' perceptions about a) timeliness of call light responsiveness, and b) accessing toileting assistance, after controlling for covariates.

In this project, the patient care unit-month is the unit of analysis, defined as data aggregated by month for each patient care unit. The sites for this study are 28 adult noncritical care inpatient units (medical, surgical and medical-surgical units) from four hospitals: University of Michigan Health System (UMHS) (913 beds) (14 study units; 750 data points; from January 2004 to December 2008), St. Mary Mercy Hospital in Livonia (304 beds) (4 units; 92 data points; from February 2007 to December 2008), Beaumont Hospital in Royal Oak (1061 beds) (4 study units; 56 data points from April 2008 to May 2009), and Sparrow Health System in Lansing (697 beds) (6 study units; 165 data points; January 2006 to December 2008). This study uses archived hospital data/reports (monthly data) to achieve the objectives of this project. We control the covariates as appropriate to the dependent variables and the availability of the data. (Please see **Table 1** for the covariates included in this project.)

The conceptual model for this study, depicted in **Figure 1**, is based on Donabedian's [5,6] framework of structure, process, and healthcare outcomes and on previously reviewed studies [7,8]. (Please see **Table 1** for the definitions of the variables.) The multi-hospital study design increases the understanding of staff response time to call lights in multiple adult inpatient acute care units and lays the foundation for future, larger, subsequent studies.

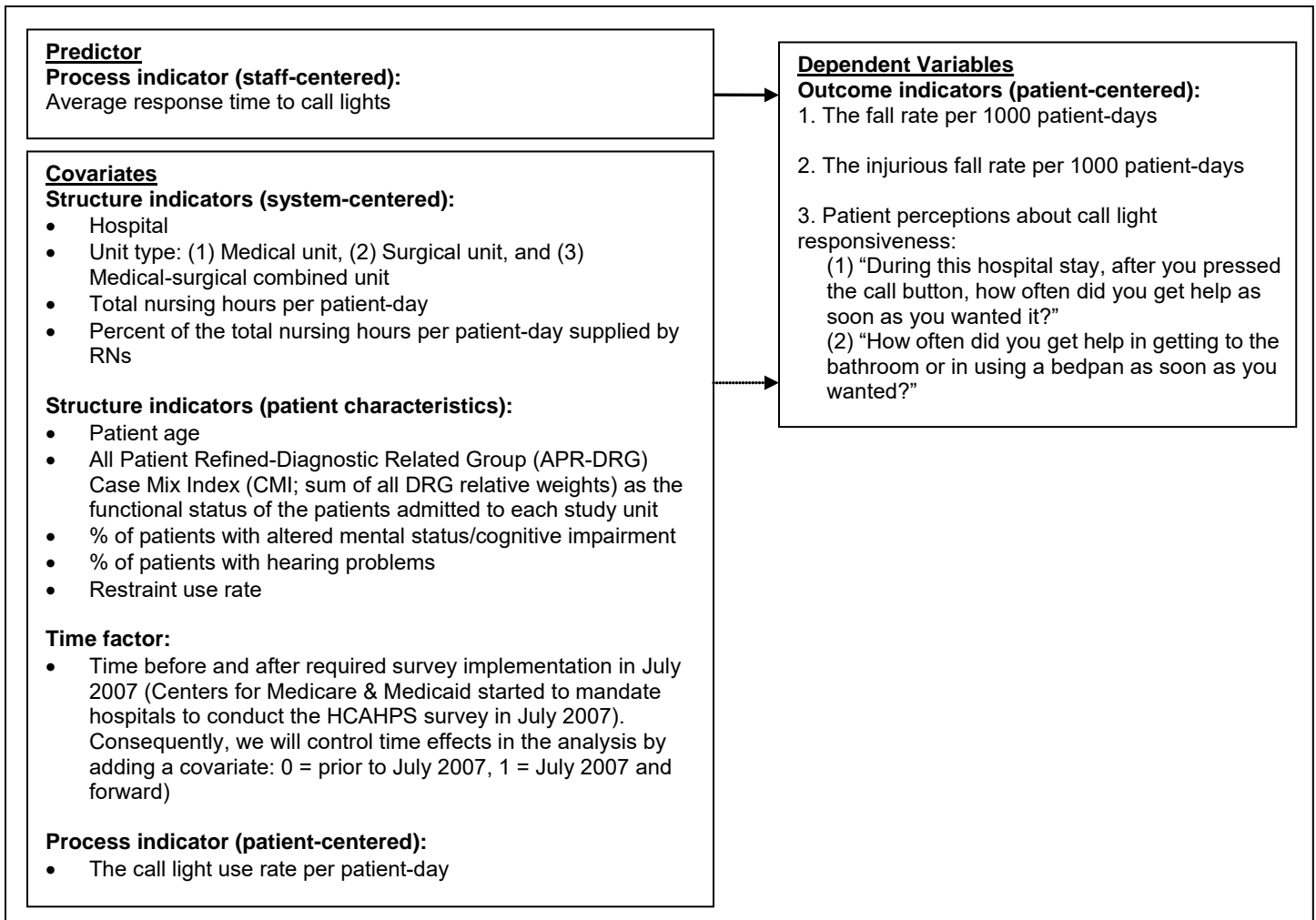


Figure 1. The conceptual model with a focus on staff's response time to patient- and family-initiated call lights for adult acute inpatient care units.

Methods

Study design

This exploratory study has been approved by the Institutional Review Boards of the study hospitals and the employed university. This project used archived hospital data/reports to achieve the Aims and was conducted at 28 acute adult inpatient care units from four hospitals: University of Michigan Health System (UMHS) (913 beds) (14 study units; 750 data points; from January 2004 to December 2008), St. Mary Mercy Hospital in Livonia (304 beds) (4 units; 92 data points; from February 2007 to December 2008), Beaumont Hospital in Royal Oak (1061 beds) (4 study units; 56 data points from April 2008 to May 2009), and Sparrow Health System in Lansing (697 beds) (6 study units; 165 data points; January 2006 to December 2008).

This study includes medical, surgical, and medical-surgical combined units and excludes critical care units. The patient care unit-month (abbreviated as unit-month) is the unit of analysis; in other words, the patient care unit is the unit of analysis with data aggregated by month for analyses. This study includes a total of 1063 data points.

Data sources and collection

This project uses archived hospital data/reports to address the three Aims and test the corresponding research hypotheses. The three hypotheses were tested using multiple regression analyses. The dependent variables for this study are 1) the total fall rate, 2) the injurious fall rate, 3) patients' perceptions about timeliness of call light responsiveness, and 4) patients' perceptions about accessing toileting assistance.

In each study hospital, a designated site coordinator (a hospital staff or administrator) was responsible for retrieving and storing the archived hospital data/reports as well as sending the data to the PI. All the retrieved archived hospital data/reports must be matched by (1) the hospital, (2) the patient care unit, and (3) the year/month (e.g., 200806 for June 2008). Detailed information about each database/report used in this project is described in **Table 1**.

The two primary dependent variables were the fall rate and the injurious fall rate. The fall rate was defined as the rate at which patients fell during their hospital stays/1000 patient-days. A fall was defined as an unplanned descent to the floor with or without injury. All falls types were included, whether falls resulted from physiologic or environmental causes. The operational definition of the fall rate was $(\text{number of total falls} \times 1000) / (\text{total patient-days})$. The injurious fall rate was defined as the fall rate/1000 inpatient-days during which physical injury occurred, regardless of severity. The operational definition of the injurious fall rate was $(\text{number of injury falls} \times 1000) / (\text{total patient-days})$ [9,10].

The primary predictor/independent variable was the average response time to call lights. These data were retrieved from the call light tracking system at each hospital. Patient/family-initiated calls made from the pillow speaker or call cord were categorized as normal calls. The response time was defined as the time that elapsed between a normal call activation to its cancellation from the patient room. The response times for "staff response" on the reports generated from the call light tracking system were aggregated at the unit level for each month and calculated as $(\text{call light response time in seconds for all the calls made for the unit and month}) / (\text{total number of calls for the unit and month})$. The operational definition of this variable was $(\text{sum of the call light response time for the calls in seconds}) / (\text{total call light use})$.

Note that the data on the percentages of patients with altered mental status and hearing problems came from chart review. Due to constrained resources, one data point by quarter for each patient care unit was collected. The percentages of patients hospitalized at the study unit on the 15th of the first month of each quarter who had cognitive impairment or altered mental status were calculated. As for the chart review procedure, the charts of 10 randomly sampled patients per study unit were reviewed by a trained research assistant. If altered mental status was identified at admission in the chart, the patient was coded as Yes (1); otherwise, No (0) was coded (**Table 1**).

For each study hospital, the patient management database was used to generate the total patient-days per unit-month. The daily count of total patient-days was the midnight census. The daily counts for a unit for a specified month were added up to indicate the total patient-days for that unit and month. The designated site coordinators calculated this variable (the total patient-days per unit-month) before sending the data to the corresponding author. Total patient-days per unit-month were used to compute the call light use rate per patient-day and fall and injurious fall rates.

Please note that three covariates (the percentages of patients with altered mental status, the percentages of patients with hearing problems, and the restraint use rate) were measured at the quarter level. The quarterly data were then entered into each corresponding unit-month; the same value was entered for each month of that quarter. As a study limitation, the data measured quarterly correlate highly from one month to the next.

Table 1 Study variables and definitions

	Data source	Conceptual definition	Operational definition
Dependent variables			
Fall rate	Incident reports/fall incident report database	The fall rate was defined as the rate at which patients fall during hospital stays/1000 patient-days [9]. A fall was defined as an unplanned descent to the floor with or without injury. All falls with or without any injuries are included, whether they result from physiologic or environmental causes [10]. Each hospital has its own form to document fall incidents. The counts of falls were done by month for each patient care unit.	$(\text{counts of total falls} \times 1000) / (\text{total patient-days})$
Injurious fall rate	Incident reports/fall incident report database	The injurious fall rate was defined as the fall rate/1000 inpatient-days at which physical injury occurs, regardless of severity [9]. Each hospital has its own form to document fall incidents. The counts of injurious falls were done by month for each patient care unit.	$(\text{counts of injury falls} \times 1000) / (\text{total patient-days})$
Patients' perceptions about timeliness of call light responsiveness	The Hospital Patients' Experience of Care Survey (HCAHPS) data	Patient perceptions are conceptualized as the timeliness of staff assistance in general in response to the call button. One HCAHPS patient satisfaction item was identified: "During this hospital stay, after you pressed the call button, how often did you get help as soon as you wanted it?" The scores were aggregated by month for each patient care unit.	This patient satisfaction item was measured on a 4-point Likert scale of "always," "usually," "sometimes," and "never." The aggregated scores were reported as positive score (the percentage of "always").
Patients' perceptions about accessing toileting assistance	The HCAHPS data	Patient perceptions are conceptualized as the timeliness of staff assistance for toileting in response to the call button. One HCAHPS patient satisfaction item was identified: "How often did you get help in getting to the bathroom or in using a bedpan as soon as you wanted?" The scores were aggregated by month for each patient care unit.	This patient satisfaction item was measured on a 4-point Likert scale of "always," "usually," "sometimes," and "never." The aggregated scores were reported as positive score (the percentage of "always").
Predictor			
Average response time to call lights	The reports generated from the call light tracking system adopted by each hospital	Patient/family-initiated calls made from the pillow speaker or call cord are categorized as normal calls. The response time was defined as the time elapsed from normal call activation to call cancellation from the patient room. The response times were aggregated at the unit level for each month, and calculated as (call light response time in seconds for all the calls made for the unit and month)/(total number of calls for the unit and month).	The average time for "Staff Response" on the reports generated from the call light tracking system was calculated as (sum of the call light response time for the calls in seconds)/(total call light use).

Covariates			
Hospital	As identified by each study hospital	Four hospitals served as study sites. This study used three dummy variables to capture four study hospitals, instead of hospital characteristics (e.g., bed size and teaching status), to control for the variations across study hospitals.	Three dummy variables were included in the regression model. Hospital 1 was used as a reference group; Hospital 2: 1 = Hospital 2, 0 = all other hospitals; Hospital 3: 1 = Hospital 3, 0 = all other hospitals; Hospital 4: 1 = Hospital 4, 0 = all other hospitals. When the values of Hospital 2, Hospital 3, and Hospital 4 = 0, Hospital 1 would be identified.
Unit type	As identified by each study hospital	The unit classification of each study unit, as designated by the hospital, was identified by the designated site coordinate. The unit type included three categories: (1) medical, (2) surgical, and (3) medical-surgical combined.	Two dummy variables were included in the regression model. Medical units were used as the reference group (unit type 2: 1 = surgical unit, 0 = all other units; and unit type 3: 1 = medical-surgical combined unit, 0 = all other units). When the values of unit type 2 and unit type 3 = 0, medical units would be identified.
Total nursing hours per patient-day (HPPDs)	The payroll database	As a system-centered measure, this was defined as the number of productive hours worked by nursing staff with direct care responsibilities per patient-day [9].	Total nursing hours/total patient-days
Percentage of the total nursing HPPDs supplied by registered nurses	The payroll database	As a system-centered measure, this was defined as the percentage of the productive nursing HPPDs worked by RNs with direct care responsibilities to the number of total productive nursing HPPDs worked by nursing staff with direct care responsibilities [9].	$(\text{Total nursing HPPDs supplied by RNs} / \text{total nursing HPPDs}) \times 100\%$
Patient age in percentage of patients aged ≥ 65 years	Patient management database	The percentage of all patients discharged from the study unit (alive or not) during the defined time period, who were ≥ 65 years.	$(\text{Sum of the years of the discharged patients in age} / \text{total discharged patients}) \times 100\%$
Case mix index (CMI)	Patient management database	CMI value mean of all patients discharged from the study unit during the defined time period represents the average diagnosis-related group relative weight for that unit-month. The CMI value is used to define the average acuity for patients admitted to a particular hospital [11].	$(\text{Sum of the CMI values of the discharged patients} / \text{total discharged patients}) \times 100\%$

Percentage of patients with altered mental status (quarterly data)	Chart review of the nursing notes at admission	<p>The percentage of patients hospitalized at the study unit on the 15th of the first month of each quarter who had cognitive impairment or altered mental status. The charts of 10 randomly sampled patients per study unit were reviewed. If any cognitive impairment or altered mental status was identified in the chart at admission, this patient was coded as Yes (1); otherwise, No (0) was coded. Each hospital has its own scale to document each patient's mental status on the paper chart (Sparrow Health System) or the electronic chart (UMHS, St. Mary Mercy Hospital, and Beaumont Hospital). Prior to chart review, the field to document each patient's mental status was identified by the coordinator at each of the study hospital and the PI together. Then, the information was abstracted from the identified field by the trained research assistants. The information on the charts may be subjective, because the nurse who admitted the patient documented the patient's mental status on the nursing note at admission. The same data collection method was used consistently on the sampled patients within each study hospital.</p>	(Number of patients with cognitive impairment or altered mental status/10) × 100%
Percentage of patients with hearing problem (quarterly data)	Chart review of the nursing notes at admission	<p>The percentage of patients hospitalized at the study unit on the 15th of the first month of each quarter, who had hearing problems. The charts of a total of 10 randomly sampled patients per study unit were reviewed. If any hearing problems (with or without correction) were identified in the chart at admission, this patient was coded as Yes (1); otherwise, No (0) was coded. Each hospital has its own scale to document each patient's hearing problem on the paper chart (Sparrow Health System) or the electronic chart (UMHS, St. Mary Mercy Hospital, and Beaumont Hospital). Prior to chart review, the field to document each patient's hearing problem was identified by the coordinator at each of the study hospital and the PI together. Then, the information was abstracted from the identified field by the trained research assistants. The information on the charts may be subjective because the nurse who admitted the patient documented the patient's hearing problem on the nursing note at admission. The same data collection method was used consistently on the sampled patients within each study hospital.</p>	(Number of patients with hearing problems/10) × 100%

Restraint use rate (quarterly data)		The percentage of patients with physical restraints (limb and vest) was a quarterly restraint prevalence of all inpatients with a limb and/or vest restraint in use on the day of prevalence study (assessed on 1 day every 3 months) [9].	(Number of patients with physical restraints/ total number of surveyed patients) × 100%
Time factor	As identified by each study hospital	Centers for Medicare & Medicaid started to mandate hospitals to conduct the HCAHPS survey in July 2007.	One dummy variable was included in the regression model: 0 = prior to July 2007, 1= July 2007 and forward
Call light use rate per patient-day	The reports generated from the call light tracking system adopted by each hospital	The normal call count will include all the calls either cancelled at the console or at the stations of origin (i.e., the patient rooms).	(Counts of normal calls/number of the covered days) × (total number of days for the month)/(total patient-days for the month) Due to the skewed distribution, this continuous variable was recorded into 10 equal groups and labeled in percentiles (10 = least frequent, 100 = most frequent). The recoded variable was analyzed as a continuous variable.

Statistical analyses

Separate multiple regression analyses were conducted to meet the aims. The covariates were entered into the multiple regression equation first. Then, the average call light response time was entered as a predictor into each model. Key outcomes of the analysis were the significance tests and estimates of regression coefficients for the average call light response time.

Results

Table 2 provides descriptive information on study variables for all data points and by hospital. The patient care unit-month was the unit of analysis. As an example of how the descriptive information was calculated in **Table 2**, the mean fall rate for Hospital 1 was calculated across all units within Hospital 1 and all months. The average total fall rate per 1000 patient-days was 4.08 (SD = 3.06), and the injurious fall rate per 1000 patient-days was 0.91 (SD = 1.11). The average call light response time was 13 minutes and 18 seconds; Hospital 1 had the longest average call light response time (mean, 17 minutes and 27 seconds), and the other three hospitals had comparable average response times within the range of 3 minutes and 7 seconds and 3 minutes and 10 seconds. In addition, a one-way between-group ANOVA was conducted to explore the differences of the study variables across the four hospitals (**Table 2**). All the one-way ANOVA tests were statistically significant, indicating that there were differences in the study variable means across study hospitals.

Table 2 Descriptive information of study variables by hospitals and results of one-way between-group analysis of variance (ANOVA) tests on differences of means across four hospitals

Variable\Mean (SD)	Hospital ^a					One-way ANOVA tests (p)
	All (n = 1063)	1 (n = 750)	2 (n = 92)	3 (n = 56)	4 (n = 165)	
Total fall rate/1000 patient-days	4.08 (3.06)	4.29 (3.24)	3.87 (2.13)	2.96 (1.96)	3.60 (2.78)	F = 5.23** (p = 0.001)
Injurious fall rate/1000 patient-days	.91 (1.11)	.97 (1.15)	.36 (.68)	.76 (.71)	1.01 (1.17)	F = 9.22** (p < 0.001)
Total productive nursing hours/patient-day	9.23 (2.23)	10.02 (2.09)	5.17 (.99)	9.05 (.73)	8.30 (.66)	F = 217.19** (p < 0.001)
Percentage of productive nursing hours provided by RNs	72.90% (8.95)	76.82% (6.82)	58.37% (2.83)	58.87% (2.85)	68.05% (4.36)	F = 413.00** (p < 0.001)
Percentage of patients aged ≥65 years	35.93% (16.40)	30.13% (13.53)	66.58% (9.18)	47.70% (7.75)	38.10% (8.28)	F = 263.99** (p < 0.001)
Average CMI value	1.76 (.72)	1.95 (.78)	1.30 (.24)	1.52 (.35)	1.31 (.26)	F = 59.36** (p < 0.001)
Percentage of patients with altered mental status at admission (quarterly data)	9.93% (11.91)	7.18% (8.71)	25.11% (16.14)	21.61% (19.33)	8.39% (7.16)	F = 106.94** (p < 0.001)
Percentage of patients with hearing difficulties at admission (quarterly data)	11.33% (10.96)	13.08% (11.19)	10.87% (10.96)	8.57% (9.42)	5.16% (7.59)	F = 24.93** (p < 0.001)
Call light use rate per patient-day	6.43 (5.32)	6.83 (6.03)	4.17 (2.02)	4.78 (2.85)	6.40 (2.55)	F = 8.72** (p < 0.001)
Patient call light use rate/patient-day (in 10 equal groups; 10 = least frequent, 100 = most frequent)	54.85 (28.30)	58.20 (30.00)	33.80 (14.96)	40.71 (18.08)	56.12 (21.74)	F = 27.09** (p < 0.001)
Call light response time in sec as well as in min and sec	798.34/ 13 min 18 sec (3909.11)	1047.30/ 17 min 27 sec (4604.87)	190.40/ 3 min 10 sec (61.35)	186.92/ 3 min 7 sec (30.11)	167.59/ 3 min 8 sec (55.49)	F = 3.50* (p = 0.02)
Call light response time (in 10 equal groups; 10 = fastest, 100 = slowest)	54.74 (28.60)	58.54 (28.76)	50.65 (27.53)	48.93 (18.46)	41.16 (27.80)	F = 18.26** (p < 0.001)

^a Values are means (SD).

*p < 0.05; **p < 0.01.

Table 3 contains the descriptive information of the study hospitals by unit types. As an example of how the descriptive information in **Table 3** was calculated, the mean fall rate for medical units was calculated across all medical units (from all four hospitals) and all months. The one-way ANOVA tests showed that only the means of the percentage of productive nursing hours provided by RNs and the staff call light response times (both the original variable and the recoded 10-percentile variable) were not significantly different across unit types (alpha was set at 0.05). Additional descriptive analysis was conducted on the total fall rate, injurious fall rate, and response time to call lights to observe the extent these three variables varied from month to month within the same study unit. The unit means ranged from 0.00 to 6.09 for the total fall rate per 1000 patient-days, 0.00 to 1.80 for the injurious fall rate per 1000 patient-days, and 119.13 to 5233.33 seconds for the average response time to call lights. The unit standard deviations ranged from 0.00 to 3.58 for the total fall rate per 1000 patient-days, 0.00 to 1.59 for the injurious fall rate per 1000 patient-days, and 12.72 to 17150.83 seconds for the average response time to call lights.

Table 3 Descriptive information of study variables by unit types and results of one-way between-group analysis of variance (ANOVA) tests on differences of a means across three unit types

Variable\Mean (SD)	Unit type ^a			One-way ANOVA tests (<i>p</i>)
	Medical (n = 531)	Surgical (n = 166)	Med-surgical combined (n = 366)	
Total fall rate/1000 patient-days	4.52 (3.14)	3.26 (2.73)	3.82 (2.97)	F = 13.14** (<i>p</i> < 0 .001)
Injurious fall rate/1000 patient-days	1.03 (1.13)	.74 (1.04)	.81 (1.09)	F = 6.54** (<i>p</i> = 0.002)
Total productive nursing hours/patient-day	9.59 (1.69)	8.12 (1.47)	9.27 (3.05)	F = 26.62** (<i>p</i> < 0 .001)
Percentage of productive nursing hours provided by RNs	72.87% (6.89)	71.80% (12.49)	73.45% (9.61)	F = 1.94 (<i>p</i> = 0.14)
Percentage of patients aged ≥65 years	39.09% (18.84)	35.90% (10.35)	31.28% (13.64)	F = 22.98** (<i>p</i> < 0 .001)
Average CMI value	1.87 (.84)	1.88 (.46)	1.52 (.56)	F = 26.15** (<i>p</i> < 0 .001)
Percentage of patients with altered mental status at admission (quarterly data)	10.19% (11.26)	7.53% (8.42)	10.77% (14.02)	F = 4.32* (<i>p</i> = 0.01)
Percentage of patients with hearing difficulties at admission (quarterly data)	12.53% (11.76)	8.92% (10.45)	10.83% (9.75)	F = 7.29** (<i>p</i> = 0.001)
Call light use rate/patient-day	6.00 (3.11)	5.85 (2.70)	7.29 (7.98)	F = 7.39** (<i>p</i> = 0.001)
Patient call light use rate/patient-day (in 10 equal groups; 10 = least frequent, 100 = most frequent)	53.20 (28.85)	51.02 (22.53)	58.96 (29.41)	F = 6.34** (<i>p</i> = 0.002)
Call light response time in sec as well as in min and sec	599.33/ 9 min 59 sec (3359.26)	548.26/ 9 min 8 sec (1385.52)	1196.54/ 19 min 57 sec (5183.10)	F = 2.86 (<i>p</i> = 0.06)
Call light response time (in 10 equal groups; 10 = fastest, 100 = slowest)	54.24 (28.54)	52.55 (29.16)	56.44 (29.68)	F = 1.19 (<i>p</i> = 0.30)

^a Values are means (SD).

P* < .05; *P* < .01

The principal findings by aims are summarized below.

Findings of Aim 1 (to examine the unique contribution of call light response time in predicting fall rates) and Aim 2 (to examine the unique contribution of call light response time in predicting fall related injuries). We found that faster call light response time was associated with lower total fall and injurious fall rates. Units with a higher call light use rate had lower total fall and injurious fall rates. A higher percentage of productive nursing hours provided by registered nurses was associated with lower total fall and injurious fall rates. For patient characteristics, the findings were not consistent. A higher percentage of patients with altered mental status was associated with a higher total fall rate but not a higher injurious fall rate. Units with a higher percentage of patients aged 65 years or older had lower injurious fall rates.

It is concluded that faster call light response time appeared to contribute to lower total fall and injurious fall rates, after controlling for the covariates. For practical relevance, hospital and nursing executives should consider strategizing fall and injurious fall prevention efforts by aiming for a decrease in staff response time to call lights. Regular monitoring of response time should be a priority [12].

In addition, we found that a higher restraint use rate was associated with a higher total fall rate but a lower injurious fall rate. Our findings challenge the suggested practice in the current US regulations restricting the use of hospital restraints. Additional research is needed to evaluate whether restraint use may separate fallers without injuries from fallers with injuries in adult inpatient acute care settings [13].

Findings of Aim 3 (to examine the unique contribution of call light response time in predicting patients' perceptions about a) timeliness of call light responsiveness and b) accessing toileting assistance). We found that faster call light response time by staff would contribute to higher patient satisfaction of the timeliness of call light responsiveness. Being on a surgical unit, having a lower percentage of patients with altered mental status at admission, having a higher percentage of patients with hearing problems, and having faster call light response time by staff would lead to higher patient satisfaction about timeliness of call light responsiveness. Also, being Hospital 1 and Hospital 2, being a surgical unit, having a higher percentage of patients aged 65 years or older, and having a lower percentage of patients with altered mental status at admission would lead to higher patient satisfaction about accessing toileting assistance. It is possible that the needs of patients younger than 65 years and the ones with altered mental status may vary, which may lead to their perceptions of the timeliness of accessing toileting assistance. Some common findings are found; the nurse-staffing structure indicators (total nursing HPPDs and percentage of the total nursing HPPDs supplied by RNs), time factor, and patient-centered process indicator (call light use rate) were not significant predictors of patients' perceptions about timeliness of call light responsiveness and accessing toileting assistance.

It is concluded that faster staff call light response time would contribute to higher patient satisfaction about timeliness of call light responsiveness but would not contribute to the levels of patients' perceptions about accessing toileting assistance. This study verified the use of staff's call light response time generated from hospital-archived call light tracking systems in predicting patient satisfaction about timeliness of call light responsiveness [14].

Limitations

Having the patient care unit-month as the unit of analysis is recognized as one of the study limitations. The reason is that some interdependence for the data points from a single unit and for the data points from the units from the same hospital existed. For statistical analyses and interpretation of results, each data point for a study unit was assumed to be independent from each other. Three covariates (the percentages of patients with altered mental status, the percentages of patients with hearing problems, and the restraint use rate) were measured at the quarter level; the data measured quarterly correlate highly from one month to the next. In addition, the differences between patients, between units, and between hospitals in the study variables were not the focus of this study and were not explored in this project as a limitation. To increase sample size, this study included data points from different time periods across four study hospitals, which is another study limitation.

List of Publications and Products (* denotes the corresponding author)

Published and in press:

Tzeng HM. Influence of patients' mental status as an issue related to inpatient falls in adult acute care settings. *J Adv Nurs* 2010;66(8):1741-1746 (SCI, SSCI).

Tzeng HM*, Larson J. Exploring the relationship between patient call-light use rate and nurse call-light response time in acute care settings. *Comput Inform Nurs* 2011;29(4 Suppl):TC75-80 (SCI, SSCI).

Tzeng HM*, Ronis D, Yin CY. Relationship of actual response time to call lights and patient satisfaction at 4 US hospitals. *J Nurs Care Qual* 2012;27(2) (SCI, SSCI). Accepted for publication on 2011/10/09.

Conference abstract (peer-reviewed conference):

Tzeng HM (Presenter), Ronis DL, Yin CY (April 14, 2012). The unique contribution of staff's call light response time to fall and injurious fall rates: An exploratory study in four US hospitals using archived hospital data. Abstract (oral/paper presentation) accepted to be presented at the 2012 Midwest Nursing Research Society (MNRS) Annual Research Conference in Dearborn, Michigan.

Paper under review (peer-reviewed journal):

[12] Tzeng HM*, Titler M, Ronis D, Yin CY. The unique contribution of staff's call light response time to fall and injurious fall rates: an exploratory study in four US hospitals using archived hospital data. *BMC Health Serv Res*. Under Review.

[13] Tzeng HM*, Yin CY. To clarify the relationship between the physical restraint use rate and total fall and injurious fall rates in two acute hospitals in US. *J Adv Nurs*. Under Review.

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