Increasing frequency of critically ill patient turns is associated with a reduction in pressure injuries

Jai N Darvall, Lidgalem Mesfin and Alexandra Gorelik

Hospital-acquired pressure injuries are a particular problem for the critically ill, with rates of up to 20–40% reported for intensive care unit (ICU) patients.[1,2] Critically ill patients are particularly susceptible to pressure injuries, owing to immobility, sedation and hypotension, as well as poor tissue perfusion and organ failure.[3] In addition, ICU patients are often older, with multiple comorbidities and variable nutritional status, which may contribute more generally to the development of pressure injuries.[4] The cost of pressure injuries in Australia has been estimated at $19 000 per critically ill patient affected;[5] in the United Kingdom, 4% of total National Health Service health care expenditure is on pressure injuries.[6]

Although patient turning is a hallmark of pressure injury prevention, data on the impact of frequency of patient turning on pressure injury incidence are limited, and conflicting results have been reported. Observational studies have shown a correlation between pressure injuries and infrequent patient turns, but there have been few interventional studies and these have mainly shown no effect of more frequent patient turns.[7,8] In addition, previous studies have generally manipulated turn frequency as part of an overall "bundle" intervention, involving factors such as mattress selection, skin care and continence management.[9,10] Given the difficulties in assessing individual components of care in bundle interventions, the effect of increasing turn frequency on pressure injury incidence in ICU patients is unclear.

We therefore aimed to assess the impact of an increase in turn frequency from 5-hourly to 3-hourly on the development of pressure injuries in critically ill patients in a prospective intervention study.

Methods

We conducted a prospective, intervention evaluation study at the Royal Melbourne Hospital (RMH) ICU, a 32-bed metropolitan ICU that admits over 2000 patients annually (about 50% of whom are mechanically ventilated). On 8 January 2016, the RMH ICU introduced a new initiative: increasing patient turn frequency to 3-hourly. The aim was to evaluate the efficacy of the initiative and its impact on patient outcomes. This low risk improvement

ABSTRACT

Objective: Pressure injuries are a significant problem for critically ill patients; they increase morbidity, cost, and duration of hospitalisation. Prolonged immobility is a major risk factor, but evidence guiding how frequently patients should be turned to prevent this complication is limited. We aimed to determine the impact of changing from 5-hourly to 3-hourly turns on pressure injury incidence in critically ill patients.

Design: We conducted a pre–post intervention evaluation study, comparing a 6-month period during which patient turns were 5-hourly (1 July 2015 – 31 December 2015) with a 6-month period during which turns were 3-hourly (1 February 2016 – 31 August 2016). These periods were separated by a 3-week wash-in period.

Setting: Intensive care unit in a metropolitan tertiary referral hospital.

Participants: All patients admitted during the pre-intervention and post-intervention periods were included.

Intervention: A change in turn frequency for critically ill patients from 5-hourly to 3-hourly.

Main outcome measures: The primary outcome was the number of patients diagnosed with a pressure injury. Secondary outcomes were the total number of pressure injuries, and the number of decubitus injuries.

Results: In the pre-intervention period, 1094 patients were admitted; in the post-intervention period, 1165 were admitted. Thirty-eight pre-intervention patients (3.5%) and 23 post-intervention patients (2.0%) developed a pressure injury ($P = 0.028$). The incidence of decubitus injuries was markedly reduced in the post-intervention period (36 v 8 injuries, $P < 0.001$). After adjusting for Acute Physiology and Chronic Health Evaluation (APACHE) III score, duration of intubation and age, the odds ratio for developing a pressure injury in the post-intervention period was 0.51 (95% CI, 0.27–0.97) ($P = 0.041$). For mechanically ventilated patients, the adjusted odds ratio for developing a decubitus pressure injury in the post-intervention period was 0.22 (95% CI, 0.06–0.85) ($P = 0.029$).

Conclusions: A change in turn frequency from 5-hourly to 3-hourly was associated with a halved incidence of pressure injuries. Critically ill patients may benefit from more frequent turns.

project was approved by the RMH Human Research Ethics Committee as a quality assurance project (QA2015170). A 6-month historical period during which mechanically ventilated patient turns were 5-hourly (pre-intervention; 1 July 2015 – 31 December 2015) was compared with the 6-month period during which turns were 3-hourly (post-intervention; 1 February 2016 – 31 August 2016). These periods were separated by a 3-week wash-in period to avoid contamination. All adult patients (> 18 years) admitted to the ICU at RMH during the two study periods were included.

Study protocol

Patient turns were conducted by nursing staff and clinical assistants in the following sequence: supine, then left side-lying, then right side-lying. In all positions, 30° elevation of the head end of the bed was maintained. Pillows were placed between bony prominences in areas not in contact with the mattress   for example, between patients' knees when side-lying. Scheduled turns could be skipped by the nursing team leader in consultation with the ICU registrar or consultant in cases of patient hemodynamic or other instability.

The RMH ICU also uses other interventions designed to reduce pressure injury incidence, including risk assessment with a pressure injury prevention plan for all patients, regular skin integrity checks, nutrition and continence management plans, allied health involvement including daily physiotherapy, early mobilisation for suitable patients, and use of pressure-relieving mattresses. Mepilex Border Sacrum and Heel dressings (Mölnlycke Healthcare AB, Göteborg, Sweden) are also applied to patients' sacrum and heels. All these interventions remained the same throughout the study. Beds used in the RMH ICU are VersaCare, TotalCare and Compella Bariatric beds (Hill-Rom, Chicago, USA), with patients cared for on either a NP100 bidensity foam mattress or an integrated air mattress for those identified as being at higher risk of pressure injury or being likely to require long term admission. During the post-intervention period, we conducted random turn audits each month, involving chart review to determine total number of turns over the preceding 24 hours (target = 8 turns/day) for a subset of mechanically ventilated patients in the ICU.

Data collection

We recorded the following baseline patient data: age; sex; comorbidities as defined in the Australian and New Zealand Intensive Care Society Adult Patient Database (ANZICS APD), including immunosuppression, haematological malignancy, cirrhosis or chronic liver disease, respiratory disease, cardiovascular disease, chronic renal failure, metastatic cancer, and insulin-requiring diabetes mellitus; diagnosis on ICU admission; whether mechanical ventilation was used; duration of intubation; and Acute Physiology and Chronic Health Evaluation (APACHE) III score on ICU admission.

Table 1. Baseline demographic and clinical characteristics of patients included in the pre-intervention and post-intervention periods of the study

Characteristic	Pre-intervention (n = 1094)	Post-intervention (n = 1165)	P
Age (years), mean (SD)	58.5 (18.6)	56.5 (19.2)	0.013
Male	716 (65.4%)	771 (66.2%)	0.549
APACHE III score, mean (SD)	61.5 (28.0)	59.0 (26.2)	0.032
Duration of ICU stay (days), median (IQR)	1.9 (1.0–3.7)	1.9 (1.0–3.7)	0.680
Duration of hospital stay (days), median (IQR)	9.8 (5.7–18.2)	9.7 (5.2–17.1)	0.169
Mechanically ventilated patients	558 (51.0%)	613 (52.6%)	0.430
Duration of intubation (hours), median (IQR)	16.3 (8.4–52.0)	17.2 (9.0–53.2)	0.513
Comorbidities			
Immunosuppressed	129 (11.8%)	134 (11.5%)	0.975
Cirrhosis or chronic liver disease	21 (1.9%)	18 (1.6%)	0.761
Metastatic cancer	22 (2.0%)	37 (3.2%)	0.166
Chronic respiratory disease	78 (7.1%)	117 (10.0%)	0.047
Chronic cardiovascular disease	43 (3.9%)	33 (2.8%)	0.345
Chronic renal failure	40 (3.7%)	37 (3.2%)	0.819
Cardiac arrest	10 (0.9%)	8 (0.7%)	0.545

APACHE = Acute Physiology and Chronic Health Evaluation. ICU = intensive care unit. IQR = interquartile range. SD = standard deviation.

Pressure injury data were derived from the RiskMan reporting system, a database of mandatorily reported pressure injuries. In the RMH ICU, any suspected pressure injury identified by bedside nursing staff must be reported to the nursing team leader and entered into RiskMan. Reporting completeness is enhanced by weekly rounds conducted by clinical nurse managers, with a dedicated pressure injury liaison manager responsible for auditing all events. For all reported pressure injuries, we recorded the bodily location, whether decubitus or not (sacral, ischial, buttock, heel, trochanteric, occipital), and the stage according to the US National Pressure Ulcer Advisory Panel scale.[11] The primary outcome was the number of patients diagnosed with a pressure injury. The secondary outcomes were the total number of pressure injuries, number of pressure injuries in the subset of mechanically ventilated patients, and the number of decubitus injuries comprising sacral, ischial, iliac crest, heel, trochanteric and occipital regions (related to recumbent pressure).

Statistical analysis

A power calculation was performed based on previous reports of pressure injury rates in the critically ill, conservatively assuming 5% of unselected pre-intervention ICU patients would develop a pressure injury, with an absolute reduction of 50% to an incidence of 2.5% in the post-intervention group. This was based on reports with comparable findings: a 2009 Japanese ICU study demonstrating an odds ratio for pressure injury of 0.45 (95% CI, 0.21–0.97; $P = 0.04$) associated with more frequent (2-hourly) patient turns,[1] and a reduction in pressure injuries in a US surgical ICU of over 70% (42 v 12 injuries across 30 audit days; $P < 0.001$) with protocolised 2-hourly turns.[12] Based on these data, 1968 patients (984 in each group) would need to be recruited to provide 80% power with a 2-sided α of 0.05. We thus planned a 1-year study period, as the admission load of the RMH ICU (about 2000 patients/year) would provide an adequate sample size.

Continuous data were tested for normality using the modified Jarque–Bera test, and summarised using mean (standard deviation [SD]), number (%) or median (interquartile range [IQR]) as appropriate. The differences between groups were assessed using 2-sample t tests, Wilcoxon rank-sum tests for continuous data, and either χ^2 or Fisher exact tests for categorical data as applicable. A multivariate logistic regression model was constructed to assess the impact of the intervention on the incidence of pressure injuries with adjustment for potential confounding covariates (such as duration of intubation, APACHE III score, and factors found to be significant on univariate analysis). For all analyses, $P < 0.05$ was considered significant. All analyses were performed using Stata 14.1 (StataCorp).

Results

During the pre-intervention period, 1094 patients were admitted to the ICU; in the post-intervention period, 1165 patients were admitted. Patients admitted during the pre-intervention period were marginally older, had slightly higher APACHE III scores, and were slightly less likely to have respiratory failure (Table 1). There was no difference in the proportion of mechanically ventilated patients (51.0% v 52.6%, respectively; $P = 0.43$) or the duration of intubation between periods. Audits of turning frequency in the post-intervention period were carried out on nine separate occasions over the 6-month period, and 42 mechanically ventilated patients were included. For these patients, a total of 329 turns were carried out in the preceding 24 hours 98% of the target of 336 turns (based on 8 turns/day).

A total of 81 pressure injuries developed during ICU stay in 61 patients, of whom 38 were pre-intervention patients and 23 were post-intervention patients (3.5% v 2.0%, respectively; $P = 0.028$) (Table 2, Table 3, Figure 1). Both total number of pressure injuries and number of decubitus injuries were higher in the pre-intervention period than in the post-intervention period (53 v 28 pressure injuries, 36 v 8 decubitus injuries; $P < 0.001$). After adjustment for APACHE III score, duration of intubation and age, the intervention was associated with a 49% reduction in the risk of a pressure injury (OR, 0.51; 95% CI, 0.27–0.97; $P = 0.041$).

Table 2. Clinical outcomes for pressure-injured patients in the pre-intervention and post-intervention periods

Outcome	Pre-intervention (n = 38)	Post-intervention (n = 23)	P
Patients with pressure injury, number (% of total population)	38 (3.5%)	23 (2.0%)	0.028
Mechanically ventilated patients	33 (86.8%)	18 (78.3%)	0.380
Duration of intubation (days), median (IQR)	6.3 (4.1–11.5)	7.2 (2.1–16.1)	0.763
Duration of ICU stay (days), median (IQR)	12.1 (4.2–16.7)	11.4 (3.6–17.4)	0.699
Duration of hospital stay (days), median (IQR)	28.9 (15.6–48.0)	20.9 (13.2–28.9)	0.165

ICU = intensive care unit. IQR = interquartile range.

There were no differences in the stages of pressure injuries between periods (Table 3).

When considering the subset of mechanically ventilated patients, there was a non-significant reduction in numbers of patients developing any type of pressure injury: 21 pre-intervention patients *v* 15 post-intervention patients (3.8% *v* 2.5%, respectively; *P* = 0.192). Among mechanically ventilated patients, the decubitus pressure injury rate fell from 62.5% of all pressure injuries in the pre-intervention period to 25.0% in the post-intervention period (*P* = 0.011). This remained significant after adjustment for APACHE III score, duration of intubation and age (OR for development of a decubitus pressure injury, 0.22; 95% CI, 0.06–0.85; *P* = 0.029).

Discussion

In this pre–post intervention study, we found a reduction in number of ICU patients with pressure injuries in association with a change in turn frequency from 5-hourly to 3-hourly. In particular, we noted marked reductions in incidence of decubitus injuries in the post-intervention period, in both the overall population and the mechanically ventilated subset of patients, suggesting that the injuries most likely to be prevented by increased turn frequency are those related to recumbent pressure. After adjusting for APACHE III score, the 3-hourly turn intervention was associated with a 49% reduction in the risk of a pressure injury.

Comparison with previous studies

This study contributes a unique perspective on the role of patient turns in pressure injury development in the critically ill. Data from ICU settings are limited, and are mostly from observational studies. A 2009 Japanese study of 98 critically ill patients who developed pressure ulceration, for example, demonstrated a significant correlation between

Table 3. Stages of pressure injuries that occurred in the pre-intervention and post-intervention periods

Pressure injury stage	Pre-intervention (*n* = 53)	Post-intervention (*n* = 28)	*P*
Stage of pressure injury*			0.251
Stage 1	19 (35.8%)	8 (28.6%)	
Stage 2	26 (49.1%)	19 (67.9%)	
Stage 3	0	1 (3.6%)	
Unstageable	5 (9.4%)	0	
Not defined	3 (5.7%)	0	

* Stage defined according to the US National Pressure Ulcer Advisory Panel scale.[11]

Figure 1. Number and location of pressure injuries in the pre-intervention and post-intervention periods, showing significantly fewer decubitus injuries in the post-intervention period
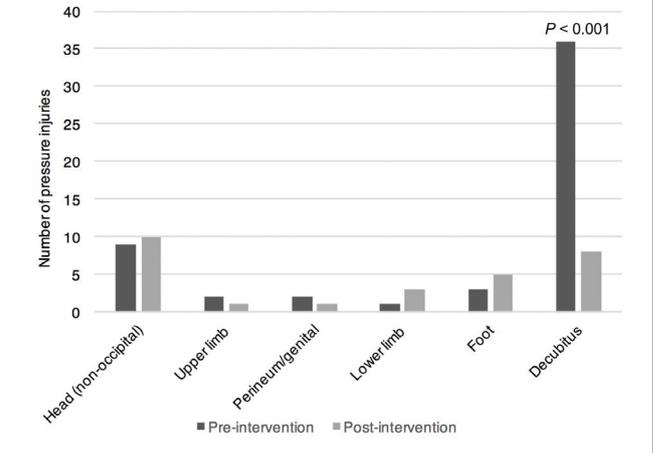
pressure ulceration and infrequent patient turns (longer than 2-hourly).[1] Conversely, interventional studies assessing the effects of more frequent turns in non-hospitalised populations have been disappointing. The recent Turning for Ulcer Reduction (TURN) trial, which included 942 nursing home residents in the United States and Canada, found no difference in the incidence of pressure injuries with turns conducted every 2, 3 or 4 hours.[13] A similar trial comparing 2-hourly and 4-hourly turns in 235 nursing home residents in Belgium also found no difference in pressure injury rates.[8] In contrast, a cluster randomised trial of 213 hospitalised (non-ICU) Irish patients found a reduction in pressure injuries, from 11% to 3%, with an increase in turn frequency from 6-hourly to 3-hourly overnight.[14] Similarly, a pre–post intervention study of implementing a "turn team" in a US surgical ICU, with turn frequency increased to 2-hourly, found a reduction in pressure injuries (42 *v* 12 injuries over 15 audit days in each period; *P* < 0.001).[12] It is likely, from these contrasting findings, that benefits from increased turn frequency are more probable in hospitalised populations. Critically ill patients, in contrast to nursing home residents, are at much higher risk of pressure injury.[2]

The only randomised controlled trial of turn frequency in an ICU setting, by Manzano and colleagues,[7] enrolled 329 mechanically ventilated patients and did not show a statistically significant difference in pressure injury incidence between 2-hourly and 4-hourly turns (10.3% *v* 13.4% of patients with a pressure injury, respectively). This trial, however, was underpowered to detect a clinically important difference, and almost 40% of patients in both groups did not have their allocated turning schedule implemented. This is important because turn implementation could be a more significant factor for individual patients than group allocation. Supporting this theory, a pressure injury

developed in fewer than 5% of patients who received more than 60% of their scheduled turns, whereas a pressure injury developed in about 20% of patients who received fewer than 33% of scheduled turns, suggesting that the actual frequency of turns is the relevant factor in pressure injury prevention. It is therefore likely that the positive finding in our study is related to important factors regarding the study population and the application of the intervention. In addition, the likelihood of relatively high compliance with increased turn frequency in our study may explain why our findings differ from those of Manzano et al.[7]

Clinical implications

Our findings suggest that increasing turn frequency, as a sole intervention that is separate from a bundle of care, may be associated with a reduction in pressure injuries in critically ill patients. Moreover, they imply that the greatest magnitude of change may be seen in the incidence of decubitus pressure injuries, which are mostly related to recumbent pressure, particularly among mechanically ventilated patients. Finally, within the limitations of a single-centre study design, we have shown that implementing such an intervention is feasible in a tertiary mixed-population ICU.

Strengths and limitations

Strengths of our study include its size (at 2259 patients, nearly seven times the size of the most similar ICU study[7]), and enrolment of all admitted patients during the two study periods. Our study population thus represents not just mechanically ventilated patients, but a comprehensive spectrum of ICU patients, enhancing generalisability to other tertiary mixed-population ICU settings comprising medical, surgical and trauma patients. Another strength was regular auditing during the post-intervention period, providing evidence of adequate group separation. In addition, the two study groups were found to be comparable, based on similarity of demographic and clinical characteristics at baseline. A further strength of our study was separate analysis according to the type of pressure injuries, as mechanisms for their development may differ.[15]

Limitations include the single-centre, non-randomised study design. As a pre–post intervention study, it is possible that variables other than turn frequency contributed to the decrease in pressure injuries. In addition, in May 2016 (during the post-intervention period) our ICU moved from a 24-bed unit into a new 32-bed unit. Given that other factors (such as pressure relieving mattresses, ICU bed type, pressure injury prevention plans, heel and sacral pressure relieving pads, and early mobilisation) remained constant throughout the study, and that we controlled for multiple known potential confounding variables, we believe that the change in turn frequency is the most likely explanation for our findings.

The methods we used to measure pressure injury incidence also have limitations, as reliance on the RiskMan reporting structure in the ICU could have introduced bias, although we consider this unlikely. As pressure injury identification and reporting was done by bedside nursing staff (who although being involved in patient turns, were unaware of this study being conducted), and was complemented by regular auditing by nursing team leaders (responsible for groups of 8–10 patients) and clinical nurse managers, we have no reason to suspect differences in reporting rates between periods.

A further limitation was that we did not assess any potential detrimental effect of increased turning on our patients. Repositioning can lead to line and tube dislodgement, pain and discomfort for patients, and sleep disturbance, which we did not measure.[16] Nonetheless, crude measures of patient outcomes (including ICU and hospital length of stay) for patients with pressure injuries did not differ between periods.

Another limitation was that we did not audit the actual time intervals between scheduled turns in the post-intervention period; instead, we audited the total number of turns in the preceding 24 hours. As other reports suggest that implementation of scheduled turns is not done well (with compliance rates in three studies reported as 61%,[7] 36.8%[17] and 20–23%[18]), it is possible that actual turn intervals in our population exceeded the 3-hour target, even if the mean number of daily turns was eight. Also, we did not separately analyse the subset of patients for whom scheduled turns were skipped for reasons such as haemodynamic instability or severe hypoxia, although high compliance with turn frequency indicated by total numbers of turns in our audit sample suggests that scheduled turns were skipped for very few patients. In addition, we did not audit turn frequency in the pre-intervention period, although we have no reason to suspect that turns were conducted more frequently than 5-hourly, as that would have contravened unit policy at the time, and because our ICU was not resourced with the extra staff and budget that would have been needed for this. Moreover, if turns were conducted more frequently than 5-hourly in the pre-intervention period, there would have to be an alternative explanation for the difference in pressure injury rates between periods.

A final limitation was that we did not examine the cost implications of changing our model of care. Although pressure injuries add considerable cost,[5] preventive measures such as increased turning are also costly in terms of increased staffing requirements. A recent randomised controlled trial of economic impact, however, found a

change from 6-hourly to 3-hourly turns was associated with projected cost savings of €510 000 across 588 non-ICU patients in 12 Irish hospitals.[19] It is likely that similar cost savings could be achieved with pressure injury reduction resulting from increased turns in an ICU population and, given the relatively high cost of ICU hospitalisation, cost savings could be even greater. A bundle intervention in four UK ICUs, which included increased frequency of turns to 2-hourly for high risk patients, saw an estimated average cost saving of £2.6 million over 4 years.[9]

Conclusion

In this single-centre study of critically ill patients, we found an association between increasing turn frequency, from 5-hourly to 3-hourly, and reduced (halved) incidence of pressure injuries. These results warrant further investigation in a prospective, multicentre trial, which should ideally be randomised.

Competing interests

None declared.

Author details

Jai N Darvall[1,2]

Lidgalem Mesfin[3]

Alexandra Gorelik[4]

1 Intensive Care Unit and Department of Anaesthesia and Pain Medicine, Royal Melbourne Hospital, Melbourne, Vic, Australia.
2 University of Melbourne, Melbourne, Vic, Australia.
3 Intensive Care Unit, Royal Melbourne Hospital, Melbourne, Vic, Australia.
4 Melbourne EpiCentre, Royal Melbourne Hospital, Melbourne, Vic, Australia.

Correspondence: jai.darvall@mh.org.au

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