

Incidence, correlates and outcomes associated with falls in the intensive care unit: a retrospective cohort study

Drayton Trumble, Michael A Meier, Maryellen Doody,
Xiaoming Wang and Sean M Bagshaw

Falls among hospitalised patients contribute to considerable morbidity, prolongation of hospital stay, and excess health care costs.^{1,2} Falls continue to be a common risk despite prospective identification of at-risk patients, with fall rates as high 9.87 per 1000 patient-days in higher-risk patient groups.^{1,3,4} Direct medical costs for the treatment of non-fatal fall injuries in the United States totalled US\$31.3 billion in 2015, with an estimated 65% of costs directly related to prolonged hospitalisation and treatment.⁵ Canadian figures suggest that the average additional per-patient costs of an inpatient fall was C\$30 696.⁶

Commonly identified risk factors for falls among hospitalised patients, such as delirium, decreased mobility, use of sedatives, use of restraints and high acuity of illness, are also frequently encountered among patients admitted to the intensive care unit.² Inpatient falls in any setting are generally believed to translate into significant morbidity,^{2,3,6} but falls occurring in a heightened monitored setting such as the ICU are of particular concern. ICUs have unique organisational structures to meet the high-intensity workload associated with support of critically ill patients. ICU patients generally have high acuity of illness, multiple organ dysfunction and require at least some enhanced monitoring or advanced life support (invasive and non-invasive ventilation, vasoactive therapy and renal replacement therapy [RRT]).² ICUs in Canada generally have dedicated intensive care physician coverage, have high nurse:patient ratios (> 1:2), and have integrated inter-professional health care teams comprised of physicians, nurses, respiratory therapists, pharmacists, dietitians, social workers, physiotherapists and occupational therapists.^{7,8}

Despite this care model, ICUs are often at a strained capacity and remain high-risk environments for patients throughout their stay and during transition to the ward.⁸ ICU patients receive numerous therapeutic interventions on a daily basis, are often confined for significant periods of time, are susceptible to delirium, and are commonly treated with a spectrum of analgesic and sedative medications. Furthermore, recent trends have shifted ICU practice towards a greater emphasis on early awakening and early mobilisation of ICU patients, aimed at improving survival and functional recovery from critical illness.^{7,9}

It remains uncertain whether these or other factors are associated with falls occurring in the ICU. We have only identified one additional study focused on fall events in

ABSTRACT

Background: Falls among hospitalised patients contribute to avoidable morbidity and prolonged hospital stay. We aimed to describe the incidence, circumstances and outcomes associated with patient falls occurring in intensive care units.

Methods: Retrospective cohort study of adult admissions to an academic, tertiary ICU in Edmonton, Canada between 1 January 2013 and 30 April 2016. Fall events were ascertained by interrogation of an electronic health record. Each fall was independently adjudicated by two intensivists to confirm that a fall did occur, and to determine if the fall was potentially avoidable. Agreement was assessed by intraclass correlation (ICC). A matched cohort (one fall to five non-fall) was created to compare course and outcomes.

Results: Of 31 events identified, 26 were adjudicated as a fall (84%), for an estimated incidence of 5.2 per 1000 ICU admissions (95% CI, 3.4–7.6). Of these, 23 were judged as avoidable (89%) (ICC, 0.69; 95% CI, 0.37–0.85). The mean age was 54.5 years (SD, 17.4 years), 20 of the falls (77%) involved men, and 10 (39%) were surgical admissions (eight [31%] for trauma). The median ICU stay before the falls was 10.6 days (interquartile range [IQR], 6.2–15.0 days), and 13 patients (50%) scored positive for delirium. At the time of the fall, three patients (12%) were invasively ventilated, and eight (31%) were classified as ward-ready. Eleven falls (42%) were witnessed and 12 (46%) occurred after hours, of which nine involved patients (75%) who had delirium. Seven falls (27%) occurred within 2 hours of a nursing shift change and 11 (42%) during a nursing break coverage. No patient sustained a major injury related to a fall but four (15%) reported minor injuries such as a laceration or abrasion. The median ICU stay after a fall was 2.2 days (IQR, 1.2–2.9 days). Compared with the matched non-fall cohort, patients who fell had a longer duration of ICU stay (median, 12.0 days [IQR, 8.3–18.6 days] v 4.7 days [IQR, 2.8–8.4 days]; $P < 0.0001$).

Conclusion: Falls in the ICU are infrequent and generally perceived as avoidable. Falls often occur at night, are unwitnessed and are associated with concomitant patient delirium and nursing shift changes and cross coverage.

ICU settings.¹⁰ Richardson and colleagues performed a 2-year retrospective surveillance of fall events occurring in four ICUs in the United Kingdom. That study described 42 incidents (incidence, 0.99 per 1000 patient-days), with falls more commonly occurring among younger patients and patients with confusion or agitation. To extend our understanding and knowledge of this issue, we performed a retrospective audit to describe the occurrence, circumstances and outcomes associated with falls occurring in adult patients admitted to a single academic, tertiary ICU in Canada. We hypothesised that fall events would be relatively uncommon, largely avoidable and associated with identifiable patient-level and ICU organisational-level factors that may be amenable to intervention.

Methods

Our study was reviewed by the Health Research Ethics Board at the University of Alberta (file Pro00064493), and was deemed outside their mandate, based on the quality assurance nature of the project. The requirement for informed consent was waived.

Design, setting and population

This was a retrospective, quality assurance audit. All patients over the age of 18 years admitted to the General Systems Intensive Care Unit (GSICU) at the University of Alberta Hospital (UAH) between 1 January 2013 and 30 April 2016 were considered eligible. The GSICU has a total of 32 funded ICU beds capable of providing full organ support (mechanical ventilation, vasoactive agents and RRT). The nurse:patient ratio is generally 1:1 or 1:2 across two 12-hour nursing shifts, with no difference in nurse:patient ratio by time of day. At the time of the audit, there was no specific procedure to prospectively identify patients at increased risk for fall events or implementation of a policy for fall prevention.

We defined fall patients as ICU patients who experienced a fall event documented in the electronic health record (EHR) while admitted to the GSICU. Two control cohorts were generated for course and outcome comparisons:

- full cohort: all adult patients admitted to ICU during the study period
- matched cohort: matched patients randomly selected (in a ratio of 1:5) based on age (± 5 years), sex, year of admission, Acute Physiology and Chronic Health Evaluation (APACHE) II score (± 2 points); and an ICU length of stay (LOS) ≥ 2 days.

Operational definitions

We defined a fall event as 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 or an assisted fall.¹¹ Each fall event description was independently adjudicated in a blinded fashion by two intensivists to confirm that a fall event did occur and to determine if the fall was avoidable.

A night-time fall was described as a fall event occurring between the hours of 7 pm and 7 am.

Delirium was defined as an Intensive Care Delirium Screening Checklist (ICDSC) score ≥ 4 .¹² The ICDSC is routinely measured twice a day for all patients admitted to the GSICU.

A patient was classified as ward-ready if they had been deemed fit for transfer out of the ICU to another hospital unit.

A transfer delay was defined as when a patient classified as ward-ready waited for ≥ 4 hours for ward transfer.

Outcomes

Our primary outcome was the incidence of falls, defined as the number of fall events per 1000 ICU admissions. Secondary outcomes were factors associated with fall events, which we categorised as being at the patient level (eg, diagnostic category, delirium, receiving advanced life support, use of restraint) and at the organisational level (eg, occurrence of falls relative to ward-ready status, transfer delays, time of day, nursing shift changes, nurse break coverage and whether the fall was witnessed). Tertiary outcomes were death, injury related to fall event (eg, laceration, fracture and head injury) and prolonged ICU or hospital LOS.

Data sources

Data were obtained from eCritical/TRACER, a bedside clinical information system and data repository for critical care in Alberta, Canada. Data extracted related to sociodemographics, primary diagnoses, chronic coexisting diseases, APACHE II score, mechanical ventilation, ICU LOS, and hospital LOS for the entire ICU cohort during the study time period. For each fall event, a detailed EHR audit was performed to ascertain a clinical description of the event, along with the clinical and operational circumstances before and after the event.

Statistical analysis

Our analysis is primarily descriptive, and we used means with SDs, medians with interquartile ranges (IQRs) and frequencies with percentages to summarise demographic, clinical, operational and outcome data. We compared continuous variables using the Student *t* test or Mann–Whitney U test, as applicable. Proportions were compared using the Fisher exact or χ^2 tests, as applicable. Inter-rater agreement for adjudication of a fall event and whether the

fall event was avoidable was assessed using the intra-class correlation coefficient (ICC). All analyses were performed using Stata, version 14.2 (StataCorp).

Results

In total, 5035 patients were admitted during the audit period. For the non-fall control population ($n = 5009$), the mean age was 56.3 years (SD, 17.1 years); 61% ($n = 3058$) were men; 37% ($n = 1860$) were surgical admissions (9% [$n = 428$] were for trauma); and the mean APACHE II score was 20.4 (SD, 8.5). Median ICU LOS was 3.4 days (IQR, 1.7–7.2 days), with survivors having a median transfer delay of 7.5 hours (IQR, 4.4–27.5 hours). ICU mortality was 13% ($n = 648$). The median hospital LOS was 15.0 days (IQR, 7.0–32.0 days) and, among ICU survivors, the hospital LOS after discharge from the ICU was 9.2 days (IQR, 2.4–23.8 days).

Summary of fall events

Thirty-one possible fall events were reported during the audit. Of these, 26 (84%) were adjudicated as a true fall event (ICC, 1.0 [exact agreement]) for an estimated incidence of 5.2 falls per 1000 ICU admissions (95% CI, 3.4–7.6). Three patients (12%) fell twice. Most fall events

(23 [89%]) were judged as avoidable (ICC, 0.69; 95% CI, 0.37–0.85).

Patient characteristics and outcomes associated with fall events

Table 1 shows the characteristics and outcomes of patients who had had a fall, the matched controls and the full non-fall cohort. Of patients who had had a fall, the mean age was 54.5 years (SD, 17.4 years), 77% were men and 54% were medical admissions. At some point during the ICU admission, most patients (96%) had received non-invasive or invasive ventilation, and 19% had received continuous RRT (CRRT).

In patients who had had falls, there were several clinical differences compared with matched controls, though none were statistically significant (Table 1). For example, fall patients had marginally lower admission Glasgow Coma Scale (GCS) scores and greater receipt of invasive mechanical ventilation. Fall patients had a longer duration of transfer delay from the ICU before the fall event and a longer cumulative ICU and hospital LOS. No patients who had had a fall event died in the ICU. There were no significant differences in ICU or hospital mortality associated with a fall event, compared with matched controls.

Table 1. Summary of clinical characteristics

Characteristic	Patients ($n = 26$)	Matched controls ($n = 126$)	<i>P</i>	Non-fall cohort ($n = 5009$)	<i>P</i> [§]
Mean age, years (SD)	54.5 (17.4)	54.4 (16.7)	0.969	56.3 (17.1)	0.598
Age < 70 years, <i>n</i> (%)	20 (77%)	102 (81%)	0.638	3871 (77%)	0.965
Age ≥ 70 years, <i>n</i> (%)	6 (23%)	24 (19%)	0.638	1138 (23%)	0.965
Men, <i>n</i> (%)	20 (77%)	97 (77%)	0.995	3058 (61%)	0.098
Admission category, <i>n</i> (%)					
Medical	14 (54%)	88 (70%)	0.096	2985 (61%)	0.069
Neurological	2 (8%)	2 (2%)	0.096	86 (2%)	0.069
Surgical or trauma	10 (39%)	35 (28%)	0.096	1860 (37%)	0.069
Mean APACHE II score (SD)	20.2 (5.4)	19.98 (5.4)	0.879	20.4 (8.5)	0.817
Median admission GCS score (IQR)	13.5 (9.0–15.0)	14.0 (12.0–15.0)	0.117	14.0 (11.0–15.0)	0.067
Treatment received, <i>n</i> (%)					
Non-invasive ventilation	4 (15%)	19 (15%)	0.585	514 (11%)	0.292
Invasive ventilation	21 (81%)	90 (71%)	0.235	3185 (65%)	0.070
CRRT	5 (19%)	14 (11%)	0.202	525 (11%)	0.142
Median transfer delay, hours (IQR)	23.2 (6.4–44.7)	13.1 (7.4–40.9)	0.819	7.5 (4.4–27.5)	0.007
ICU death, <i>n</i> (%)	0	14 (11%)	0.075	648 (13%)	0.049
Hospital death, <i>n</i> (%)	2 (8%)	27 (21%)	0.105	1026 (21%)	0.107
Median length of stay, days (IQR)					
ICU	12.0 (8.3–18.6)	4.7 (2.8–8.4)	<.0001	3.4 (1.7–7.2)	< 0.0001
Hospital	31.0 (19.0–49.0)	17.0 (7.0–38.0)	0.014	15.0 (7.0–32.0)	0.002
Post-ICU	13.9 (6.9–27.9)	7.9 (1.9–24.8)	0.125	9.2 (2.4–23.8)	0.164

SD = standard deviation. APACHE = Acute Physiology and Chronic Health Evaluation. GCS = Glasgow Coma Scale. IQR = interquartile range. CRRT = continuous renal replacement therapy. ICU = intensive care unit. § *P* for comparison of case v all others in total cohort.

Clinical and operational characteristics associated with fall events

Table 2 summarises clinical and ICU operational features at the time of the fall events. The mean ICU occupancy before falls was 83% (SD, 6.1%; range, 70.0%–93.8%), with six falls (23%) occurring when occupancy was < 80% and four falls (15%) occurring when occupancy exceeded 90%. Of the falls, 31% occurred in patients designated as ward-ready, 46% occurred after hours, and only 42% were witnessed. Falls were common during nursing cross-coverage for breaks (42%) and 27% occurred within 2 hours of a shift change. Before the fall, 50% of patients had delirium and 12% had restraints applied. No patient sustained a major injury related to their fall (eg, fracture or head injury), but four (15%) reported minor injuries (eg, laceration or abrasion). The mean ICU LOS after the fall was 2.2 days (range, 1.2–2.9 days).

Discussion

We performed a retrospective, quality assurance audit of all adult patients admitted to a large, tertiary academic ICU to describe the incidence, correlates, outcomes and operational circumstances associated with patient fall events.

Summary of key findings

Fall events identified were infrequent but mostly avoidable. Falls appeared to be associated with a mix of patient-specific vulnerabilities and ICU operational factors. Our audit suggests that, although not statistically significant, patients who fell were often men, often had impaired levels of consciousness and/or had delirium. These are all identifiable factors that can be the target for quality improvement initiatives.

We also showed that several ICU organisational factors may be key targets for improvement to reduce the occurrence of avoidable fall events. About one-third of falls occurred in patients classified as ward-ready. Fall patients also appeared to have ICU discharge delays, with considerably longer transfer delays compared with controls. In addition, close to half of fall events occurred after hours, similar numbers occurred during periods of nursing cross-coverage (ie, when there was a transiently reduced nurse:patient ratio), and over half went unwitnessed (ie, patient found on floor).

Falls in our audit were not associated with major morbidity or risk of death, but fall patients did have longer cumulative duration of ICU stay compared with controls.

Interpretation and context with previous literature

Inpatient safety is a recognised priority for improving health care delivery in acute care hospitals,¹³ but adverse events are common and a significant proportion are preventable.¹⁴

Table 2. Summary of fall characteristics

Variable	Data
ICU occupancy before fall, % (mean [SD])	83% (6.1 [70.0–93.8])
Fall factors, <i>n</i> (%)	
Ward-ready before fall	8 (31%)
Night-time fall	12 (46%)
Within 2 hours of nursing shift change	7 (27%)
Primary nurse at break during fall	11 (42%)
Witnessed	11 (42%)
Adjudicated as avoidable	23 (89%)
Patient delirium	
Median ICDSC score (IQR)	3.5 (1–6)
Delirium (ICDSC score ≥ 4), <i>n</i> (%)	13 (50%)
Treatment factors, <i>n</i> (%)	
Non-invasive ventilation before fall	1 (4%)
Invasive ventilation at time of fall	3 (12%)
CRRT before fall	5 (19%)
Restraint used before fall	3 (12%)
Restraint used after fall	11 (42%)

ICU = intensive care unit. SD = standard deviation.
ICDSC = intensive care delirium screening checklist.
CRRT = continuous renal replacement therapy.

Falls are a leading contributor of largely avoidable and unintentional injury in hospitalised patients.¹⁵ Numerous patient and organisational factors have been associated with the risk of falls and risk of serious injury.^{4,11,16,17} There has been substantial focus on improved fall awareness, risk identification and prevention strategies.^{1,15,18,19} Multifactorial audit criteria for development of fall-prevention strategies have been described to improve health care provider awareness and reduce patient risk.¹

There is a paucity of data that has focused on falls in ICUs. The only previous study was also a relatively small retrospective study of fall events occurring in four ICUs.¹⁰ In this study, fall events were also reported as relatively uncommon (42 events; incidence, 0.99 per 1000 patient-days). Similarly to our study, Richardson and colleagues found that falls occurred more often among those with confusion and/or agitation. However, most previous studies have generally focused on fall events occurring in hospitalised patients after ICU discharge. In a single-centre audit of 190 survivors of critical illness requiring mechanical ventilation and an ICU LOS of at least 7 days, 17% had a fall on the hospital ward after ICU discharge.² This study did not provide significant details on patient-specific and operational-specific risks, but the identification of patients at heightened risk of falls may represent an important aspect of ICU discharge planning and care transition.²⁰

Factors found to be associated with an increased risk for in-patient falls include frailty, muscle weakness, impaired mobility, delirium, medications with central nervous system effects (ie, sedation) and postural hypotension.^{7,16,17} These features may be particularly common among survivors of prolonged critical illness.²¹ Our audit suggests that delirium and several ICU operational features may be important factors contributing to falls.

Implications for health policy

Falls are largely preventable adverse events and are potentially associated with major morbidity for patients.^{7,16} We contend that information on ICU-specific fall events should be routinely captured and reported as a key ICU performance measure. We also suggest that data on the operational setting, clinical circumstances and outcomes related to falls be ascertained. This would enable development and implementation of focused, quality-improvement initiatives aimed at prevention. Optimal strategies for fall prevention are uncertain and it is likely that they are context-specific, but such approaches are ideally multifactorial interventions developed through interprofessional engagement.⁷

Limitations

Our project has limitations that warrant consideration. First, this was an audit of a single tertiary academic ICU experience with fall events. Second, we relied on EHR descriptions of fall events to identify patients and it is plausible that many fall events were not clearly documented. Third, relatively few fall events occurred. These factors predispose our study to bias and limited generalisability. Fourth, we did not have additional information on selected aspects of patient treatment such as continuous or interrupted sedation or analgesia. Likewise, we did not have detailed information on concurrent rehabilitation or mobilisation. These factors may have represented important sources of confounding in our audit, but we also note that close of half of falls occurred at night-time, many were unwitnessed and no event was described as an assisted fall. These features would imply that ICU-specific initiatives to mobilise patients were not significant precipitants for fall events.

Conclusions

Falls in the ICU are infrequent and generally perceived as avoidable. Falls often occur at night, are unwitnessed, and are associated with concomitant patient delirium and nursing shift changes and cross-coverage. Fall events should be routinely reported as quality and performance indicators. Additional studies are needed to further describe the contributing factors and delineate patient and resource outcomes associated with falls in ICUs.

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Competing interests

None declared.

Author details

Drayton Trumble¹

Michael A Meier^{1,2}

Maryellen Doody²

Xiaoming Wang³

Sean M Bagshaw^{1,2}

1 Department of Critical Care Medicine, Faculty of Medicine and Dentistry, University of Alberta, Edmonton, Alberta, Canada.

2 Department of Critical Care Medicine, General Systems Intensive Care Unit, University of Alberta Hospital, Alberta Health Services, Edmonton, Alberta, Canada.

3 Research Facilitation; Research Priorities and Implementation; Research, Innovation and Analytics; Alberta Health Services, Edmonton, Alberta, Canada.

Correspondence: bagshaw@ualberta.ca

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