Article

Understanding Design Vulnerabilities in the Physical Environment Relating to Patient Fall Patterns in a Psychiatric Hospital: Seven Years of Sentinel Events

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Abstract

BACKGROUND: The influence of the physical environment on patient falls has not been fully explored in psychiatric units, despite this patient population's vulnerability and the critical role of the physical environment in patient safety. **AIMS:** The research objective is to describe the spatial and temporal pattern of falls occurrences and their location in relation to the levels of safety continuum model. **METHOD:** This article presents an exploratory case study design. Seven years of retrospective data on patient falls, yielding 818 sentinel events, in an 81-bed psychiatric hospital in the United States were collected and analyzed. Data focused on extrinsic factors for falls, emphasizing the physical environment. Through a content analysis of the sentinel event narratives, recorded by the hospital staff, this study explored patient falls related to location and elements of the physical environment. **RESULTS:** The analysis revealed that 15% of recorded falls were attributed to some aspect of or element within the physical environment. The most typical locations of falls were patient rooms (39%), patient bathrooms (22%), and dayrooms (20%). Also, the results identified patterns of environmental factors that appeared linked to increasing patients' susceptibility to falls. Risk factors included poor nighttime lighting, flooring surfaces that were uneven, and spaces that inadvertently limited visual access and supervision. **CONCLUSIONS:** The physical environment plays an often-unexamined role in fall events and specific locations. These results are deserving of further research on design strategies and applications to reduce patient falls in psychiatric hospital settings.

Keywords

patient falls, psychiatric hospital, environmental design, evidence-based design, physical environment, work system

Introduction

Patient safety in health care settings is a well-recognized priority for health care organizations (Agency for Healthcare Research and Quality, 2013; Joint Commission, 2014, 2015). Fall prevention essentially links to patient safety (Ulrich et al., 2008), since a fall resulting in an injury within a hospital setting may complicate the health status, length of stay, or result in additional heath complications of patients, adversely affecting the quality of care and health care utilization (Agency for Healthcare Research and Quality, 2013). Research shows 30% of falls occurring in hospital settings lead to physical injuries and additional treatments, which is problematic for the patient and increases hospitalization costs (Lavsa, Fabian, Saul, Corman, & Coley, 2010). For falls resulting in a more severe injury, such as a hip or pelvic fracture or upper extremity fracture, the average the length of the hospital stay increases 6 to 12 days. This can increase hospital costs up to $35,561 (Wong et al., 2011).

In 2008, the U.S. Department of Health and Human Services' Centers for Medicare & Medicaid Services (CMS) initiated changes to reimbursements received by hospitals to incentivize patient safety and quality care. This change followed the release of the Institute of

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Medicine's findings on high-frequency events that threatened patient safety during hospitalization (Inouye, Brown, & Tinetti, 2009). This prompted CMS to develop a list of high-cost and high-volume patient risks within hospital settings; in 2013, this list grew from 8 to 14 concerns, with patient fall risks remaining a central concern (CMS, 2015). In other words, hospital administrators are expected to seek and implement preventive measures to reduce or eliminate patient falls and are in jeopardy for not being reimbursed for treating patient fall outcomes that require additional treatment.

The call for inquiry on psychiatric patient falls is compelling, given the high fall risk of this vulnerable population. Psychiatric patients are estimated to experience falls at a higher rate than other hospitalized adults; indeed, 13 to 25 falls per 1,000 inpatient days compared with other adult patients in medical–surgical units (Blair & Gruman, 2005). Unlike most adult inpatients in medical–surgical units, psychiatric patients are typically not limited to their beds, which in itself is a contributor to falls. In addition, psychiatric patients may be more likely to be prescribed sedating drugs that elevate the potential for falling, whereas medical–surgical patients require fewer sedative drugs with side effects linked with fall risks. There is strong evidence linking psychiatric patient falls to psychotropic medications (Estrin, Goetz, Hellerstein, Bennett-Staub, & Seirmarco, 2009). In fact, falls can increase by 78% when antipsychotic drugs are taken (Bloch et al., 2014). Another study by Williams et al. (2015) showed that diagnoses such as depression and anxiety per se are not significant fall contributors; however, psychotropic medication, antidepressant, and benzodiazepine use are linked to patient falls. Difficulties in maintaining balance and other side effects of psychotropic drugs increase the risk of falls, and include sedation, confusion, balance issues, difficulty in neuromuscular coordination, and changes in vision, blood pressure, and cardiac rhythm (Howland, 2009). Other factors contributing to patient falls can be those stemming from aggressive, agitated behavior, rapid movements among manic patients, suppressed movements, including gait changes, typical of clinically depressed patients (Morse, 2008).

Among the many factors associated with falls, the role of the physical environment is deserving of close study. A longitudinal study from 1995 to 2003 by the Joint Commission attributed 44% of patient falls to the physical environment (Hignett & Masud, 2006). While experts encourage promoting a safety culture within the hospital, patient care in health care environments can suffer from factors including caregiver workload, inconsistencies in communication related to patient data, and even inadvertent limitations posed by the design of the facility. In fact, some argue that the physical environment can be more influential in improving patient safety in hospitals when compared with creating a safety culture alone (Lopez, Gerling, Cary, & Kanak, 2010). For these reasons, all influential fall factors should be considered as ways to ensure patient safety.

From a work system standpoint, the physical environment is a component of a larger system including people and organizations, as described in a model developed by Systems Engineering Initiative for Patient Safety, which aims to improve patient safety through synergies between (a) organization, (b) person, (c) technology, (d) tasks, and (e) the physical environment (Carayon et al., 2006). Guided by the work system approach, a study by Taylor and Hignett (2016) systematically reviewed the body of literature on inpatient falls and classified patient fall contributors into intrinsic and extrinsic factors. The overarching themes under extrinsic category include those related to the environment (workspace envelope, personal workspace, products, and ambient environment), organization (staffing and maintenance), and people (patients and staff); the intrinsic categories were related to physiological and psychological conditions of patients, which includes the extrinsic physical environment, people, and organization (Taylor & Hignett, 2016). This generated a framework for understanding falls in hospital settings called SCOPE of falls, which is theoretical model categorizing falls such that environmental factors, in addition to people and organization, are one of the main factors involved in fall events.

The role of the environment on falls has not been well studied in inpatient psychiatric settings where the care dynamics significantly differ from other inpatient settings (Shepley & Pasha, 2013). Therefore, this study aims to describe the spatial and temporal patterns of falls occurrences, their location along the levels of safety continuum, and the role of the physical environment on falls.

Method

Design and Setting

A case study method, using quantitative and qualitative data collection and analysis, was adopted to allow for an in-depth exploration of 7 years of fall-related sentinel events at one 81-bed academic psychiatric hospital. The qualitative data about environmental and situational factors that were perceived to be involved in patient falls were analyzed using content analysis of open-ended sentinel event narratives, which also allowed for quantitative summaries of the fall events in relation to the environment and the type of space in which they occurred.

In the psychiatric hospital under study, patients had an average length of stay of 8 days. More than 150 staff members worked in this facility, a 27-year-old, one-story hospital located in the southeast region of the United

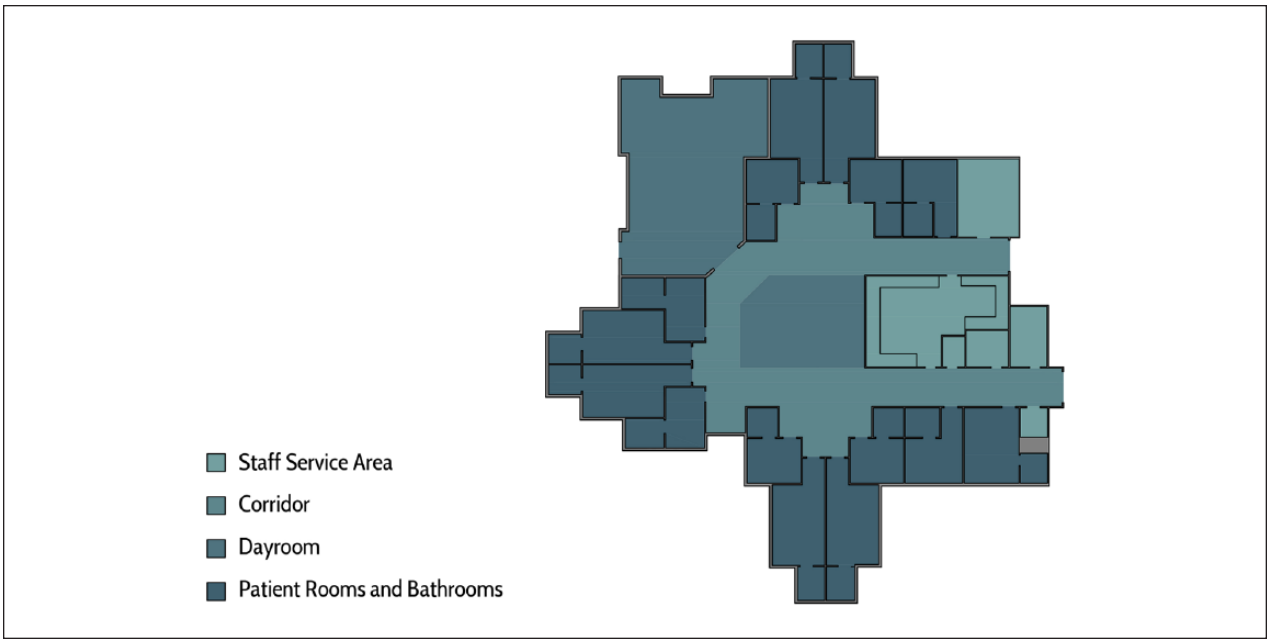

Figure 1. Space types based on the levels of safety framework.

States. The facility included five units, four of which were included in this study. The fifth, an eating disorders unit, was excluded from the study due to small number of patients and fall events.

The four units that were investigated had a combination of single and double rooms with private bathrooms. Each of the four units included an open communal area in the center adjacent to the nursing station, which was enclosed with glass to maximize visibility and connection with the patients. Bedrooms were located around the communal area. Each unit had a dedicated patio for patient activities. Figure 1 shows the floor plan of each unit. In addition to these four units, the study included data from the intake unit where patients were first examined before being admitted to one of the four units.

The patient population differed across the four units. Unit 1 was dedicated to children and adolescents with age range of 7 to 23 years. Unit 2 focused care on adults with depression and elders, including 19- to 100-year-old patients. Unit 3 included patients with alcohol or substance abuse issues between ages of 19 and 85 years. Unit 4 contained patients with psychotic disorders, with an age range of 15 to 87 years.

Data Collection

This study used 7 years of retrospective data (sentinel events) collected between January 2007 and December 2013, the only available data in digital format at the time of data retrieval. The data collection phase was performed after obtaining institutional review board approval and was conducted by reviewing the sentinel events record of 7 years.

The sentinel event reports were recorded by staff members, usually a nurse or a mental health technician. All fall records contained the following information: (a) time of the fall event, (b) level of severity of the injury from the fall, (c) age, and (d) patient diagnosis. Hospital protocol required that each fall episode be classified into one of 10 standardized fall scenarios: (a) fall from Hoyer lift, (b) fall from bedside commode, (c) fall outside of patient room, (d) fall while picking something up, (e) fall from toilet, (f) fall from bed, (g) fall from chair, (h) found on the floor and reporting a fall, (i) fall while walking (ambulating), and (j) other types of falls. Although there were two observation rooms per unit equipped with video cameras and motion detectors for high-risk patients, especially those prone to falls, the data collected for this study did not contain video-recorded information.

Each sentinel record contained a brief open-ended narrative of the sentinel event that described the situation, context, and patient status perceived by the report writers to have played a role in the episode. Content analysis was performed on these narratives. The coding key for content analysis included levels of safety environmental factors (Bayramzadeh, 2017; Hunt & Sine, 2009), the association with the physical space based on the SCOPE of falls model (Taylor & Hignett, 2016), and multisystem fall prevention model (Choi, Lawler, Boenecke, Potoski, & Zimring, 2011).

Data Analysis

Two coders with design background were trained together on 60 randomly selected sentinel event reports to determine whether those events were related to the physical environment according to Levels of Safety framework and SCOPE of Falls model. After agreeing to a coding strategy, all cases, referencing the physical environment, were coded independently. Following this, a second sorting was done. The fall rate was calculated for the hospital by diving the total number of falls by the number of patient days, multiplied by 1,000.

All fall events were first categorized as witnessed or unwitnessed falls. Witnessed falls refer to those observed by staff, and unwitnessed falls to those not seen by staff or others. Next, within each of these two categories, falls were divided into intrinsic and extrinsic, based on a study by Taylor and Hignett (2016). Extrinsic factors are those that are not inherent within the condition of patient's physiological or psychological status, whereas intrinsic conditions are those related to preconditions the patient had already acquired. The extrinsic category included factors related to the environment (workspace envelope, personal workspace, products, and ambient environment), organization (staffing and maintenance), and people (patients and staff); intrinsic factors were related to physiological and psychological conditions of patients (Taylor & Hignett, 2016). Workspace envelope is defined as physical attributes of the environment such as proximities of different spaces. Personal workspace refers to areas surrounding people and often associated with specific functionalities such as workstation or interactions such as those with furniture or equipment. Products include furniture or equipment, and ambient environment includes environmental conditions such as light and noise (Taylor & Hignett, 2016). Additional subcategories were added to the existing ones as determined necessary for this study.

Fall events were divided according to the levels of safety framework (Bayramzadeh, 2017; Hunt & Sine, 2009), which describes safety risks that are linked to the type of location and level of supervision by staff on those locations. These locations are categorized as (a) staff service areas, (b) corridors, (c) dayrooms, (d) patient rooms and bathrooms, (e) admission spaces, and (f) seclusion areas. For example, there are fewer opportunities for appropriate staff supervision in private bedrooms and bathrooms than in public spaces in the facility such as dayrooms.

Results

A total of 818 inpatient falls was recorded from January 2007 to December 2013. The highest number of falls was recorded in Unit 2, a geropsychiatric unit including patients diagnosed with major depression, with 39% of all falls (n = 315) and a rate of 6.9 falls per 1,000 patient days over the 7-year period. The second highest number of falls was recorded in Unit 3, the alcohol and substance abuse unit, with 32% of all falls (n = 259) and a rate of 6.8 falls per 1,000 patient days for the 7-year period. This was followed by Unit 4, the adult psychiatric unit, with 25% of falls (n = 203) and a rate of 4.9 falls per 1,000 patient days. The child and adolescent unit (Unit 1) contributed to 3% (n = 25) of the reported falls in the hospital, with a fall rate of 2.3 per 1,000 patient days. The intake unit incurred 1% (n = 10) of falls. The overall fall rate for the hospital was 5.8 per 1,000 patient days. Environmentally related falls were specifically 15% (n = 83) of all falls, while 85% (n = 496) of events appeared to be related to organization (n = 14, 2.4%), people (n = 176, 30%), intrinsic factors (n = 135, 23%), and some were unknown (n = 171, 30%).

Of 818 falls, those that specified patient gender totaled 653 sentinel events with 49.7% (n = 325) female and 50.3% (n = 328) male. Falls across three nursing shifts were categorized into day (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.). The results showed most falls occurred in the evening shift with 37% (n = 304), followed by the day shift with 35% (n = 288) and the night shift with 28% (n = 225). In addition, the severity for each fall scenario was categorized as follows: no injury, minor injury (e.g., slight bleeding, mild skin abrasion), and major injury (e.g., head injury and hypertensive crisis, severe pain, fractures, bleeding). The results showed that in 272 total falls citing extrinsic factors, 68.4% (n = 186) of falls did not result in any injury, 29.4% (n = 80) of falls resulted in minor injury, and 2.2% (n = 6) of falls resulted in a major injury; see Table 1.

The content analysis of the sentinel events narratives showed that 45% of the events (n = 263) were witnessed and 55% (n = 316) were unwitnessed. Of 579 falls for which qualitative data were available, 270 falls (47%) were related to extrinsic factors. Extrinsic factors included the environment (e.g., workspace, ambient environment), the organization (staffing and maintenance), and people (patients and staff).

Table 2 shows the witnessed and unwitnessed as well as intrinsic and extrinsic falls. Environmental factors included ambient environment, workplace envelope, personal workspace, and products. Products, as the most frequent type of environmental related fall, included 51% (n = 42) of all environmental related falls, followed by workspace envelope (37%, n = 31), ambient environment (6%, n = 5), and personal workspace (6%, n = 5). The subcategories of each environmental fall are provided in Table 3.

Table 1. Fall Types and Related Level of Injury.

Fall type	No injury	Minor injury	Major injury
Extrinsic	119	60	5
Ambient environment	0	1	1
Environment: Workspace envelope	7	11	0
Environment: Personal workspace	1	2	0
Environment: Products	19	4	2
Organization: Maintenance	5	2	0
People: Patients	87	40	2
Unwitnessed: Extrinsic	67	20	1
Ambient environment	1	2	0
Environment: Workspace envelope	9	3	1
Environment: Personal workspace	2	0	0
Environment: Products	14	3	0
Organization: Maintenance	5	2	0
People: Patients	36	10	0
Total (n = 272)	186 (68.4%)	80 (29.4%)	6 (2.2%)

Table 2. Extrinsic and Intrinsic Fall Types.

Fall type and category	Frequency	Percentage
Extrinsic	185	32%
Ambient environment	2	03%
Environment: Workspace envelope	18	3.1%
Environment: Personal workspace	3	0.5%
Environment: Products	25	4.3%
Organization: Maintenance	7	1.2%
People: Patients	130	22.5%
Intrinsic	78	13.5%
Disease	5	0.9%
History of previous falls	3	0.5%
Mobility deficiencies	18	3.1%
Other physiological and psychological factors	17	2.9%
Sensory deficiencies	35	6%
Unwitnessed: Extrinsic	88	15%
Ambient environment	3	0.5%
Environment: Workspace envelope	13	2.2%
Environment: Personal workspace	2	0.3%
Environment: Products	17	3%
Organization: Maintenance	7	1.2%
People: Patients	46	8%
Unwitnessed: Intrinsic	57	10%
Disease	3	0.5%
History of previous falls	4	0.6%
Mobility deficiencies	16	2.7%
Physiological and psychological factors	18	3.1%
Sensory deficiencies	16	2.7%
Unwitnessed: Unknown	171	29.5%
Total	579	100%

A total of 579 sentinel event reports referenced the location or the elements within the hospital spaces. Locations noted in the sentinel event reports were categorized based on the levels of safety framework and included corridors, dayrooms, patient rooms and bathrooms, admission and seclusion rooms. The content analysis also expanded the framework to include transitional and exterior areas including the front door entrance area, patio space, and volleyball courts.

An analysis of extrinsic factors showed that patient rooms had the most fall occurrences with 39% (n = 107). This was followed by patient bathrooms with 22% (n = 59), dayroom or activity rooms with 20% (n = 55), corridors with 8.5% (n = 23), and patios with 9% (n = 24). The admission area included only two falls, quiet room, and staff area each included only one fall event.

Within patient rooms, out of 107 falls, 27% (n = 29) were related to the environment, where products accounted for 15% (n = 16), and workspace envelope, ambient environment, and personal workspace accounted for 6% (n = 7), 3% (n = 4), 1.8% (n = 2), respectively. About 40% (n = 42) of falls occurring within patient rooms were not witnessed by staff.

Patient bathrooms accounted for the second highest number of falls across all types of spaces in the psychiatric hospital with total of 59 falls with 47% (n = 28) directly referencing the physical environment. Unwitnessed falls accounted for 50% (n = 30) of falls in the bathrooms. Other fall categories occurred in the following order: workspace envelope (24%, n = 14), products (17%, n = 10), personal workspace (5%, n = 3), and ambient environment (2%, n = 1).

Dayrooms were the setting for the third highest frequent falls with a total of 55 falls, out of which 25% (n = 14)

Table 3. Falls Associated With the Physical Environment.

Fall type and category	Frequency	Percentage
Witnessed: Extrinsic	48	58%
Ambient environment	2	2%
Poor lighting	2	2%
Environment: Workspace envelope	18	22%
Clutter (tripping hazards)	3	4%
Cords or tubing	1	1%
Doors in patient rooms not open/out of the way	1	1%
Flooring	7	8%
Lack of space for patient physical activities	1	1%
Level change	4	5%
No lift	1	1%
Environment: Personal workspace	3	4%
Bathroom layout	1	1%
Bedside commode	1	1%
Call system inaccessibility	1	1%
Environment: Products	25	30%
Furniture	9	11%
Slide from furniture	10	12%
Unstable/unmovable furniture	6	7%
Unwitnessed: Extrinsic	35	42%
Ambient environment	3	4%
Poor lighting	3	4%
Environment: Workspace envelope	13	16%
Bathroom location or distance to bathroom	3	4%
Clutter (tripping hazards)	1	1%
Doors in patient rooms not open/out of the way	3	4%
Flooring	6	7%
Environment: Personal workspace	2	2%
Lack of/poorly positioned permanent assistive devices	2	2%
Environment: Products	17	20%
Furniture	5	6%
Slide from furniture	8	10%
Unstable/unmovable furniture	4	5%
Total	83	100%

were related to the environment. Most of the falls in this category were associated with products that made 24% ($n = 13$) of the total ($n = 55$), and one remaining case was related to workspace envelope.

Patios were the fourth most frequent location for falls and accounted for a total of 24 falls where 42% ($n = 10$) were environmental. Corridors were ranked as the fifth place to host the most falls with a total of 23 falls (8.5%) with only two cases related to the environment. The summaries of type of falls across different types of spaces are provided in Table 4.

The sentinel event narratives constructed a holistic understanding of environmental factors associated with falls and shed light on fall occurrences: revealing new insights on the roles that location and the physical environment play in patient falls. To show how these qualitative results relate to the SCOPE model's factors, narrative exemplars are provided in Table 5.

Patient Rooms and Bathrooms

According to the sentinel event narratives, there were many cases of nighttime falls that implicated the physical environment. Typical scenarios involved patients falling while ambulating in their rooms at night. Inadequate lighting, tripping hazards, and the level of patient alertness all contribute to this situation that supports ambient environment issues of concern described by the SCOPE model.

Another frequent type of fall occurring in the patient room was triggered by obstacles that cause patient tripping. Fall events relating to tripping over or sliding from furniture happened in different situations when patients were awake or asleep: laying down or getting in or out of the bed.

Falls in bathrooms presented a variety of environmental issues, including the layout, lack of grab bars, ADA design, and reachable positioning of the fixtures. For example, a narrative stated that a patient had reported that when she attempted to sit on the toilet, the seat was lower than what she expected, and there was no side rail on the wall to offer support. Other complaints included difficulty in reaching the sink or the toilet to flush, which resulted in patient fall and injury.

Corridors

Corridors represent shared/public spaces in a hospital frequented by patients. The sentinel event report excerpts suggested a range of factors contributing to ambulating events in the corridors, including wet floor that caused falls or racing with other patients. In the case of wet flooring, some patients ambulated in recently cleaned areas despite caution signage, which often resulted in slipping.

Dayroom

Sentinel event narratives revealed some falls in the dayroom are associated with furniture, such as chairs, tables, and wheelchairs while getting up from a chair or seated in a wheelchair. Sliding off furniture was one of the common ways of falling from chairs or wheelchairs, which was more prevalent among elderly patients. Another hazard of falling occurred when patients tried to get up from their chairs when table legs or chair legs were positioned in the way.

Table 4. Fall Types by Space in Psychiatric Units.

Fall type	Admission	Corridors	Dayroom	Patient bathroom	Patient room	Patio	Quiet room	Staff service area
Extrinsic	-	-	-	-	-	-	-	-
Ambient environment	-	-	-	1	1	-	-	-
Environment: Workspace envelope	-	-	1	7	3	6	1	-
Environment: Personal workspace	-	-	-	2	1	-	-	-
Environment: Products	-	-	11	5	8	1	-	-
Organization: Maintenance	-	2	2	1	1	1	-	-
People: Patients	2	15	35	13	51	12	-	1
Unwitnessed: Extrinsic	-	-	-	-	-	-	-	-
Ambient environment	-	-	-	-	3	-	-	-
Environment: Workspace envelope	-	1	-	7	4	1	-	-
Environment: Personal workspace	-	-	-	1	1	-	-	-
Environment: Products	-	1	2	5	8	1	-	-
Organization: Maintenance	-	-	-	6	1	-	-	-
People: Patients	-	4	4	11	25	2	-	-
Total (n = 272)	2 (0.7%)	23 (8.5%)	55 (20%)	59 (22%)	107 (39%)	24 (9%)	1 (0.4%)	1 (0.4%)

Patios

In patios, nearly half of falls occurred while patients were walking and commonly caused by tripping over the ground or uneven floor surfaces. For instance, a sentinel event narrative reported that a patient fell during a group walk by tripping over uneven concrete and landed on his knees.

Discussion

Falls are one of the most critical patient safety concerns in all hospital settings (Ulrich et al., 2008), and this includes psychiatric hospitals. The physical environment has been recognized as a contributing factor to patient falls constituting 9% to 16% of falls (Al-Khatib et al., 2013). This study reviewed patterns of patient falls in relation to the physical environment within the context of a psychiatric hospital from a 7-year period of sentinel event reports and contributes new insights regarding environmental design factors related to inpatient falls in a psychiatric hospital.

Understanding the root cause of this phenomenon calls for a close examination of all contributing factors. However, a challenge to research on falls is the reality that a large number of fall events in health care settings are unwitnessed (Ward & Armitage, 2012). Unwitnessed falls constituted more than half of the recorded fall cases and were recorded based on self-report information by patients. Unwitnessed falls data can raise concerns about relative lack of staff knowledge pertaining to antecedent environmental risk factors (Ward & Armitage, 2012). The hospital under study revealed a fall rate of 2.3 to 6.9 per 1,000 patient days, a rate much lower than the rate of 13 to 25 per 1,000 patient days found in another study of falls in psychiatric settings (Blair & Gruman, 2005). As in the same study (Blair & Gruman, 2005), gender or time of the day did not play a significant role in changing the fall rate in our study. A critical concern derives from the potential associated injuries that patients can sustain in falls. However, the rate of falls resulting in an injury in the current study was relatively lower compared with other studies (Chan et al., 2013). It is not known whether this can be attributed to the patient population in the present study, the physical environment, or other factors.

The findings revealed that patient rooms and patient bathrooms were the sites with the most frequent falls, followed by patios, dayrooms, and corridors. Although these results support the five levels of safety model in terms of frequency of falls in different locations, Chan et al. (2013) found that among 145 psychiatric patients fall cases, corridors were the most frequent place where falls occur (39.3%, n = 57), followed by patient rooms (26.9%, n = 39), patient bathrooms (18.6%, n = 27), and the activity room (6.9%, n = 10). Both studies did identify patient rooms and bathrooms as a relatively frequent site of falls;

Table 5. Instances of Categorizing the Sentinel Event Narratives.

Fall type and description	Sentinel event narrative
Lighting and visibility at night	
Poor lighting	Patient reported to this writer that she had got up in the night, not turning on the light and fell.
	Patient found on the floor after staff heard her yell for help. Patient stated she fell after tripping over the edge of the bed. All the lights were out in the room and the door was closed making the room totally dark.
	Patient came out of his room stating he had fallen. [patient] states he turned out his light and was trying to find his bed and fell on the floor hitting his forehead and left arm.
Furniture/fixture and difficulty with negotiating the physical environment	
Furniture/fixture	Patient claims to have fallen and hurt her nose when attempting to flush toilet. Head-to-toe assessment performed by nurses and doctor without any notable trauma. Patient declined any medication for pain.
Cords or tubing	Patient climbed on top of the table below the TV and fell after attempting to plug in the cord into the outlet and turn on the television. [patient] was found by the toppled table and landed on her knees. [patient] was aided to her feet and she had no complaints of injury. No apparent injury, vital signs were stable.
Furniture	[Patient] was sitting in chair in day room and slide off chair. She said she was OK and declined ice. Nurse was notified.
	Watched [patient] walk down hallway go into room. Five minutes later heard crash. Went in to see [patient] on floor and chair turned over. [patient] was responsive and in no physical distress. [patient] complained of dizziness, no sign of seizure.
Toileting challenges in the bathroom and bedside	
Doors in patient rooms not open/out of the way (due to spatial conflicts)	Patient states he fell while attempting to enter the bathroom because the bathroom door got in his way.
Lack of/poorly positioned permanent assistive devices	[Patient] was found in floor. She stated she was trying to get over rail to go to bathroom and fell. [Patient] refused to allow staff to check for injuries. She stated she did not hurt herself.
	[Patient] went into bathroom on own using a rolling walker. [Patient] stated that when she started to sit on the toilet she realized that the seat was too low and there was no side rail on the wall and the sink was too far away for her to reach. Stated that she fell to the floor and caught herself with the backs of her hands. Patient said she did not hit her head and only has minimal pain on left hand. Patient was able to get herself up with the use of her walker, and then patient came to nurses' station to tell staff she had fallen and needed a higher toilet seat.
Bedside commode	Patient fell from bedside commode in room when he leaned over to his right too much. He was found on floor by nurse and suffered abrasions to end of nose and forehead. Assessed by nurse-no serious injury . . . Dr. called. Patient was closely observed the rest of evening.
Mobility limitations that compound environmental challenges	
Environment: Products: Slide from furniture	Patient slid form wheelchair and was found sitting on the floor, in the doorway of her room. She was assisted back into her wheelchair. Patient had no complaints of pain and no injuries were observed. Family was notified, Doctor was notified.
Environment: Products: Unstable/unmovable furniture	Patient was attempting to get out of bed and the mattress went with him; both mattress and patient ended on the floor.
	Patient was laying on bed propped up against wall, staff came in to do temperature, after temperature was done, and staff turned around and was leaving room, when she heard a bang. Staff turned around, saw bed pushed away from wall, and patient lying on ground between wall and bed, with back to wall and holding his head.
Inconclusive linkage with physical environment	
Other ambulatory issues	Patient came to nursing station and reported to me that while he was running on the patio during a ball game he was unable to stop and ran into a wall.

however, the findings diverged on the level of falls with Chan et al. (2013) finding a greater number of falls in corridors as compared with the present study. It is difficult to draw a firm conclusion based on these results. Differences in the length of the corridors, traffic patterns with the facilities, level of lighting and visibility as well as patient demographics all may have influenced the results. What is important to note is that the design and location of corridors and hallways can support ambulatory patients or inadvertently create fall hazards.

Patient Rooms and Bathrooms

In patient rooms and bathrooms, the environment should be viewed as an extrinsic factor contributing to falls when there is inadequate lighting, a poor spatial layout or ill-conceived adjacencies between the patient's bedroom and bathroom. According to one of the sentinel reports for instance, patients who want to use the bathroom in the middle of the night may be reluctant to walk the distance required to go from their beds to the threshold of their room where the main light switch is located to turn on the lights; instead, patients often walk to the bathroom in darkness, risking a fall. The patient's inability to easily control lighting complicates their functioning and ability to perform regular activities that they would have been able to do in a well-lit room. Poor lighting can increase the risk of falls (Vu, Weintraub, & Rubenstein, 2004), and adequate lighting can benefit special populations such as geriatric or disabled patients (Lopez et al., 2010). In psychiatric settings, the majority of falls occur when patients walk to the bathroom at night (Tsai, Witte, Radunzel, & Keller, 1998). However, there is not much evidence clarifying what level of lighting is considered "adequate" in such a setting (Gulwadi & Calkins, 2008).

In many of the sentinel event narratives, uneven flooring surfaces (i.e., in the transition between carpeting and linoleum) or level changes (i.e., in the threshold between sheet vinyl and tile flooring) were identified as problematic. Uneven flooring has been identified as a falling hazard in previous studies (Lopez et al., 2010). Therefore, both new flooring installations and repairs of existing floors (e.g., retiling a sections of a flooring) call for careful attention to ensure level flooring surfaces to alleviate falls.

In this study, falls from the bed were the third highest type of fall in patient rooms. For example, an unassisted effort to sit up or get up from bed can result in slipping or rolling off the bed, whether asleep or awake. The dangers of falling when some patients try to get out of bed unassisted has been reported elsewhere (Lee, Mills, & Watts, 2012). Although efforts have been taken by hospital staff to monitor such attempts by patients, another strategy calls for minimizing the potential injury caused from such falls by providing bedside mats that buffer these potential accidents (Lee et al., 2012). Other strategies include specifying bedrails, bed heights, and bed alarms. However, these options are not always fail-safe; for example, some research on the use of bed rails in hospital settings not only does not show a significant decline in the frequency of falls, but ironically this design intervention may actually exacerbate the severity of the bed fall injury (O'Keeffe, 2004). Lower bed heights were introduced as a patient safeguard by the Joint Commission (2014) since a lower height enables patients to touch the floor; however, a literature review conducted by Hignett and Masud (2006) was unable to corroborate the influence of bed height on the frequency or severity of the fall. Another strategy for reducing falls from beds is the use of bed alarms. However, a study by Tideiksaar, Feiner, and Maby (1993) found the use of bed alarms failed to identify any significant difference in fall frequency between the control and intervention groups. Furthermore, staff, in general, may not be supportive of bed alarms, which are not considered easy-to-use or effective and consequently, often are deactivated for extended periods of time in hospitals (Lopez et al., 2010).

In the present study, handrails and grab bars contributed to some falls when they were reported by patients to be inconveniently located or absent in key locations, such as bathrooms. The absence of handrails has been relatively well-substantiated as being associated with fall risks, especially for the elderly. This finding has been established across context from residential settings (Marshall et al., 2005) to health care facilities (Lopez et al., 2010). Unlike the somewhat inconclusive findings regarding bed rails, bed heights, or bed alarms, the tactic to install grab bars in accident-prone locations of facilities does seem to reduce the risk of falling. Yet it is important to be aware that even grab bars can pose hidden dangers. For instance, a tragedy can result when grab bars and bed rails lack anti-ligature features and thus become an aid for suicide attempts.

Finally, in this study, some bathroom falls appear to have been caused, in part, by the overall layout of the space, the height of the commode or sink, or the level changes in flooring or thresholds. To help prevent accidents in bathroom areas, design solutions are called for that consider commodes with easy access toilet seats that facilitate the ability to sit down and get back up with greater ease and safely and that have manual flushes at a convenient height or alternatively implement automatic flushes. Other narrative results describe the falls when flooring is not adequately slip-resistant or cases where tripping over the threshold between the bedroom and bathroom becomes a problem. These extrinsic factors become even more dangerous when the patient is medicated, causing increased drowsiness or dizziness.

Corridors

Few falls took place in corridors in this study. This may be explained, in part, by the design of the hospital under study. As corridors were relatively short and were surrounded by staff service areas, the length of time to get from one area of the facility to another was shorted and patient movement throughout most of the corridor could be easily monitored. Overall, shorter corridors in conjunction with the positioning of staff areas seemed to

reduce patient falls in the hallways (see Figure 1). Other researchers have advocated for shorter travel distances for in-patient hospitals as an effective strategy in reducing falls among psychiatric patients (Lee et al., 2012). The length of a patient's travel distance in the facility influences the level of patient falls as does the layout of spaces and overall size of the unit (Lee et al., 2012).

Narratives pointed out that some patients use corridors as a social space. In the hallways, patients can engage with others, even racing from one end of the hall to the other. Given the relatively narrow width of the corridors, a patient who is walking very quickly may fall or even run into another patient or staff member who, in turn, falls. Of course, using the corridors for power walking or racing can be dangerous and might signal the lack of adequate or patient recreation. If psychiatric patients are discouraged to spend time alone in their rooms and have limited opportunities for entertainment in a secured environment, it is incumbent on caregivers and staff to provide places, other than the corridors, for patient activities.

Dayrooms

Falls were relatively infrequent in dayrooms in this study compared with other spaces. When falls were reported in dayrooms, furniture often was the culprit as narrated in sentinel event reports. Furniture placement could become a tripping hazard; patients could slide off chairs or tumble into a sharp edge; other times, patients fell over furniture, slid from furniture, tumbled off furniture; in other cases, patient falls while ambulating resulted from nonenvironmental factors, such as a seizure or the interaction between intrinsic and extrinsic factors.

In short, falling is a complex issue, and fall prevention does not lend itself to easy solutions. As found in this study, the physical environment is only one factor contributing to falls and cannot be categorically separated from human and organizational factors. Each fall event may be an artifact of one or more contributing causes, ranging from intrinsic human factors to extrinsic organizational and environmental influences. Although some falls might have been most heavily influenced by a physiological condition, the root cause of other falls could be traced to a combination of human, organizational, and environmental factors at play. More research is called for to explore the relative importance of these factors in association with typical patient fall scenarios.

Limitations

Although accessing the retrospective data provided an invaluable opportunity to explore fall patterns over time, the collected data did not allow for inferential statistical analysis. Lack of information on patient treatment approaches and medications did not allow for control of related risk factors that played a role in patient falls. The amount of time that patients spent in each type of space and whether that had a role in the frequency of falls is also unknown. At times, the sentinel event narratives lacked more detailed information on environmental design features that might have strengthened the results. Therefore, the effects of environmental design on falls in this study may have been underestimated. Furthermore, the sentinel event reports may have somewhat misrepresented the location of the falls in the case of sentinel events occurring with the dayrooms and adjacent corridors, given their adjacency. Specifically, in the hospital under study, dayrooms were designed as relatively spacious areas that opened into the corridors and circulation spaces. For this reason, some falls may have been designated as occurring in the dayroom instead of corridors or vice versa.

Another shortcoming of the study was that diagnostic information on the total resident population was not available. Since permission to access patients' diagnosis information was only limited to patients who fell (and excluded those who did not fall), it was not possible to correlate patient diagnoses and fall patterns. About 20% of the sentinel events did not provide gender of patient, which limited any conclusions drawn on gender. The collected data did not allow for identification of chronic fallers, who could have represented a disproportionate share of falls. More importantly, data from a single case study cannot be generalized to the population of psychiatric hospitals; however, the issues raised on extrinsic fall factors are important in directing further research.

Conclusion

Reducing patient falls and improving patient safety is essential in today's health care system. Psychiatric patient falls are greater in frequency and severity compared with other patient populations. Although this may be partially due to the use of psychotropic drugs, the environment appears to play a role in the number of falls occurring and associated patient injuries. The study findings can help inform decisions about the design of safer psychiatric hospitals.

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Author Roles

Sara Bayramzadeh: Made a substantial contribution to the concept and design, acquisition of data or analysis and interpretation of data; drafted the article or revised it critically for important intellectual content; approved the version to be published.

Margaret Portillo: Made a substantial contribution to the concept and design; revised the article critically for important intellectual content; approved the version to be published.
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