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Project Title

Assessing pressure injury risk using a single mobility scale in hospitalised patients: A comparative study using case-control design

Project Lead and Members

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Aims

To ascertain the whether using the Braden mobility subscale alone is comparable to the full Braden scale for predicting the development of pressure injury.

Project Category

Clinical Improvement, Research

Keywords

Clinical Improvement, Research, Applied Research, Comparative Study, Comparative Analysis, Safe Care, Pressure Injury, Hospitalisation, Inpatient, Mobility, Acute Care, Risk Assessment Tool, Preventive Interventions, Nursing, Efficiency of Care, Productivity, Acute Hospital,National University Hospital, Plymouth University (UK), Deakin University (Australia), Saw Swee Hock School of Public Health, National University of Singapore, Braden Mobility Subscale, Braden Scale, Retrospective Case-Control Design, Pressure Injury Predictor, Empirical Evidence

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Journal of Research in Nursing
2018, Vol. 23(5) 387–403

DOI: 10.1177/1744987118762006
journals.sagepub.com/home/jrn
SAGE

Assessing pressure injury risk using a single mobility scale in hospitalised patients: a comparative study using case-control design

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Abstract
Background: Pressure injury is known to cause not only debilitating physical effects, but also substantial psychological and financial burdens. A variety of pressure injury risk assessment tools are in use worldwide, which include a number of factors. Evidence now suggests that assessment of a single factor, mobility, may be a viable alternative for assessing pressure injury risk.
Aims: The aim of this study was to ascertain whether using the Braden mobility subscale alone is comparable to the full Braden scale for predicting the development of pressure injury.
Methods: This study, a retrospective case-control design, was conducted in a large tertiary acute care hospital in Singapore. Medical records of 100 patients with hospital-acquired pressure injury were matched with 100 medical records of patients who had no pressure injury at a 1:1 ratio.
Results: Patients who were assessed using the Braden mobility subscale as having 'very limited mobility' or worse were 5.23 (95% confidence interval (CI) 2.66–10.20) times more likely to develop pressure injury compared with those assessed as having 'slightly limited' mobility or 'no limitation'. Conversely, patients assessed using the Braden scale as having 'low risk' or higher were

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3.35 (95% CI 1.77–6.33) times more likely to develop pressure injury compared with those assessed as 'no risk'. Using full model logistic regression analysis, the Braden mobility subscale was the only factor that was a significant predictor of pressure injury and it remained significant when analysed for the most parsimonious model using backward logistic regression.
Conclusions: These findings provide the empirical evidence that using the Braden mobility subscale alone as an assessment tool for predicting pressure injury development is comparable to using the full Braden scale. Use of this single factor would simplify pressure injury risk assessment and support its use within busy clinical settings.

Keywords
acute care, adult inpatient, Braden mobility subscale, Braden scale, mobility limitation, nursing, pressure injury, pressure ulcer, risk assessment tool

Introduction

Hospitalised patients are at risk of pressure injury (National Health Service [NHS], 2012), which can cause damage to the skin, undue pain and infection and compromise the patient's psychological, emotional, physical and social wellbeing (Gorecki et al., 2012). Infection is reported as the most common major complication (Kirman, 2017), and if severe, it can prolong hospitalisation and increase the risk of mortality (Russo et al., 2008). Patients may also experience psychological and financial effects of pressure injuries, which render them distressed (Gorecki et al., 2009).

Preventing the development of pressure injuries during a patient's hospitalisation remains challenging. Despite extensive research and notable advancement in pressure injury preventive management, there seems to be an increasing trend of patients in hospitals with a secondary diagnosis of pressure injury (Russo et al., 2008). Pressure injury has been identified as one of the healthcare-acquired conditions that can be largely preventable through the application of evidence-based preventive interventions (Rosenthal, 2007; McCannon et al., 2007). This was demonstrated to be effective as a result from the 10-year International Pressure Ulcer Prevalence Survey, which reported a significant reduction of facility-acquired pressure injury in the USA of 6.4% in 2006 to 2.9% in 2015 (VanGilder et al., 2017).

One of the strategies to reduce hospital-acquired pressure injury is the use of a risk assessment tool to identify patients at risk of developing pressure injury which is recommended in various guidelines (National Institute for Health and Care Excellence, 2014; National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance, 2014; Perry et al., 2012) and initiate preventive interventions (Bergstrom, 2008; National Institute for Health and Care Excellence, 2014; National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance, 2014; Perry et al., 2012).

Through a systematic review, the Braden scale was identified as the most studied risk assessment scale (Pancorbo-Hidalgo et al., 2006). It is widely used in healthcare facilities, especially in the USA (Lyder and Ayello, 2008), and is recommended for use by the Institute for Clinical System Improvement (Perry et al., 2012). However, scoring of the Braden scale is complex (Anthony et al., 2010), and there is no direct alignment for determining preventive interventions based on the Braden scale risk levels. Healthcare providers are recommended to initiate interventions based on the assessment of the factor on mobility, moisture and nutrition rather than on the assessed risk level (National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance, 2014). Although evidence on the effectiveness of an assessment tool in preventing the development of pressure injury is inconclusive, an assessment tool is still required (Pancorbo-Hidalgo et al., 2006). Given the issues associated with the use of the full Braden scale, identifying a simpler effective alternative assessment tool is warranted.

Risk assessment

The Braden scale is a psychometric pressure injury risk assessment scale originally developed for use in nursing homes (residential care facilities) to identify patients at risk of developing pressure injury (Braden and Bergstrom, 1989). It consists of six subscales related to sensory perception, moisture, activity, mobility, nutrition, and friction and shear, with four ratings scored from 1 to 4 for increasing levels of severity, except for friction and shear, which is scored from 1 to 3. The sum of the subscale scores determines the individual's pressure injury risk level; a lower score indicates a higher risk for developing pressure injury. The score corresponds to five risk levels – 'very high risk' (score 9 or less), 'high risk' (score 10–12), 'medium risk' (score 13 or 14), 'low risk' (score 15–16) and 'no risk' (score 17 or above) (National University Hospital, 2006).

Using accumulated meta-analysis techniques, Pancorbo-Hildago et al. (2006) reported that the Braden scale gave the best balance of sensitivity (57.1%) and specificity (67.5%) when compared with other commonly used scales, such as the Norton (1989) and Waterlow (2005) scales, and clinical judgement. Furthermore, the meta-analysis revealed that the Braden scale (odds ratio (OR) 4.08, 95% confidence interval (CI) 2.56, 6.48) was the best predictor of pressure ulcer development (Pancorbo-Hidalgo et al., 2006). Although Pancarbo-Hidalgo et al. (2006) found that the Braden scale had been extensively validated, their review also found that there was not enough evidence that the use of risk assessment scales reduced the incidence of pressure injury. Subsequently, a systematic review (Moore and Cowman, 2014), which evaluated the effectiveness of using a validated risk assessment tool versus clinical judgement, found no significant difference in the reduction of the incidence of pressure injury between the groups assessed using the Braden scale versus clinical judgement (Saleh et al., 2009), or between Waterlow, Ramstadius and clinical judgement (Webster et al., 2011).

Therefore, it raises the question of the need for a risk assessment scale in pressure injury prevention when the use of clinical judgement may be as good or better at reducing the incidence of pressure injury (Anthony et al., 2010). Anthony et al. (2010) surmised that performing the complex assessment and scoring of risk assessment scales would be an unnecessary use of nurses' time if the use of clinical judgement was comparable to using the risk assessment scale. However, expertise is a key component in clinical judgement to predict and prevent pressure injury. Pancorbo-Hidalgo et al. (2006) suggested that the lack of consistency of assessment based solely on clinical judgement provides the rationale for continuing the use of structured assessments. It is the contention that a structured yet simpler assessment may be adequate. An extensive systematic review (Coleman et al., 2013) found that mobility is a significant factor in 29 of 36 included studies. However, the review did not report on the comparative predictive measure of the mobility subscale and the full structured scale to furnish the empirical evidence required to support using mobility as the replacement simplified structured tool for assessing pressure injury risk.

In view of the findings from the literature, a systematic review was undertaken (Mordiffi et al., 2011) to ascertain the effect of assessment of mobility on the development of pressure injury. The review concluded that mobility impairment was found to be a significant predictor of pressure injury (Mordiffi et al., 2011). However, there was insufficient evidence to indicate that the assessment of mobility was comparable to the currently available full risk assessment scales, including the Braden scale, as a predictor of pressure injury.

The combined European and national advisory panel and the Pan Pacific Pressure Injury Alliance recommend use of a structured pressure injury risk assessment tool that includes activity and mobility assessment (National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance, 2014). The guideline rationalised that, in order for pressure to develop, mobility and activity limitations have to be present. However, as this is level C evidence, which is indirect evidence or expert opinion (National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance, 2014), more empirical evidence is warranted before this recommendation can be adopted in practice. Thus this paper reports the findings of a study undertaken to ascertain the comparability of the Braden mobility subscale to the full Braden scale in predicting pressure injury.

Methods

The setting for the study was a large 1100+-bed acute care tertiary hospital in Singapore. It was not possible to determine the sample size from historical data from within the country as no previous studies conducted in Singapore were identified that evaluated the effect of exposure to mobility on the incidence of pressure injury. Thus the effect size was derived from one study that had a similar ethnicity to Singapore, and which reported the mean and standard deviation (Chan et al., 2009). Although there is a difference and this is acknowledged, the effect size was computed based on the reported means by Chan et al. (2009) of the Braden scale scores of 2.61 (standard deviation (SD) 0.78) and 2.91 (SD 0.48) for patients with and without the incidence of pressure injury, respectively. Assuming a study power of 80% and an alpha value of 5%, the corresponding sample size was 70 cases per group. As the intention was to perform multivariable regression analysis, the recommendation is that the minimum number of events per risk factor to be included in the regression model should be 10–20 (Harrell et al., 1985; Peduzzi et al., 1996). Thus the sample size was increased to 200 samples from the original 140 samples to accommodate the additional predictors. Using a retrospective design, medical records of adult patients admitted to the inpatient wards from 1 June 2009 to 31 July 2011 were reviewed. Two distinct groups, ‘cases’ and ‘controls’, were formed. ‘Cases’ comprised adult patients 18 years or older, who had acquired a stage 1 or greater pressure injury during their hospitalisation and were identified from the electronic hospital occurrence report (eHOR) for having had hospital-acquired pressure injury events (Figure 1). The eHOR is an electronic reporting system for events such as acquiring a pressure injury during hospitalisation.

The remaining records formed the pool of potential controls and consisted of adult patients who did not have any recorded pressure injury. The controls were matched with the cases on a ratio of 1:1 using the following criteria: patient’s age, gender, surgery, length of stay and previous admission to the intensive care unit (ICU) or the high dependency (HD) ward (Figure 2).

Ethics approval was granted by the university and hospital human ethics review boards. Waiver of informed consent was sought and was approved.

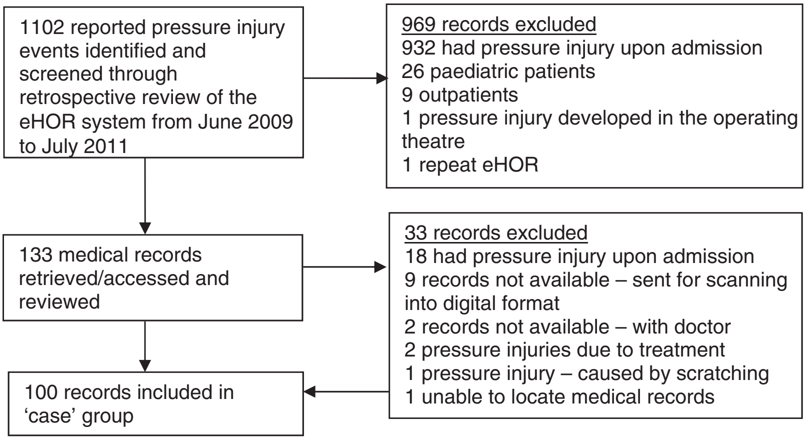

Figure 1. Flowchart on the process for identifying records for inclusion in the case group.

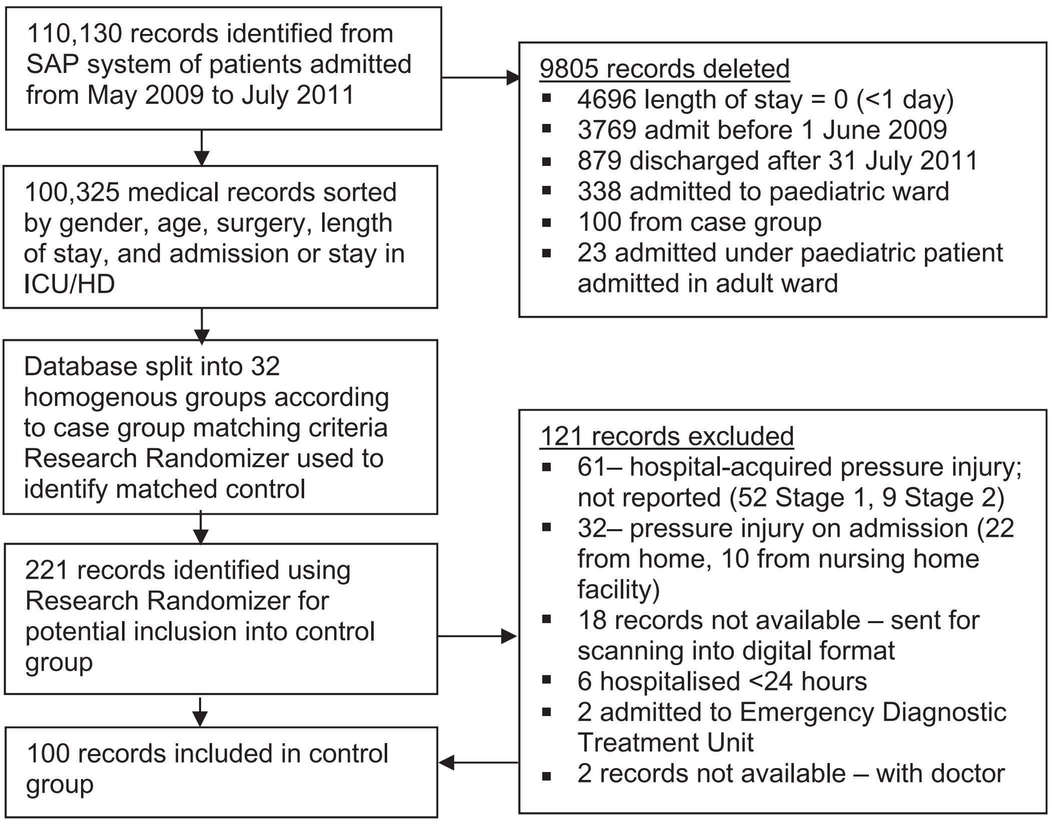

Figure 2. Flowchart on the process for identifying records for inclusion in the control group.

Instrument

A specific data collection tool was created to capture patients' demographic characteristics, admission assessments and characteristics of the pressure injury (case group only). For the group with hospital-acquired pressure injury (cases), characteristics of pressure injury as defined by the European Pressure Ulcer Advisory Panel/National Pressure Ulcer Advisory Panel (EPUAP/NPUAP) classification (European Pressure Ulcer Advisory Panel and National Pressure Ulcer Advisory Panel, 2009) were collected. As the hospital's eHOR provided options for pressure injury ranging from stage 1 to stage 4 only, it was not possible to capture injuries described as 'unstageable' and 'suspected deep tissue injury' as defined by the EPUAP/NPUAP (European Pressure Ulcer Advisory Panel and National Pressure Ulcer Advisory Panel, 2009).

Data analysis

Data were analysed using SPSS version 19.0 (IBM, NY, USA) in consultation with a statistician. Univariate analyses were performed to describe the characteristics of the cases (with pressure injury) and controls (without pressure injury). Bivariate analyses, using the *t*-test for parametric data, and Pearson's and Yate's continuity correction chi-square tests for non-parametric data were performed to identify significant association between the independent variables and the dependent variable (Corty, 2007). Statistical significance was set at 0.05 or less (Corty, 2007; Riffenburgh, 1999). Diagnostic testing, using sensitivity, specificity, accuracy and the receiver operating characteristic (ROC) curve, was undertaken to ascertain the optimal Braden scale and Braden mobility subscale cut-off scores (Warner, 2004). The OR was computed using logistic regression to compare the predictive performance of the variables.

According to Glas et al. (2003) the use of sensitivity and specificity can be disadvantageous when comparing the performance of competing tests (assessment tool), as it is difficult to read and cannot be easily ranked. None of the diagnostic tests in isolation is able to determine the performance of a test (assessment or screening tool) which is based on the interpretation of the combination of the individual diagnostic results simultaneously. Unfortunately, sensitivity and specificity cannot be aggregated to one measure of performance to facilitate comparison. Other reasons are that the results are dependent on the prevalence of the disease and, if rare, such as the case with pressure injury, the predictive values may not be usable. The accuracy is a single measure of the correctly classified (true values of) diagnostic tests generated by adding the true positive and true negative values and dividing it by the total sample (true positive + true negative)/(true positive + true negative + false positive + false negative) (Glas et al., 2003). However, it can only inform on the proportion that is correctly classified and may not be clinically useful.

Logistic regression

According to Levin (2006b), in a case-control design the OR is used to measure the effect of the exposure on the disease. In this current research, the OR is generated using regression tests which assess the impact of a set of predictors on the dependent variable (Pallant, 2011). Given that the dependent variable (for example, the presence or absence of pressure injury) is dichotomous, logistic regression was used in the present study. The omnibus test of model coefficient is reported to check for goodness of fit of the model (Pallant, 2011), whereby an omnibus value of $p < 0.05$ signifies goodness of fit of the model. When there is more than one factor analysed, multivariable logistic regression is utilised, with the factors entered as covariates concurrently. For this analysis, the OR is reported along with beta, standard error (SE), Wald test, degree of freedom (df), significance and the 95% CI. Beta indicates the direction of the relationship between the independent variable and the dependent variable, and its positive value denotes that as the exposure increases so does the outcome of pressure injury. Multicollinearity was explored to establish whether predictor variables are correlated with each other (Pallant, 2011). Its presence in a logistic regression modelling may cause problems and may overestimate the effect of the exposure (Bewick et al., 2005). An SE exceeding 2.0 indicates the presence of multicollinearity (University of Texas, 2012), indicating the need to consider retaining only one of the correlated variables. The Wald test provides an estimate of the importance of the contribution of each variable in the model, with the higher value indicating greater importance. The Hosmer–Lemeshow goodness of fit test is also reported to ascertain whether the model is supported statistically. A significance value exceeding 0.05 ($p > 0.05$) demonstrates support for the model (Pallant, 2011). This test is the most reliable test of model fit. The Cox and Snell, and the Nagelkerke R^2 demonstrate the usefulness of the model in predicting the dependent variable (Bewick et al., 2005). It explains the amount of variation in the dependent variable and can be reported as a percentage (Pallant, 2011). The Nagelkerke R^2 is the most suitable measure of effect size for logistic regression (Bewick et al., 2005; Gómez-Benito et al., 2009). An R^2 of 0–0.1 denotes poor effect, 0.1–0.3 denotes modest effect, 0.3–0.5 denotes moderate effect and 0.5 or more denotes strong effect (Muijs, 2011). Finally, backward logistic regression was undertaken to select important factors that fit into a model (Harrell et al., 1985).

The likelihood of developing pressure injury following assessment using the Braden mobility subscale and the Braden scale was examined; a number of models for further testing were developed. For the Braden scale, four models were tested. For example, for model A, the Braden scale was dichotomised at the cut-off score of 16 or less, denoting the patient as being ‘at risk’ and assigned a value of 1, and a score of 17 or greater corresponding to ‘not at risk’ was assigned a value of 0. The models and the associated cut-off scores were model A ($\leq$16), model B ($\leq$14), model C ($\leq$12) and model D ($\leq$9). The Braden mobility subscale contains only four levels of impairment. Thus only three models at different cut-off scores were tested: model A1 ($\leq$3), model B1 ($\leq$2) and model C1 ($\leq$1).

In terms of the dependent variable, the absence of pressure injury was denoted as 0, and the presence of pressure injury was assigned a value of 1. The dichotomous Braden scale and Braden mobility subscale values for each model were entered separately into a binary logistic regression.

Inter-rater reliability

Inter-rater reliability of the three data collectors was performed on the data collected from the medical records of 10 cases. A discrepancy between raters was observed on the coding for heart failure and cardiovascular disease. The discrepancy was discussed, clarified and the affected entries were re-checked against the information in the medical records, and the data were corrected.

Table 1. Location of pressure injury.

Location of pressure injury	*n*	%
Sacrum	59	59
Gluteal/buttock	16	16
Heel	8	8
Spinal/back	5	5
Malleolus	5	5
Ear	2	2
Occiput	0	0
Shoulder/scapula	0	0
Thorax	0	0
Hip/thigh	0	0
Anal/perineal	0	0
Others:		
Spinal/back and sacral	3	3
Shoulder/scapula and right wrist	1	1
Hip/thigh and sacral	1	1
Total	100	

Results

Description of patient characteristics

A total of 100 records of patients with pressure injury were included in the analysis for the cases. Most pressure injuries were located on the sacrum (59%), followed by those found on the gluteal area (16%) (Table 1).

There were no differences between the cases and control groups in the characteristics that they were matched for, suggesting that matching was successful (Table 2).

The demographic characteristics and contributing factors of pressure injury are summarised in Table 3. Medical specialty, type of admission, anaemia, level of consciousness, needing help in turning in bed, get-up-and-go test, the use of diapers, urinary incontinence, the use of vasopressors and sedation were variables found to be significantly associated with the development of pressure injury.

Comparison between the Braden mobility subscale and the Braden scale

Diagnostic analysis revealed that the greatest accuracy (64.5%) for the Braden scale was found to be a cut-off score of 17. At this cut-off score, sensitivity of 56%, specificity of 73%, positive predictive value of 67.5% and negative predictive value of 62.4% were achieved. Comparatively, the Braden mobility subscale yielding the highest accuracy of 66.5% was found to be the cut-off score of 2 (very limited mobility). At this cut-off score, the sensitivity, specificity and positive predictive value achieved were 48%, 85%, 76.2% and 62%, respectively. An ROC curve was generated to test the accuracy of the Braden scale and the Braden mobility subscale. The area under the ROC curve for the Braden scale and the Braden mobility subscale were comparable at 0.681 (95% CI 0.608, 0.754; $p < 0.001$) and 0.691 (95% CI 0.618, 0.765), respectively (Figure 3).

Table 2. Matched characteristics.

Characteristics	Pressure injury ($n = 100$)		No pressure injury ($n = 100$)	
Gender:				
Female	62%		62%	
Male	38%		38%	
Surgery:				
Yes	44%		44%	
No	56%		56%	
Had been to ICU/HD:				
Yes	27%		27%	
No	73%		73%	
Age:[a]				
Mean (SD)	69.58	(15.765)	65.69	(17.342)
Length of stay (days)[b]				
Median (min to max)	24.00	(5–237)	22.00	(1–97)

ICU: intensive care unit: HD: high dependency ward.
[a]Independent *t*-test.
[b]Mann–Whitney U test.

Logistic regression models for the Braden scale found model C (cut-off score ≤ 12) had the highest OR of 8.647 (95% CI 1.922, 38.898; $p = 0.005$, $R^2 = 7.9\%$) (Table 4). However, the 95% CI was very wide, signifying considerable instability of the point estimates. Although the Braden scale model B (cut-off score ≤ 14) and model A (cut-off score ≤ 16) have a lower OR of 3.50 (95% CI (1.595, 7.679); $p = 0.002$, R^2=7.1%) and 3.35 (95% CI 1.772 to 6.332; $p < 0.001$, $R^2 = 9.5\%$) respectively, compared to model C, models A and B have a narrower 95% CI.

Logistic regression models for the Braden mobility subscale revealed model C1 had the highest OR of 6.056 (95% CI 1.307, 28.073; $p = 0.021$, $R^2 = 4.8\%$). However, its 95% CI was comparatively wider than that of other Braden mobility subscale models. Conversely, the Braden mobility subscale model B1 had the second highest OR of 5.231 (95% CI 2.664, 10.270; $p < 0.001$) but had the highest variance explained ($R^2 = 16.4\%$). Even when compared with the Braden scale models, model B1 demonstrated a modest effect of predictive measure when all other models demonstrated poor effect. Thus the Braden mobility subscale model B1 emerged as a more acceptable model for predicting pressure injury than the Braden scale.

Evaluating the predictive ability of the Braden subscales

Two regression models, models A1 (cut-off score ≤ 3) and B1 (cut-off score ≤ 2) of the Braden subscales, were computed. However, none of the Braden subscales in model A1 was found to be significant. Regression analysis for subscale model B1 (Table 5) revealed that all four Braden subscales were statistically significant: $\chi^2(4, N = 200) = 28.41$; $p < 0.001$). The model as a whole explained 17.7% (Nagelkerke R^2) of the variance in the incidence of pressure injury. In this model (B1), the Braden mobility subscale was the only independent variable in relation to other Braden subscales that made a unique statistically significant contribution to the model, with an OR of 5.714 (95% CI 2.062, 15.676; $p = 0.001$).

Table 3. Characteristics of cases and controls.

Characteristics	Pressure injury ($n = 100$) n (%)		No pressure injury ($n = 100$) n (%)		p value
Medical specialty					0.001
Medical	48	(48.00)	63	(63.00)	
Orthopaedic	36	(36.00)	16	(16.00)	
Surgical	16	(16.00)	21	(21.00)	
Type of admission					0.007
Emergency	88	(88.00)	70	(70.00)	
Scheduled	8	(8.00)	12	(12.00)	
Direct admission	3	(3.00)	9	(9.00)	
Not documented	1	(1.00)	9	(9.00)	
Comorbidities					
Anaemia	25	(25.00)	6	(6.00)	<0.001
Needs help in turning in bed					<0.001
Yes	57	(57.00)	25	(25.00)	
No	43	(43.00)	75	(75.00)	
Level of consciousness					0.025
Unresponsive	5	(5.00)	1	(1.00)	
Drowsy	10	(10.00)	4	(4.00)	
Confused	7	(7.00)	2	(2.00)	
Awake and orientated	78	(78.00)	93	(93.00)	
Get up and go test					0.001
0	5	(5.00)	16	(16.00)	
1	4	(4.00)	11	(11.00)	
3	17	(17.00)	26	(26.00)	
4	73	(73.00)	46	(46.00)	
Not documented	1	(1.00)	1	(1.00)	
Died	18	(18.00)	2	(2.00)	<0.001
Use absorbent products/diapers on admission					<0.001
Yes	28	(28.00)	8	(8.00)	
No	69	(69.00)	89	(89.00)	
Not documented	3	(3.00)	3	(3.00)	
Use diapers during hospitalisation	70	(70.00)	53	(53.00)	0.020
Urinary incontinence					0.009
Yes	34	(34.00)	17	(17.00)	
No	65	(65.00)	82	(82.00)	
Not documented	1	(1.00)	1	(1.00)	
Medications					
Vasopressors	25	(25)	6	(6)	<0.001
Sedatives	24	(24)	12	(12)	0.043

Only results that are significant at $p < 0.05$ are reported here.
Pearson's chi square test used throughout except where sample sizes were small, in which Yates continuity correction chi square test was used instead.
Factors that are not significant (not listed in table): race, smoking, admitted from (own home, nursing home, other hospital, community hospital), comorbidities (cardiovascular disease, diabetes, infection, cancer, renal failure, heart failure, peripheral vascular disease), skin integrity (dryness), sensory (numbness), nutritional status, fever ($\geq$38 degrees) during hospitalisation, bowel incontinence, medications (diuretics, steroids, calcium antagonists, nitrate, skeletal muscle relaxant), blood pressure, nutrition score, duration of surgery.

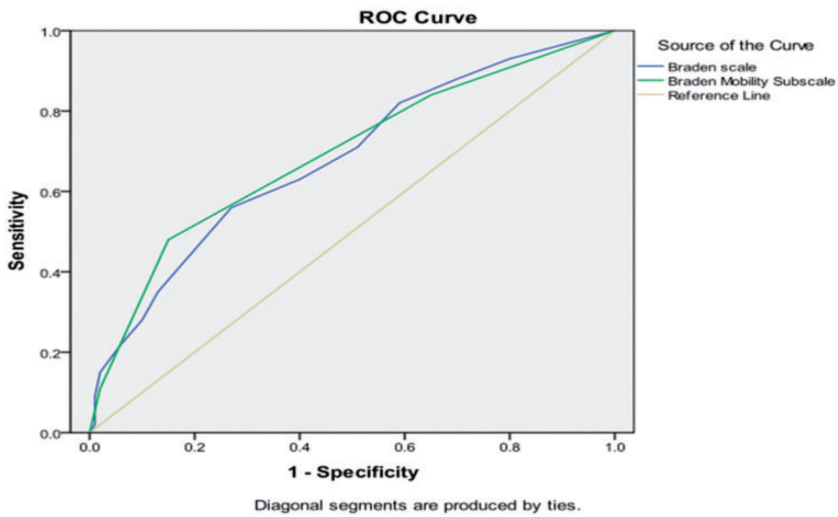

Figure 3. Receiver operating characteristic curve: Braden scale and Braden mobility subscale.

The Braden mobility subscale model B1 remained significant in relation to all other factors when subjected to backward logistic regression with an OR of 5.941 (95% CI 2.816, 12.537; $p < 0.001$) (Table 6).

Discussion

The Braden scale has been extensively validated and was found to be most predictive of pressure injury risk compared to other validated scales such as Waterlow and Norton (Pancorbo-Hidalgo et al., 2006). The Braden scale comprises six subscales, which attract an assigned score using a psychometric scoring system, reflecting the pressure injury risk level. However, the pressure injury risk level does not directly inform the preventive interventions to be instituted. Thus its utility in clinical practice was contentious (Anthony et al., 2010). A simpler, more efficient alternative risk assessment tool of greater utility was warranted. Mobility impairment appeared to be a significant predictor of pressure injury, but until now there has been no comparison of its predictability made conclusively against the full Braden scale (Mordiffi et al., 2011). Thus this study sought to compare the predictive measure of the Braden mobility subscale.

Despite the constraints of a single-site study design, the findings from this study supported the theory that the Braden mobility subscale alone is comparable to the full Braden scale as a predictor of pressure injury development, thus addressing the gap in the evidence arising from the earlier review by Mordiffi et al. (2011).

The need to include all the subscales of the Braden scale had been questioned by Anthony et al. (2010), and the finding reported here – that the Braden mobility subscale was the only Braden subscale that was significant in predicting pressure injury, and it was 5.7 (95% CI 2.062, 15.676; $p = 0.001$) times more likely to predict pressure injury than the other subscales – further support this argument. Consequently, the evidence now indicates that the assessment of pressure injury risk could be safely simplified to the use of a single factor, namely that of mobility.

The growing evidence in support of the use of mobility alone as an assessment tool for preventing pressure injury incidence was supported by one of two studies that were reported

Table 4. Predicting pressure injury: comparison between Braden scale and Braden mobility subscale at various cut-off scores.

Models	Odds ratio (95% CI#)	p-value	Omnibus tests of model coefficients	Nagelkerke R^2 %
Braden scale				
Model A	3.350 (1.772–6.332)	**<0.001**	**14.787 ($p<0.001$)**	**9.50**
Model B	3.500 (1.595–7.679)	**0.002**	**10.882 ($p=0.001$)**	7.1
Model C	**8.647** (1.922–38.898)	**0.005**	**12.176 ($p<0.001$)**	7.9
Model D	4.125 (0.453–37.573)	0.209	1.974 ($p=0.160$)	1.3
Braden mobility subscale				
Model A1	2.827 (1.440–5.548)	**0.003**	**9.68 ($p=0.002$)**	6.3
Model B1	5.231 (2.664–10.270)	**<0.001**	**26.2 ($p<0.001$)**	**16.4**
Model C1	**6.056** (1.307–28.073)	**0.021**	**7.293 ($p=0.007$)**	4.8

Braden scale models	Assigned value and Braden scale score		Braden scale risk level
	0*	1* (cut-off score)	
Model A	≥17	≤16	Low risk
Model B	≥15	≤14	Medium risk
Model C	≥13	≤12	High risk
Model D	≥10	≤9	Very high risk

Braden mobility subscale	Assigned value and Braden mobility subscale score		
	0	1 (cut-off score)	
Model A1	=4	≤3	Slightly immobile
Model B1	≥3	≤2	Very limited mobility
Model C1	≥2	=1	Completely immobile

CI#: confidence interval.
*Assigned value for risk of pressure injury: 0 = not at risk; 1 = at risk.
Note: Bold is showing 'highest' OR on Model C for this group (Braden scale). Similar to the Braden mobility subscale which is bold for Model CI.

in a systematic review (Moore and Cowman, 2014). The systematic review found no difference in pressure injury incidence between using a structured risk assessment scale (Waterlow) and the Ramstadius risk assessment tool or clinical judgement. The Ramstadius risk assessment tool defines patients at risk of developing pressure injury as those who cannot reposition themselves without assistance (Sharp and McLaws, 2006; Webster et al., 2011). However, as the Ramstadius risk assessment tool, has not been used widely, the author suggested that evidence in support of its effectiveness is limited (Webster et al., 2011). Furthermore, Webster's study compared two different tools, whereas this current study was specifically designed to ascertain the comparativeness of the Braden

Table 5. Logistic regression entered for Braden subscales.[a]

Braden subscale Model B1	Adjusted odds ratio	95% CI for odds ratio		Sig.*
		Lower	Upper	
Sensory	1.257	0.334	4.727	0.735
Activity	0.684	0.279	1.675	0.406
Mobility	5.714	2.062	15.676	**0.001***
Nutrition	1.566	0.738	3.321	0.243
Constant	0.603			0.010

Sig.: significance; CI: confidence interval.
*Significant at $p \leq 0.05$.
[a]Excluding friction and shear, and moisture subscales which were not significant in the bivariate analysis.

Table 6. Logistic regression entered for all significant predictors following backward logistic regression.

Significant independent predictors	Adjusted odds ratio	95% CI for odds ratio		Sig.*
		Lower	Upper	
Discipline medical				0.004
Discipline orthopaedics (1)	3.493	1.574	7.750	0.002
Discipline surgical (2)	0.810	0.318	2.067	0.660
Anaemia (1)	5.215	1.830	14.863	0.002
Vasopressor (1)	9.061	3.166	25.937	0.000
Braden mobility subscale model B1 (1)	5.941	2.816	12.537	0.000
Constant	0.256			0.000

Sig.: significance; CI: confidence interval.
*Significant at $P \leq 0.05$.
Model B1: Braden mobility subscale score (cut-off score) ≤ 2 = at risk (assigned value = 1); Braden mobility subscale score ≥ 3 = not at risk (assigned value = 0).

mobility subscale and the full Braden scale within the same study, which to the best of our knowledge has not been undertaken before.

In addition to activity/mobility, a recent systematic review (Coleman et al., 2013) found two other independent predictors, perfusion (including diabetes mellitus) and skin/pressure injury status, that frequently emerged as significant. The review concluded that no single factor explains pressure injury risk. However, the authors reiterate that the heterogeneity of the review in including studies conducted in different settings comprising different populations, poor sample size of not meeting the criteria of 10 samples per pressure ulcer variable, dissimilar study participant starting points, which included those both with and without pressure injury may have biased the findings of the review. Other limitations identified in the systematic review were around the analyses whereby some studies did not use multivariable regression analysis. In some studies statistical interactions between the factors were not tested, thus multicollinearity among the factors may exist, for example bedfast/chairfast patients with mobility restriction, and when entered into the multivariable analysis may generate biased estimation (Yoo et al., 2014), which can give rise to misleading results and erroneous interpretations (Tu et al., 2005). Consequently, this may account for the absence of significant difference in the results for mobility in some studies. The authors (Coleman et al., 2013) recommended future research to address these issues. Nevertheless, this current study has addressed those issues of statistical tests using regression analysis as well as the issue of multicollinearity that was alluded to by Coleman et al. (2013).

Limitations

This was a single-site study in an acute care tertiary hospital. As such, the findings cannot be generalised to other settings due to differences in nursing culture, devices used, and pressure injury protocols. The limitations of collecting data retrospectively are also acknowledged, and include the possibility of incompleteness and inaccuracy of medical record documentation as there was no control over the information recorded or reported (Mann, 2003). Nevertheless, Mann (2003) reasoned that a cohort study is inefficient when the outcome is rare, as a large sample is required (Levin, 2006a; Schulz and Grimes, 2002). In such instances, a case-control design is considered the most feasible (Mann, 2003) – the rationale for choosing the case-control design in the study reported here.

Other limitations of this study are the study endpoint and the timing of data collection. The endpoint of this study was the date of the first reported pressure injury, which may also be the first identified pressure injury in most cases. Unfortunately, information on progression of the extent of the pressure injury was not abstracted in this study as it was outside the scope of this research. In this study it was not possible to assess the effects of gender, age, length of stay, surgery and whether the patients had been admitted to the ICU or HD ward for pressure injury, as these factors were used as the matching criteria for finding a matched control.

Conclusion

This study is specifically designed to ascertain the comparativeness of the Braden mobility subscale and the full Braden scale. We found that the Braden mobility subscale is a comparable predictor of pressure injury with the full Braden scale. Furthermore, mobility emerged as the only significant predictor of pressure injury when other Braden subscales were included in the regression. When compared with other risk factors, mobility remained a significant predictor of pressure injury.

Key points for policy, practice and/or research

- The Braden mobility subscale is predictive of pressure injury, and the findings from this study indicate that it is not unsafe to use mobility as a risk assessment tool in this clinical setting.
- The current study provides further empirical evidence to support using mobility alone as a risk assessment tool for assessing the risk of pressure injury in clinical practice.
- Future research on comparative analysis of the Braden mobility subscale in developing/ascertaining preventive interventions and correlating it with the Braden scale and the Braden mobility subscale should also be considered.
- Subsequently, evaluation on the implementation of the use of the single factor of the Braden mobility subscale and pressure injury interventions dyad should be considered.

Acknowledgements

The authors would like to thank the management and staff of the National University Hospital who supported this study, specifically staff from the Department of Management Information Services, Mrs Lee Siu Yin (then Director of Nursing) and Dr Emily Ang, Deputy Director of Nursing, National University Hospital for their support.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Ethics

Ethics approval was received from the Deakin University Human Research Ethics Committee (DUHREC), Melbourne, Australia, reference no. 2011-160, and the Domain-Specific Review Board, National Healthcare Group (Singapore), reference no. 2011/01368.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship and/or publication of this article: This study was funded by the Deakin University Postgraduate Research (DUPR) Scholarship, Australia for the amount of AU$88,320 (tuition fees) and AU$67,500 (stipend) covering a 3-year period from 2010 to 2013. The National University Hospital Singapore provided manpower and administrative support in kind.

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