Patient falls: Glossary (variables, metrics and measurement methods)

	Term	Definition	Metrics	Measurement method
Environmental variable	**Bed alarm, Medical vigilance system (bed sensors connected to nurse call system)**	A passive sensor array, including bed exit sensors, embedded into a coverlet around the patient bed's mattress and connected to the nurse call system (Spetz et al., 2007)	Presence versus absence (Spetz et al., 2007)	**Experimental manipulation** - The medical vigilance system was installed on 42% of beds in a nursing unit. Outcomes of patients on these beds were compared with outcomes of patients on beds without the system (Spetz et al., 2007)
	Bedrail and other physical restraints	Physical restraints: mechanical or manual devices used to limit a patient's physical mobility (Capezuti et al., 1998). Bedrail: a rail or board running along the side of a patient bed; often used to prevent easy egress from the bed (Hanger et al., 1999).	- Nighttime bed rail use (Capezuti et al., 2002) - Physical restraints use (Capezuti et al., 1998) - Bed rail use (Hanger et al., 1999) - Bed rail use versus no use (Van Leeuwen et al., 2001)	**Observation** - Nighttime bed rail uses were classified into several levels--bilateral rail use, one-side rail use, no use of side rail (Capezuti et al., 2002). - Levels of physical restraints used in nursing homes were directly observed and classified into several levels: vest, wrist/ankle, belt, pelvic, geriatric/recliner chairs, wheelchairs with fixed tray tables (Capezuti et al., 1998) - In a fall-prevention program, bed rail use was reduced through policy change and education (Hanger et al., 1999) **Incidence/accident reports** - Bed rail use data were collected from patient incident form (Van Leeuwen et al., 2001)
	Falls - Multifaceted environmental intervention	Simultaneous modification of multiple aspects of the physical environment for the purpose of reducing patient falls and injuries (Becker et al., 2003; Brandis, 1999)..	Before versus after the implementation of a fall-prevention program including environmental modifications (Becker et al., 2003; Brandis, 1999)	**Design manipulation** - Environmental modification based on environmental hazard check and discussion with staff and administrators (lighting, chair and bed height, floor surfaces, room clutter, grab bars, walking aids) together with staff training, resident education, exercise and hip protectors) (Becker et al., 2003)
	Interior finish material	Material covering interior surfaces such as ceiling, floors, and walls (Calkins et al., 2011)	- Flooring type: carpet vs. vinyl (Donald et al., 2000; Healey, 1994), with vs. without carpet (Simpson et al., 2004); linoleum, VCT, ceramic tile (Calkins et al., 2011) - Flooring pattern: pattern size (no, small [less than 1"], medium [1'-6"], large pattern [>6"]) (Calkins et al., 2011)	**Research Manipulation** - Installation of a new carpet flooring (Donald et al., 2000). **Incidence/accident reporting** - Data about flooring types were gathered from the accident forms completed by nurses (Healey, 1994) **Environmental inspection/audit** - Existing flooring materials were examined through environmental inspection (Simpson et al., 2004)
	Noise	A sound that is loud, unpleasant, unexpected, or undesired (Free Dictionary)	- Alarms and overhead paging heard frequently, infrequently, never used (Calkins et al., 2011)	**Environmental inspection/audit** - Environmental inspection performed by hospital staff using the Falls Environment Evaluation Tool (FEET) (Calkins et al., 2011)

	Term	Definition	Metrics	Measurement method
	Nursing station layout	Spatial arrangement of nurse work stations in a nursing unit (Dutta, 2008; Gurascio-Howard & Malloch, 2007)	Types: decentralized versus centralized (Hendrich et al., 2004)	**Design manipulation** - Environmental changes implemented during a nursing unit renovation (Hendrich et al., 2004)
	Patient bathroom design	Architectural and interior design of bathrooms containing bath and toilet facilities for patients (Calkins et al., 2011).	Private versus shared or no bathroom; open versus closed door; 18" space on the opening side of bathroom door versus no space; bathroom located on footwall versus headwall; toilet on side wall versus across from entrance; two bars on both sides of toilet in bathroom, one bar, no bar (Calkins et al., 2011)	**Environmental inspection/audit** - Environmental inspection performed by hospital staff using the Falls Environment Evaluation Tool (FEET) (Calkins et al., 2011)
	Patient room layout	Spatial arrangement of architectural elements and equipment in patient rooms (Calkins et al., 2011).	- Designated family space versus no designated family space (Calkins et al., 2011)	**Environmental inspection/audit** - Environmental inspection performed by hospital staff using the Falls Environment Evaluation Tool (FEET) (Calkins et al., 2011)
	Subfloor	Rough floor serving as a base under a finished floor (Simpson et al., 2004)	Type: wood versus concrete (Simpson et al., 2004)	**Environmental inspection/audit** - Existing subfloor materials were identified through environmental inspection (Simpson et al., 2004)

	Term	Definition	Metrics	Measurement method
Fall related outcome	**Fall-related injuries**	• Any graze, bruise, laceration, or fracture resulting from a fall; includes complaints resulting from a fall, even if a lesion is not visible (Healey, 1994). • Serious injury: all fractures and other injuries resulting in medical attention and bed rest for at least 2 days. Minor injuries: do not meet the criteria for serious injury, e.g., bruises, abrasions, certain sprains, and other soft tissue injuries (Capezuti et al., 2002). • Serious injuries: fractures; dislocation of joints; head injuries requiring neuro-observations; skin lacerations requiring skin grafts, suturing, or plastic surgical attention; and any hip pain preventing the patient from mobilizing, even if an X-ray shows no fracture. Minor injuries: small bruises, skin tears, and lacerations requiring cleansing and steristripping but no suturing (Hanger, Ball, & Wood, 1999). • Minor injury: minor cuts, minor bleeding, skin abrasions, swelling, pain, minor contusions. Moderate injury: excessive bleeding, lacerations requiring sutures, temporary loss of consciousness, moderate head trauma. Severe injury: fractures, subdural hematomas, other major head trauma, cardiac arrest, and death (Hitcho et al., 2004).	**Prevalence** - Number of patients injured per 1,000 admissions (Brandis, 1999) - Number of injuries per 1,000 patient days (Capezuti et al., 1998) **Severity** - Percentage of falls resulting in injuries of different severity levels (Capezuti et al., 1998; Hanger et al., 1999; Schwendimann et al., 2006; Van Leeuwen et al., 2001) - Number of hip fractures per 100 falls (Simpson et al., 2004)	**Incidence/accident reporting system** as described above - Nursing home incidence report (Capezuti et al., 2002) - Routine data collection using incident forms (Hanger et al., 1999) - Falls register of nursing home (Simpson et al., 2004) **Radiograph review** - Radiograph review of hip fractures (Simpson et al., 2004)

	Term	Definition	Metrics	Measurement method
	Falls, patient	There is no universally accepted definition of patient falls. The following definitions are used in literature and practice: • An unplanned descent to the floor (or extension of the floor, e.g., trash can or other equipment) with or without injury to the patient, and occurring on an eligible reporting nursing unit. All types of falls are included, whether they result from physiological reasons (fainting) or environmental reasons (slippery floor). • Includes assisted falls which occur when a staff member attempts to minimize the impact of a patient's fall (NDNQI, 2005). • Unintentionally coming to rest on the ground, floor, or other lower level regardless of the cause (Becker et al., 2007). • A sudden, unanticipated change (downward) in body position with or without physical injury (Brandis, 1999). • An accidental collapse to the ground leading to the completion of an accident report form by nursing staff (Donald, Pitt, Armstrong, & Shuttleworth, 2000). • A sudden, unexpected descent from a standing, sitting, or horizontal position, including slipping from a chair to the floor, a patient found on the floor, and an assisted fall (Hitcho, 2004).	**Prevalence** - Number of patient falls per 1,000 patient days (occupied bed days) (Calkins et al., 2011; Hendrich et al., 2004; Hitcho et al., 2004) - Number of patient falls per 1,000 resident year (nursing home) (Becker et al., 2003) - Number of patient falls per 100 patients (admissions) (Hanger et al., 1999; Van Leeuwen et al., 2001) - Number of patient falls per 1,000 admissions (Brandis, 1999) - Fall rate (number of falls per patient) (Spetz et al., 2007) **Severity** - Percentage of falls resulting in injuries (Capezuti, 2002; Healey, 1994; Hitcho et al., 2004)	**Incidence/accident reports** Most patient falls data come from incidence/accident report forms completed by nurses. Therefore, the quality of data relies on the work of individual nurses. An incident report form of patient falls usually includes patient information (e.g., demographics, diagnosis, fall risk assessment), details of fall incident, circumstantial/environmental factors contributing to the fall (e.g., staff ratio, floor condition), and the results of the fall (e.g., injury levels). - Falls calendar sheets completed by nurses daily (Becker et al., 2003) - Nursing home incidence report (Capezuti, 2002; Capezuti et al., 1998) - Accident forms reported by nurses (Healey, 1994) - Hospital's adverse event reporting system (Hendrich et al., 2004) **Medical records** - Medical records were examined to calculated fall rate (Spetz et al., 2007)

Patient Falls: Article Analysis

Reference	Environmental feature		Outcome		Study design	Results	Setting	Sample
	Variable	Metric	Variable	Metric				
Becker, C., Kron, M., Lindemann, U., Sturm, E., Eichner, B., Walter-Jung, B., & Nikolaus, T. (2003). Effectiveness of a multifaceted intervention on falls in nursing home residents. *Journal of the American Geriatrics Society, 51* (3), 306-313.	Environmental modification based on environmental hazard check and discussion with staff and administrators (lighting, chair and bed height, floor surfaces, room clutter, grab bars, walking aids) together with staff training, resident education, exercise and hip protectors)	Before vs. after the implementation of a fall prevention program	Incidence density rates of falls, fallers, frequent fallers (>2), hip fractures, and non-hip fractures (number of incidence per 1000 resident years). Quarterly data.	Falls calendar sheets completed by nurses daily	Prospective, cluster-randomized controlled trial, 3 nursing homes as intervention group and 3 as control group	Significant lower incidence density rate of falls, fallers, and frequent fallers in the intervention group. Due to low rate of fractures in both groups, larger sample size would be needed to detect an interventional effect.	6 nursing homes in Germany	Nursing home residents (n=981)
Brandis, S. (1999). A collaborative occupational therapy and nursing approach to falls prevention in hospital inpatients. *Journal of Quality in Clinical Practice, 19*(4), 215-220.	Environmental modifications on design faults in bathrooms (slippery floors, inappropriate door openings, poor placement of rails and accessories, incorrect toilet and furniture heights) together with other changes (high-risk patient flagging system, education) were included in the patient fall prevention program	Before vs. after the implementation of a fall prevention program	Fall incidence rate (number of falls per 1000 occupied bed days, number of patient falling per 1000 admissions, falls per weighted separations taking into account patient acuity) Fall-related injury rate (Percentage of patients falls resulting in injury [bruise, abrasion, laceration, fracture, etc.], number of patients injured per 1000 admissions)	Incidence forms database Injury rates are reliable as these are more likely to be reported.	Before-after the intervention of a patient falls prevention program	A comparison between patient fall data showed a decrease in falls and fall-related injuries after the implementation of the patient falls prevention program including environmental modifications	An Australian hospital	One year of data before and one year of data after intervention
Calkins, M.P., Biddle, S., & Biesan, O. (2011). *Contribution of the designed environment to fall risk in hospitals.* Concord, CA: Center for Health Design.	Bathroom design Patient room layout Flooring materials Noise Other environmental factors	Environmental inspection/audit using the Falls Environment Evaluation Tool (FEET) - Bathroom: private vs. shared or no bathroom; open vs. close door; 18" space on the opening side of bathroom door vs. no space; bathroom on footwall vs. headwall; toilet on side wall vs. across from entrance; two bars on both sides of toilet in bathroom, one bar, no bar; Patient room: designated family space vs. no designated family space Flooring: pattern size (no, small [less than 1"], medium [1'-6"], large pattern [>6"]); linoleum, VCT, ceramic tile Noise: alarms and overhead paging heard frequently, infrequently, never used	Patient fall rate: number of falls per 1000 patient days	Data provided by participating facilities, collected from medical records - total number of patient days, location of patient falls	Observational study	The following environmental factors were found to be associated with lower rates of patient falls: private bathroom (as opposed to shared or no bathroom), bathroom door that could remain in an open position, 18" space available at the opening side of the bathroom door, bathroom on footwalls (vs. headwalls), toilet on the side wall of bathroom (vs. toilet across from the entrance), two grab bars on both sides of the toilet (vs. one bar, two bars on wall), designated family space in patient room. Factors associated with more falls included: medium size flooring pattern (vs. no, small, or large pattern), linoleum flooring (vs. VCT, ceramic tile), and frequently heard alarms and overhead paging.	27 patient units in 12 hospitals	995 falls, 670 patient rooms
Capezuti, E., Maislin, G., Strumpf, N., & Evans, L. K. (2002). Side rail use and bed-related fall outcomes among nursing home residents. *Journal of the American Geriatrics Society, 50* (1), 90–96.	Nighttime side rail use	Levels of side rail use, including bilateral rail use, one-side rail use, no use of side rail (direct observation)	Presence or absence of bed-related falls, falls resulting in serious injuries (fractures, dislocated joint, subdural hematoma, laceration requiring sutures), and recurrent falls	Nursing home incidence report	Longitudinal study, repeated measurement; Comparisons between patients with different levels of bed rail use	There was an increase in bilateral side rail use over a 1-year period observation period probably due to declines in residents' physical and cognitive function. Bilateral bed rail use was not associated with reduced fall risk.	Three nonprofit nursing homes	463 residents in 3 nursing homes

Reference	Environmental feature		Outcome		Study design	Results	Setting	Sample
	Variable	Metric	Variable	Metric				
Capezuti, E., Strumpf, N. E., Evans, L. K., Grisso, J. A., & Maislin, G. (1998). The relationship between physical restraint removal and falls and injuries among nursing home residents. *Journals of Gerontology. Series A, Biological Sciences and Medical Sciences, 53* (1), M47-52.	Physical restraints	Three levels of physical restraints use in nursing homes including vest, wrist/ankle, belt, pelvic, geriatric/recliner chairs, wheelchairs with fixed tray tables (direct observation)	Individual level: presence or absence of any fall, fall with minor or serious injury; Institutional level: fall rate (# of falls per 1000 patient days), fall-related injury rate (# of injuries per 1000 patient days; major injury: all fractures and other injuries resulting in medical attention and bed rest for at least 2 days; minor injury: bruises, abrasions, certain sprains, and other soft tissue injuries) Crude and adjusted incidence density ratio (ratios calculated by dividing one nursing home's incidence rate by the rate of the control nursing home)	Nursing home incident report	Comparison of residents with restraints removed and those who remained to be restrained; Comparison of nursing homes with different level of restraints use	The removal of restraints was associated with lower fall rates and injury rates.	Three nursing homes in the Philadelphia area	126 residents (restraint users at baseline); 633 residents (including non restraint users)
Donald, I. P., Pitt, K., Armstrong, E., & Shuttleworth, H. (2000). Preventing falls on an elderly care rehabilitation ward. *Clinical Rehabilitation, 14* (2), 178-185.	Flooring type; Type of physiotherapy	Two flooring types - carpet and vinyl (experimental manipulation: Installation of new carpet and use of physiotherapy)	Number of patient fallers, number of falls	Accident report form by nursing staff	Experiment design, randomization but significant dropouts	Vinyl flooring (compared to carpeting) and physiotherapy with additional leg strengthening exercises were associated with lower risk of falls but the differences were not statistically significant due to small sample size.	Elderly care rehabilitation ward in a community hospital in UK	54 patients
Hanger, H. C., Ball, M. C., & Wood, L. A. (1999). An analysis of falls in the hospital: Can we do without bedrails? *Journal of the American Geriatrics Society, 47* (5), 529–531.	Reduction of bed rail usage by policy change and education program	Implementation of fall prevention program	Falls per 100 admissions, Falls per 10,000 bed days Number of injuries (serious, minor), staff injuries	Routine data collection using incident forms	Before-after the intervention (restriction of bedrail use)	After the reduction of bedrail use, fall rate did not change but the number of serious injuries was significantly reduced.	Five wards for older people in a New Zealand hospital	1968 hospital ward admissions in 12-month period (987 before and 981 after)
Healey, F. (1994). Does flooring type affect risk of injury in older in-patients? *Nursing Times, 90* (27),40-41.	Flooring type	Two flooring types - carpet vs. vinyl (accident form reported by nurses)	Proportion of falls resulting in injuries	Accident form reported by nurses	Retrospective observational study	Vinyl flooring was associated with higher risk of injury. Four (17%) out of 27 patients who fell on carpet received injuries; 91 (46%) of 186 patients who fell on vinyl flooring received injuries.	A care of the elderly unit in UK	213 accident forms randomly selected
Hendrich, A. L., Fay, J., & Sorrells, A. K. (2004). Effects of acuity-adaptable rooms on flow of patients and delivery of care. *American Journal of Critical Care, 13* (1), 35-45.	Acuity-adaptable room with decentralized nurse stations and supplies	Renovation of nursing unit	Patient fall index: number of falls per 1000 patient days). Yearly data.	Hospital's adverse event reporting system	Before-after the renovation of nursing unit	The annual patient fall index decreased from 4 or more falls per 1000 patient days to 2 falls per 1000 patient days.	Coronary care unit (critical and progressive care)	2 years of data before renovation and 3 years of data after
Hitcho, E., Krauss, M., Birge, S., Dunagan, W., Fischer, I., Johnson, S., . . . Fraser, V.J. (2004). Characteristics and circumstances of falls in a hospital setting. *Journal of General Internal Medicine, 19* (7), 732–739.	Environmental circumstances and environmental interventions used by nurses	Adverse event report system; Observation; Interview	Fall rate (number of falls per 1000 patient days) Number of falls resulting in different types of injuries	Adverse event report system	Prospective descriptive study of falls and environmental and other factors related to falls	Most falls were unassisted, elimination-related, and occurred in patient rooms at night. The most common used fall interventions were video surveillance or placement patients close to the nurse station and restraints. Environmental contributors to falls included wet floor and environmental obstacles (furniture, device, equipment).	A 1300-bed urban academic hospital	200 falls occurred in 34 units in 7 services
Schwendimann, R., Buhler, H., De Geest, S., & Milisen, K. (2006). Falls and consequent injuries in hospitalized patients: Effects of an interdisciplinary falls prevention program. B*MC Health Services Research, 6* , 69.	Interdisciplinary fall prevention program (including patient screening, environmental modifications, etc.)	Implementation of fall prevention program	Patient fall rate: number of falls per 1000 patient days Severity of fall-related injuries (annual percentage of falls resulting in no injuries, minor injuries, and major injuries)	Standardized fall incident report form	Before and after study	A slight but nonsignificant decrease in patient falls was observed after the implementation of falls prevention program. No significant reduction in the severity of fall-related injuries.	A 300-bed urban public hospital	34972 hospitalized patients from 1999 to 2003

Reference	Environmental feature		Outcome		Study design	Results	Setting	Sample
	Variable	Metric	Variable	Metric				
Simpson, A. H., Lamb, S., Roberts, P. J., Gardner, T. N., & Evans, J. G. (2004). Does the type of flooring affect the risk of hip fracture? *Age and Ageing, 33* (3), 242-246.	Floor types (underfloor structure and floor covering): wood sub-floor w/ carpet wood sub-floor w/o carpet concrete sub-floor w/ carpet concrete sub-floor w/o carpet	Inspection and classification of floors	Number of falls, number of hip fractures per 100 falls (falls register, clinical records, radiographs)	Falls register of nursing home, radiograph review of fractures	Observational study	Wooden carpeted floors had lowest number of fractures per 100 falls. Compared to wooden sub-floor, concrete sub-floor was related to a higher risk of hip fracture in a fall. Carpeting was not associated with significantly lower risk of hip fracture. More falls occurred in carpeted floors. But this might be related to the large amount of time residents spent in carpeted rooms.	34 residential care homes in UK	733 rooms, 6641 falls and 222 fractures
Spetz, J., Jacobs, J., & Hatler, C. (2007). Cost effectiveness of a medical vigilance system to reduce patient falls. *Nursing Economic$, 25* (6), 333-338, 352.	A medical vigilance system (bed sensors connected to nurse call system)	Experimental manipulation	Fall rate (number of falls divided by number of patients) Cost per patient Length of stay	Medical records	Quasi-experiment	The fall rate was 0.0194 for patients in beds with the vigilance system and 0.0323 for patients in beds without this system. The estimated incremental cost of the vigilance system was around 6,000 per avoided fall.	A 24-bed post-neurosurgery unit	567 patients
Van Leeuwen, M., Bennett, L., West, S., Wiles, V., & Grasso, J. (2001). Patient falls from bed and the role of bedrails in the acute care setting. *Australian Journal of Advanced Nursing, 19* (2), 8-13.	Bedrail use (used vs. not used)	Patient incident form	Fall rate (number of falls per 1000 patient admissions) Injury severity	Patient incident form, nurse notes	Retrospective observational study	For all age-gender groups, the rate of falls from bed when bedrails were used was higher than or equal to when bedrails were not used. No difference was found in injury severity.	An urban acute care hospital	419 patient falls from 1993 to 2000

Patient falls: Matrix of relationships

		Outcome	
	Variable	Patient falls	Fall-related injuries
Environmental feature	Nursing station layout		
	Interior finish material		
	Subfloor		
	Bedrail and other physical restraints		
	Medical vigilance system (bed sensors connected to nurse call system)		
	Multifaceted environmental intervention		
	Patient bathroom design		
	Patient room layout		
	Noise		

Note: Cells shaded in gray indicate the existence of evidence supporting relationships between environmental features and outcomes