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Keeping patient beds in a low position: An exploratory descriptive study to continuously monitor the height of patient beds in an adult acute surgical inpatient care setting

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Abstract

This descriptive study was intended to measure the percentage of the time that patient beds were kept in high position in an adult acute inpatient surgical unit with medical overflow in a community hospital in Michigan, United States. The percentage of the time was calculated for morning, evening, and night shifts. The results showed that overall, occupied beds were in a high position 5.6% of the time: 5.40% in the day shift, 6.88% in the evening shift, and 4.38% in the night shift. It is recognized that this study was unable to differentiate whether those times patient beds being kept in a high position were appropriate for an elevated bed height (e.g., staff were working with the patient). Further research is warranted. Falls committees may conduct high-bed prevalence surveys in a regular basis as a proxy to monitor staff members' behaviors in keeping beds in a high position.

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INTRODUCTION

Hartford Institute for Geriatric Nursing (2008) and the Joint Commission (2007) suggested that nursing managers should adopt very low bed levels to ensure patients' safety as they get in and out of bed. If very low beds are not available, patient beds should be kept in the lowest position possible. Failing to keep patient beds in the lowest position in acute care units may cause patients to fear falling or lead to falls when they get in and out of bed (Roubenoff & Wilson, 1993; Tzeng & Yin, 2006, 2007, 2008a). A recent study (Tzeng & Yin, 2008b) found that 26.5% of patients who had a fall during a hospital stay fell from their bed, and 3.6% fell over rails, footboards, or headboards. One study (Tzeng, 2010) found that more than 50% of the falls that occurred in acute inpatient care settings were associated with an activity at the bed and 56% of injurious falls occurred while the patient was getting out of or back into a bed. Another study (Tzeng & Yin, 2009) found that recently discharged older adults and their family members reported that hospital beds were often so high that when patients were getting out of bed, their feet dangled above the floor. Family members emphasized that it is essential for staff members to bring patient beds to the lowest level after they have finished providing care. In other words, staff's noncompliance with a safety standard of keeping patient beds in the lowest position has risen as a concern that may jeopardize patients' safety during hospital stays.

The appropriate height of a hospital bed in the horizontal position is at the patient's knee height; the average knee height for males is 21.3 inches and the average knee height for females is 19.49 inches (Roubenoff & Wilson, 1993). The height of hospital bed frames plus the thickness of the mattress is 18 to 22 inches or higher (Tzeng & Yin, 2006) which indicates patient beds would be close to the average knee height. If kept at the lowest position, it would ensure safe transfer into or out of the bed (Tzeng & Yin, 2008a).

One study (Tzeng & Yin, 2008c) based on the bed height measurements taken 3 times a day in a 32-bed, adult inpatient, acute medical unit ($n = 288$ measurements) found that the average staff working-height measurement was 25.54 inches (SD = 1.94; range: 23–37.20 inches). The bed height measurements were taken only on occupied patient beds when clinicians and staff members were not delivering bedside care, and were taken on two weekdays and one weekend day at three pre-determined time points on each day. The mean staff working-height measurement was 25.35 inches (SD = 1.66) in the morning (9:30 a.m. to 10:30 a.m.), 25.90 inches (SD = 2.50) in the afternoon (1:30 p.m. to 2:30 p.m.), and 25.38 inches (SD = 1.45) in the evening (6:30 p.m. to 7:30 p.m.). However, there was no statistically significant difference in the staff working-height measurements taken at different times (morning, evening, and night shifts) (Tzeng & Yin, 2008c). To further understand the percentage of the time patient beds being kept in a high position, continuous monitoring of the staff working height for patient beds is needed.

Purpose of the study

This descriptive study was intended to measure the percentage of the time patient beds were kept in high position in an adult acute inpatient surgical unit with medical overflow in a community hospital in Michigan, United States. The percentage of time that patient beds were kept in a high position was calculated for morning (7:00 a.m. to 3:00 p.m.), evening (3:00 p.m. to 11:00 p.m.), and night (11:00 p.m. to 7:00 a.m.) shifts.

We assumed that staff members are the primary ones who will adjust the overall height of the beds, because the height-adjustment controller is located at the foot board of the beds and is not accessible to patients when they are lying on their beds. Family members can access the height-adjustment controller and adjust the overall height of the beds if they are aware of the location of the controller. In addition, the percentage of the time patient beds being kept in a high position was proposed as a proxy to indirectly comprehend staff members' behaviors, awareness and compliance in keeping beds in a low position. The authors recognized that this study was unable to differentiate whether those times patient beds being kept in a high position were appropriate for an elevated bed height (e.g., staff were working with the patient).

METHOD

Design

Study site and study period—This exploratory descriptive study was intended to measure the percentage of time patient beds were kept in a high position in an adult inpatient acute surgical unit with medical overflow in a community teaching hospital located in Michigan (a nonprofit teaching hospital with 304 beds, including 9 inpatient care units). The study unit, which included 52 beds, was identified by the Chief Nurse Officer of the study hospital, because it is located on the highest floor (the 5th floor) of the building where all inpatient care units were housed and the bed-height sensors would have least interferences, if any, on the medical equipment currently being used in the hospital. The director of the information technology department of the study hospital evaluated the sensor prototype and confirmed that the sensors had minimum interferences with the medical equipment currently being used in the hospital.

The alpha prototype of the bed-height sensor network was tested in the study unit from September 2010 to April 2011. The entire unit started using Stryker S3 beds (Stryker Corporation, Kalamazoo, Michigan) on June 7, 2010 (all the beds were Stryker S3 beds, except for bariatric). Fifteen bed sensors were deployed on Stryker S3 beds. Stryker S3 beds have builtin, high-bed alert lights located at the two lower corners of the foot board as one of the local bed system monitors. Staff members had control to turn on or off this high-bed alert function; the controller was located on the foot board. If the high-bed alert function of a patient bed was on and this bed was not kept in the lowest position, two high-bed alert lights would flash. Due to multiple adjustments of the bed-height sensors, only the data collected from January 20, 2011 to February 19, 2011, were included in the analysis as a study limitation.

This interdisciplinary collaborative pilot project included members of faculty and undergraduate and graduate students from the disciplines of nursing as well as computer science and engineering. This project was approved by the institutional review boards of the study hospital and the corresponding author's home university.

The bed-height sensor network used to measure bed height—The alpha prototype of the bed-height sensor network, composed of 15 wireless sensors, was developed to measure and record bed height, with the intention of studying staff adherence to keeping beds in a low position as a fall prevention strategy. This system generates computerized reminders to enhance staff adherence to bed height recommendations. A sensor located under each bed collects bed height measurement and sends information through a wireless relay to a central touch-screen computer in the nurse's station that displays the state of the bed.

Bed height was measured every 10 minutes. The lowest height of the beds used in the study unit was 24 inches from the floor to the top of the mattress. The top of the bed frame to the floor measures 17 inches and the mattress height is 7 inches. If a bed height was 26 inches (2 inches above the lowest height) or higher in two consecutive measurements, staff would be notified by a blinking yellow alert on the central computer. If a bed was left high for more than 30 minutes, the on-screen high bed alert turned red to indicate noncompliance. The rationale for the time limits was based on a staff member elevating a patient bed to perform a treatment or procedure; a staff member may spend about 30 minutes (estimated) at bedside. Therefore, noncompliance was not issued within 30 minutes after a high bed alert was generated, but rather 50 minutes from the time a high bed was detected.

After the alpha prototype of the bed-height sensor network was finalized and deployed, four staff education sessions about the network were conducted by the trained research assistant with a nursing background. Three of the staff education sessions were held in mid-September 2010 and a refresher session was given on mid-December 2010. Licensed and unlicensed assistive nursing personnel participated in the education sessions, with their participation counting toward their on-job training hours. Staff members were requested, but not required to respond to high bed alerts. Only 15 out of the 52 beds had bed sensors.

Data source and collection

The information used to calculate the percentage of the time patient beds were kept in a high position was abstracted from the data collected by the bed-height sensor network: bed sensor identification number, patient bed identification number, date and time each sensor was activated, date and time each sensor was off or reassigned to anther bed, and bed height measurements (26 inches or higher versus lower than 26 inches).

The information of the date and time each sensor was activated, the date and time each sensor was off or reassigned to anther bed, and the bed height measurements were used together to calculate the total number of minutes a bed sensor was active and the time patient beds were kept in a high position. For example, if a low bed measurement was reported by the sensor at 10:01 a.m., a high bed measurement at 10:11 a.m., and a low bed measurement at 10:21 a.m., 10 minutes would be recorded for the time a patient bed was kept in high position. Unless the sensor was off or reassigned to another bed, the time a patient bed was kept in high position would be in 10-minute increments.

Only the data collected from occupied beds were included in the analyses. Whether the bed height measurements were taken from occupied beds was determined by the information (patient bed identification number, dates, and times) documented in the bed management database provided by the study hospital.

The percentage of the time that patient beds were kept in the high position was calculated. The operational definition of the percentage of the time that patient beds were kept in the high position was (total number of minutes a bed was kept in a high position) $\times$ 100/(total number of minutes a bed sensor was active). The mean value of the percentage of the time each patient bed was kept in the high position was calculated by using all data points and by shift. Three shifts were included: morning (7:00 a.m. to 3:00 p.m.), evening (3:00 p.m. to 11:00 p.m.), and night (11:00 p.m. to 7:00 a.m.) shifts. The staff members of the study unit and the other units within the study hospital worked on 8-hour shifts or 12-hour shifts. We chose to look at three 8-hour shifts because this choice offered more observation points within a day.

Data analyses

The abstracted data collected by the bed-height sensor network were entered into the Statistical Package for the Social Sciences (SPSS ver. 19.0 for Windows; SPSS, Chicago, IL, USA). Descriptive analyses (mean, standard deviation, maximum, and minimum) were calculated using all data points and by morning, evening, and night shifts.

RESULTS

During the study period from January 20 to February 19, 2011, 30 cases (independent records) with a different combination of bed sensor identification number, patient bed identification number, and time frame (a period of time during the study period) were identified and included in the analysis. For illustration purpose, Sensor 1 was first deployed on the patient bed identification number A. A few days later, Sensor 1 was removed for maintenance. Sensor 1 was deployed again to the patient bed identification number B. In this example, two cases with two unique combinations of bed sensor identification number, patient bed identification number, and time frame were identified. Note that a sensor may be removed from a designated bed because the patient bed itself needed maintenance. Also, each case with a unique combination of bed sensor identification number, patient bed identification number, and time frame may include multiple patients because the average length of stay of the patients discharged from the study unit was 4 to 5 days.

Beds were designated as occupied for a total of 257,273 minutes (4,287.88 hours) when sensors were active. The monitored beds were in a high position, defined as 26 inches or higher from the floor to the top of the mattress, for a total of 14,412 minutes (240.2 hours).

Overall, occupied beds were in a high position for 5.6% (range: 0%–67.18%) of the time. With regard to the bed height differences across shifts, occupied beds were left in a high position for 5.40% (range: 0% – 63.57%) of the time in the day shift; 6.88% (range: 0%–87.53%) of the time in the evening shift, and 4.38% (range: 0%–50.63%) of the time in the night shift.

As an exploratory descriptive study and for illustration purpose, the actual bed height measurements were generated on the 30 cases. The average bed height measurement for occupied beds were 25.04 inches (range: 24–29.6), 24.76 inches (range: 24–29.53) in the day shift, 25.50 inches (range: 24–34.08) in the evening shift, and 24.87 inches (range: 24–28.12) in the night shift. Note that the bed height in the lowest position was 24 inches from the top of the bed frame to the floor.

DISCUSSION

Study limitations

The data used in this study were collected while pilot testing the feasibility of the alpha prototype of the bed-height sensor network. Therefore, there are no comparative data for before and after deploying the sensors. Due to lack of comparative data, this study did not link the percentage of the time patient beds were kept in high position with bed-related fall and injurious fall occurrences. This study found a limited number of high beds and the reason might have been the staff members' learning about the Stryker beds. However, no data are available to support this presumption.

Discussion of the findings

The findings of this descriptive study suggested that despite the sensors were installed in the beds at an earlier time, yet there were occupied beds still in a high position for 5.6% of the

time. In other words, more than 1 out of every 20 occupied beds were kept in a high position at any time point, averaging about 80 minutes per occupied bed per patient day. Patient beds were left in a high position more often during the evening shift (6.88%), followed by the day shift (5.40%) and night shift (4.38%). The authors recognized that this study did not have comparison information to know whether 5.6% is an appropriate amount of time considering the care provided to the patients. Further research is warranted.

Could family presence be a possible factor in the beds being high in the evening? The study of the prevalence of non-staff visitor presence in two adult acute inpatient medical care settings of a Michigan teaching medical center conducted by Tzeng and Yin (2011) found that the prevalence of family presence during the evening hours (7:00–8:30 p.m.;32.1–33.7%) was comparable with the ones during the morning (9:00–10:30 a.m.;34.9–34.5%) and afternoon hours (2:00–3:30 p.m.;33–31.8%). The proposition that family presence could be a possible factor in the beds being high during evening shift was not supported by Tzeng and Yin's ()[11] study and needs further research.

In contrast to the day and evening shifts, the night shift had the lowest percentage of time patient beds were kept in a high position. The possible reasons are that in the night shift, patients are often asleep and few treatments and procedures that require elevating patient beds are conducted.

The aforementioned findings were not consistent with the findings of the study conducted by Tzeng and Yin (2008c), which showed that the mean staff working-height measurement taken in the afternoon (1:30 p.m. to 2:30 p.m.) was the highest (mean = 25.90 inches), followed by the one taken in the evening (6:30 p.m. to 7:30 p.m.; mean = 25.38 inches) and the one taken in the morning (9:30 a.m. to 10:30 a.m.; mean = 25.35 inches). This inconsistency may be due to different research designs and different practice cultures in the study units between Tzeng and Yin's study (2008c) and the current study.

When comparing the maximum values of the percentage of the time patient beds were kept in a high position by shift, the same pattern existed. The maximum values were highest in the evening shift (87.53%), followed by the day shift (63.57%) and the night shift (50.63%). In addition, the ranges of the percentage of the time patient beds were kept in a high position by shift were noteworthy. For example, when we included the data from all three shifts, occupied beds were in a high position for 5.6% of the time with a range from 0% to 67.18%. This finding suggested that the majority of the occupied beds were kept in a low position and the outliers (the ones with high percentages) can be the evidence of poor compliance which require further investigation. Additional research is warranted to further explore the reasons why some patient beds were kept in a high position in more than, such as, 50% of the time (eg, patient preferences, staff practice pattern).

Practical implications

Hospitals' falls committees and quality improvement initiatives for preventing bed-related injurious falls should focus on improving staff members' adherence to keeping beds in the lowest position possible (Hartford Institute for Geriatric Nursing, 2008; Joint Commission, 2007). Falls committees may consider conducting prevalence surveys of occupied patient beds left in a high position in a regular basis, such as one day per month or per quarter at two predetermined time periods of a day. Occupied beds, whether or not patients are lying on them, should be measured from floor to the top of the bed frame. This bed frame location should be pre-determined by the falls committee; this location should not move up or down when changing the position of the head or foot portion of the bed but will be elevated or lowered when adjusting the overall bed height. The measurement should not be taken if a

nurse or physician is at the bedside, such as, implementing procedures or administering medications or treatments.

A successful example which supports the aforementioned notion can be found in the study of the effect of implementing an inpatient fall prevention initiative in a tertiary care hospital conducted by Weinberg and associate (Weinberg et al., 2011) Four years after implementing this initiative, a significant reduction in the total fall rates (63.9% decrease), the minor fall related injury rates (54.5%), and the moderate fall-related injury fall rates (64%) was found. Prior to the implementation of this initiative, poor compliance with protocols was identified as one of the system dysfunctions. Three steps were taken to resolve this dysfunction: 1) tracking the fall rate by patient care unit and shared the trend with staff and nurse managers (outlier units were identified for focused reviews); 2) reviewing fall incidents in details with staff and nurse managers to identify the areas when it was evident that protocols were not being followed; and 3) offering counseling to the individual staff identified as breaching protocols. In addition, daily fall prevention rounds to assess new admission and ensure that appropriate fall risk assessments were completed and appropriate prevention measures were implemented by staff. These strategies led to improved staff accountability to follow fall prevention protocols and reduced incidents of falls occurring due to policy breaches (Weinberg et al., 2011).

CONCLUSION

This study concluded that occupied beds were kept in a high position about 80 minutes per occupied bed per patient day. Patient beds were left in a high position more often during the evening shift, followed by the day and night shifts. To prevent hospital-acquired injuries related to falls, it is important for hospitals to monitor staff members' compliance with keeping patient beds in a low position at all times. Falls committees may consider conducting prevalence surveys of all patient beds left in a high position in a regular basis as a proxy to monitor staff members' compliance.

Acknowledgments

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