Assessment and consideration of foot risk factors is essential for proactive prevention of hospital-acquired foot pressure injuries

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The research outlined in this article aimed to see if high-risk feet were also identified as 'at risk of ulceration' by the Braden Score. One-hundred-and-thirty-two patients had foot risk stratified by a podiatrist and their admission Braden pressure injury (PI) risk level was compared. Only 36% were decreed to be at the same level of risk by both methods. The lack of agreement was demonstrated by a very low Kappa score. The Braden score underestimated PI risk to feet for 52% of the study population. Therefore, the authors concluded that less reliance on the Braden score is needed for the implementation of prevention to reduce rates hospital-acquired foot PIs.

All patients who are admitted to hospital in Western Australia (WA) are assessed for their risk of developing a pressure injury (PI) during their stay (Australian Commission on Safety and Quality in Health Care [ACSQHC], 2012). Within 8 hours of admission, the Braden pressure injury (PI) risk score (Bergstrom, 1987) must be completed by nursing staff and a PI risk management plan, including prevention strategies are put in place as determined by the patients risk score (ACSQHC 2012, Australian Wound Management Association [AWMA], 2012). In addition to the Braden score, clinicians should carry out a full skin assessment and be encouraged to consider comorbidities, such as chronic illnesses and conditions that impair oxygen delivery, tissue perfusion, sensation and/or lymphatic function, as these are all known to increase PI risk (AWMA, 2012).

Pressure injuries can occur over many different bony prominences of the body — the heels account for approximately 30% of all PIs (Graves et al, 2005, Mulligan et al, 2011). They are considered to be a largely preventable condition if appropriate risk identification and management plans are put in place. However, they continue to contribute to extended length of stay, as well as high health, personal and emotional costs to individuals and organisations (Graves et al, 2005; Van Den Bos et al, 2011). Outcomes for heel ulceration on high-risk feet (HRF) are often poor with 50% of calcaneal osteomyelitis (OM) resulting in a major amputation (Faglia et al, 2013).

Podiatrists assess the risk of ulceration to the feet from any cause by identifying a combination of specific foot risk factors and the presence of underlying medical conditions or history. Knowledge of pervious foot complications is critical in assessing current foot risk as patients with previous lower-extremity ulceration or amputation carry a 60% greater risk for re-ulceration (Boulton et al, 2008). The National Health and Medical Research Council (NHMRC) diabetic evidenced-based foot guidelines 2 recommends that foot risk is assessed using the following method (NHMRC, 2011):

- Inquiring about previous foot ulceration and amputation
- Visually inspecting the feet for structural abnormalities and ulceration
- Assessing for neuropathy/loss of protective sensation (LOPS) using either the Neuropathy Disability Score or a 10 g monofilament
- Palpating foot pulses (dorsalis pedis and posterior tibial).

Foot risk is then stratified in the following manner:

- Low risk — people with a relevant underlying medical condition (e.g. diabetes), but no established risk factors and no previous history of foot ulcer/amputation
- Intermediate risk — people with one risk factor (neuropathy/LOPS, peripheral arterial disease or foot deformity) and no previous history of foot ulcer/amputation

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- High risk — people with two or more risk factors (neuropathy/LOPS, peripheral arterial disease or foot deformity) and/or a previous history of foot ulcer/amputation
- People with an active foot complication are also stratified as high risk.

A management plan and risk reduction strategies are then put in place dependent on the risk level assigned (McCabe et al, 1998; Boulton et al, 2008; Leese et al, 2011; NHMRC, 2011; Miller et al, 2014).

Patients who are identified as being at elevated risk by either method of assessment should have heel PI prevention strategies in place for the duration of their admission. It has been observed anecdotally that the Braden score and foot risk stratification do not always identify the same people as at risk. This research has been conducted to assess the degree of congruity of these two methods for identifying heel PI risk, to assist in improving PI risk assessment and, therefore, more effective directed initiation of proactive prevention strategies in hospitals.

Method

This study is an observational cross-sectional sample study comparing the paired results of two well-established methods for identifying heel PI risk. Four wards of a metropolitan general hospital in Perth, Western Australia, were chosen from which to randomly select a sample of hospital admitted participants. These wards were chosen as they are most likely to have patients with medical history, associated risk factors and comorbidities relevant to the research question (Young et al, 2002; Coleman et al, 2013). The wards chosen were:

- Geriatric Medicine and Stroke Unit: 26 beds
- Rehabilitation Unit: 30 beds
- General Medicine: 60 beds.

Inclusion criteria

Patients had to be admitted to one of the wards on the day of data collection and must meet the following criteria:

- Be aged 18 years old and over
- Consent to participate in the study
- Be able to speak and read English
- Be deemed by the ward coordinator to have the cognitive ability to understand and respond appropriately to the questions and screening tests and be well enough to participate.

Consent and ethics approval

Prior to data collection commencement, ethics approval was sort and granted by both the Saint John of God (SJOG) and The University of Western Australia (UWA) Human Research ethics committees as a low-risk study.

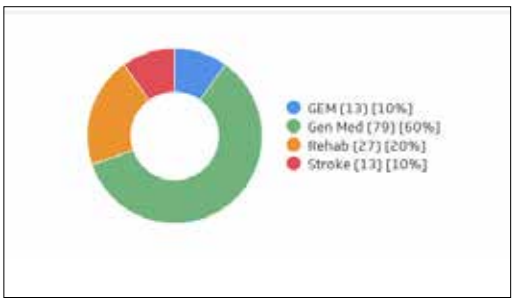

Figure 1. Admission speciality.

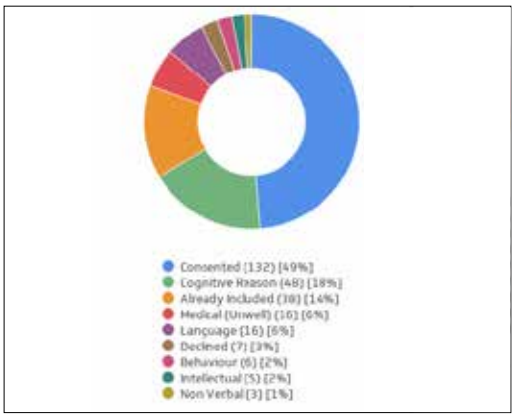

Figure 2. Sample consent/exclusion outcome.

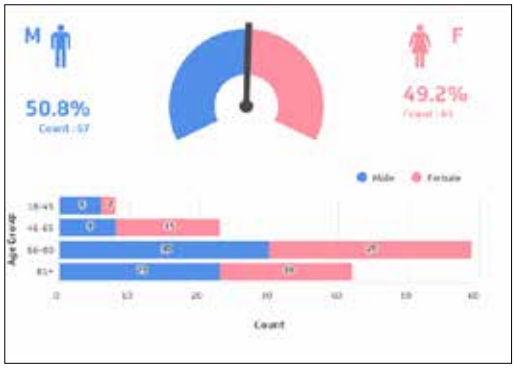

Figure 3. Age and gender demographics of sample.

Data collection process

Data were collected twice from each ward 2 weeks apart to help address variance in the distribution of the sample proportions. The two datasets were recorded in digital form on a tablet to ensure consistency of data collection. The primary investigator (a senior podiatrist) completed the foot risk stratification and collected the HRF data. The Braden score was assigned by the ward staff on admission and copied by the research assistant; it was not recalculated. The two digital data collection

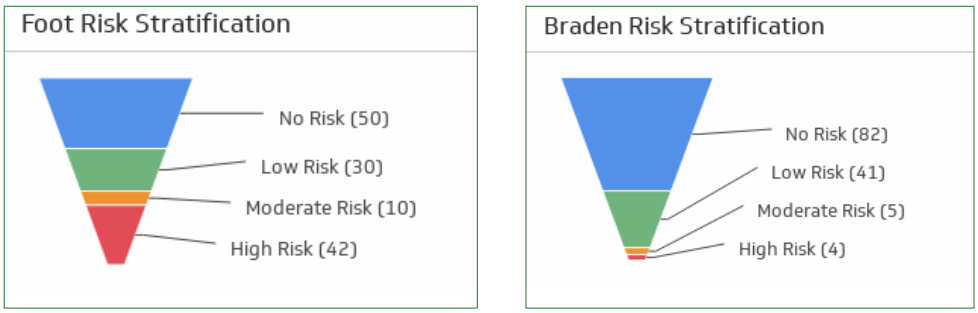

Figure 4. Comparison of proportions of risk stratification identified between Foot Risk Stratification and the Braden Scale.

	No Risk Foot		Low / Mod Risk Foot		High Risk Foot	
Braden No Risk	36	27.3%	28	21.2%	18	13.6%
Braden Low / Mod Risk	13	9.8%	10	7.6%	23	17.4%
Braden High Risk	1	0.8%	2	1.5%	1	0.8%

Figure 5. Paired results matrix.

forms were used independently on the same day and only linked by patient Medical Record Number (MRN) once both had been completed. During collection the primary investigator was blinded to the Braden results and vice versa.

The foot risk stratification that was followed was taken from the NHMRC Diabetic foot guidelines (NHMRC, 2011), which has already been described.

A total of 131 participants were required to reach sufficient power as determined by estimated proportions of foot and PI risk of admitted patients reported in prior research (Young et al, 2002; Lazzarini et al, 2016).

Results

The total population of patients admitted under the relevant specialties/wards was 271 individuals, of which 132 (49%) consented to participate. The majority (60%) of the sample was admitted under general medicine *[Figure 1]*. See *Figure 2* for the reasons people were excluded, as well as the outcome of the sample consent/exclusion.

Figure 3 and *Table 1* show the study population demographics and comorbidities. They were consistent with recent data on the burden of foot disease in hospital-admitted patients in Australia (Lazzarini et al, 2016).

One hundred per cent of the sample population had a Braden score completed on admission. Overall, there were significantly more patients identified as having elevated foot risk than the number identified as at risk of pressure injuries by the Braden score *[Figure 4]*.

The proportion of the population identified as no risk by the Braden score was the biggest group — 82 individuals (62%) with 41 patients (31%) at low risk and only nine individuals (7%) identified as moderate/high risk of pressure injuries. In comparison, the foot risk stratification results showed 50 participants (38%) had no risk identified, 30 (23%) were low risk, 10 (8%) moderate risk, and 42 (32%) had high-risk feet.

When the results of these two risk assessment methods are paired by individual patient only 47 (36%) were identified as at the same level of risk by each method *[Figure 5]*.

Key points of Figure 5

- Forty-six participants (35%) were identified as being at elevated foot risk, but no pressure injury risk. Eighteen of these (14%) had high-risk feet and would not have been identified by the Braden Scale as requiring any prevention strategies
- A further 23 patients (17%) who have high-risk feet were identified as low-moderate risk of PI by the Braden Scale, the risk to feet was likely to be underestimated in this group
- These three groups together equals 69 participants, 52% of the study population,

Table 1. Comorbidities and risk factors of study population.	
Aboriginal or Torres Strait Islander ethnicity	6 (4.5%)
Type 1 Diabetes	3 (2%)
Type 2 Diabetes	45 (34%)
Peripheral arterial disease (including history of revascularisation)	29 (22%)
Peripheral neuropathy	51 (38.6%)
Chronic renal failure (not dialysis)	34 (25.8%)
Self-reported cigarette smoking (including quiting within the last 12 months)	31 (23.5%)
Current acute foot complication	14
Foot ulcer	14 (11%)
Necrosis	1 (0.8%)
OM/severe infection	3 (2%)
Significant high risk foot history	14 (11%) (4 also had current acute foot complication)
Previous foot ulcer	10 (8%)
Amputation	4 (3%) 3 major amputations
Necrosis	3 (2%)
OM/Infection	7 (5%)
Self-reported previous heel pressure injury	8 (6%)

where the Braden score was inadequate in identifying the true PI risk to the feet

- Only 16 participants (12%) were identified as being at higher risk of PIs than their foot risk; in these groups appropriate minimisation strategies should be in place
- Only 36 (27%) were identified on admission as at no risk by both methods
- Only one participant was identified on admission as being both high risk for PIs and had high-risk feet.

Statistical analysis

Cohens Kappa coefficient was used to measure of agreement for two sets of qualitative results. The Kappa value is statistically more reliable than a simple percentage of observed agreement because the Kappa value takes into consideration if the values match by chance. A weighted version is used to take the degree of disagreement into account. A mismatched rating of no risk and high risk is given a higher weighting than a mismatch of no risk and low-moderate risk *[Table 2]*.

Table 2. Statistical analysis of agreement.			
Observed agreement	47/132	35.61%	
Expected agreement by chance	46/132	35.06%	
	Kappa	**SE**	**96% CI**
Kappa value (adjusted for chance)	0.0085	0.051	-0.092 to 0.109
Kappa value with linear weighting	0.082	0.0492	0.033 to 0.179

Regardless of adjustment for chance and weighting the statistical strength of agreement between these two methods for identifying heel PI risk is considered very poor and almost equal to chance.

Current foot PIs in the sample population

Twenty-one individuals in the sample population had 26 PIs, 12 of which were on the feet *[Table 3]*.

Only one of these foot PIs was on a foot with no identified risk factors and 9/12 were on HRF, (three of which were hospital-acquired PIs) (HAPI). A total of 67% were in group with a combination of both elevated PI risk and HRF. Unfortunately, the sample was too small to show any statistical significance.

Discussion

The sample population is considered to be a good representation of a usual population admitted to a general hospital under the four specialities. The demographics were as expected. Male and female ratio was very

Table 3. Foot pressure injuries in the sample population.			
N=12	**No risk foot**	**Low – moderate risk foot**	**High risk foot**
No risk Braden	0	1 (stage 3)	2 (stage 3, US) 1x HAPI
Low-moderate risk Braden	1(stage 2) HAPI	1(stage 1)	7 (stage 1,2,2,2,US, SDT, SDT) 2 x HAPI
High risk Braden	0	0	0

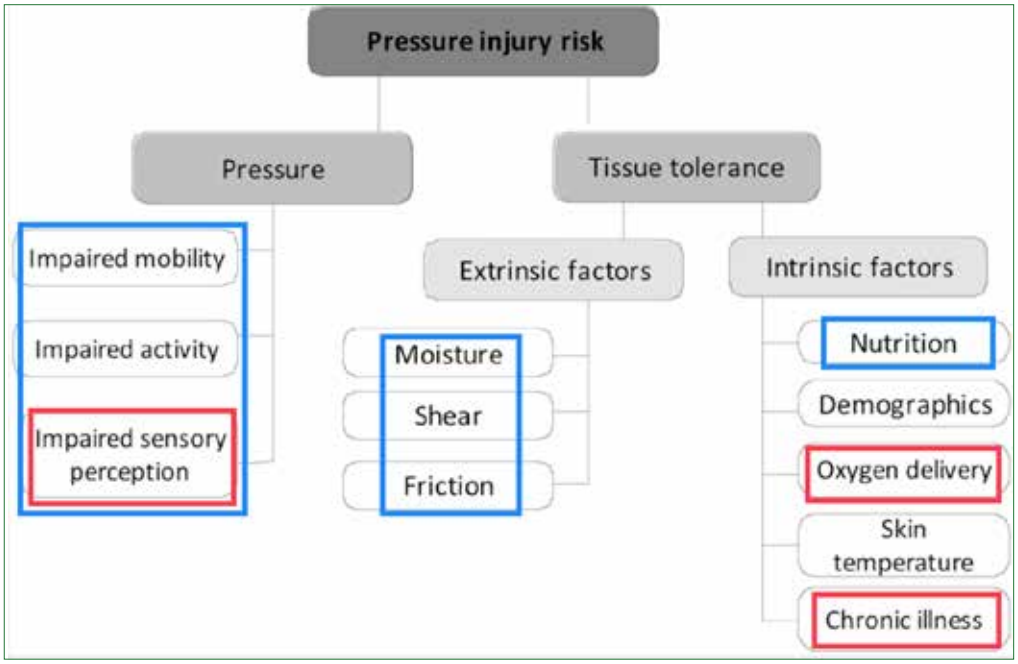

Figure 6. Comparison of risk factors assessed by the two methods (Image taken from Pan Pacific PI guidelines; Australian Wound Management Association, 2012).

even, average age and comorbidities seen were all comparable with other research (Lazzarini et al, 2017).

The Braden score and foot risk stratification are designed to measures different things and it is important to recognise that the Braden risk score is generalised and foot risk stratification is very specific in nature. However, as the results of both methods of screening can be used as justification to guide heel PI prevention it is reasonable to expect a good congruity. However, the Kappa score shows that this is not the case and the two methods of screening identify different people at risk of feet PIs. The use of these two screening process independently of each other is likely to result in over identification of risk and have cost implications when providing prevention.

Foot screening includes two elements of the intrinsic factors that the Braden does not cover — oxygen delivery (PAD) and chronic illness (Diabetes). The Braden assesses five other elements of PI development not included in foot risk assessment *[Figure 6]*.

The only risk factor that is included in both methods of risk assessment is sensory perception, but the approaches to evaluation are very different. The Braden scale has no guidance on how to assess the lack of peripheral sensation, plus assessment is often focused more on conscious level than loss of protective sensation (LOPS). In foot screening, peripheral neuropathy is assessed by using a 10 g monofilament, a validated method of assessing for LOPS as recommended in many best practice guidelines (Leese et al, 2011; NHMRC, 2011; Miller et al, 2014).

Some risk factors assessed by Braden may be less or more important in the development of foot PIs than PIs in other locations. For example, moisture as a risk factor is strongly associated with sacral PIs due to incontinence. Feet at high risk of ulceration tend to be dry and fragile due to autonomic neuropathy and PAD, but dryness it not considered important. Conversely, friction and sheer is highly relevant to heels. It has been shown that heel PIs after major lower-limb amputation is very common, especially for patients who have diabetes (Spittle et al, 2001).

Despite the relevance/impact of comorbidities not being included in the Braden scoring there has been extensive research into their role individually and in combination. In particular, a large retrospective study of 100,000 patients and their comorbidities associated with PI development in the USA revealed 28 diagnoses with an odds ratio >2 (Fogerty et al, 2008) Of these 28 conditions three out of the top four (and eight out of the top 28) are commonly seen in patients who are admitted to hospital with HRF conditions. Gangrene with an OR of 10.94 (95% CI 10.43, 11.48) had the strongest association. Septicaemia OR 9.78 (95% CI 9.33, 10.26) and osteomyelitis OR 9.38 (95% CI 8.81,

9.99) were third and fourth.

A study of the relationship between comorbidities and PI prevalence in long-term care in Australia showed there was a clear relationship between comorbidity status and PI prevalence (Santamaria et al, 2005). No individual comorbidities correlated with prevalence, but the authors concluded that the combinations and severity of the diagnosis is more meaningful than simply the presence or absence of a condition.

Limitations

Patients with dementia, confusion and delirium accounted for 18% of exclusions due to issues gaining their consent to participate. Many of these patients would be of any older age, have poor mobility, multiple comorbidities and, therefore, likely be at elevated PI risk (Young, 2002, Coleman, 2013). Dementia by itself is also a strong risk factor for PIs (Fogerty et al, 2008). The exclusion of these patients in the sample population may have altered the results.

Conclusion

The Braden pressure injury risk score and foot risk screening results did not correlate in this study when assessing for foot pressure injury risk. Statistical analysis using Kappa demonstrated that these two methods of identifying foot PI risk do not identify the same people as at risk. The Braden score missed or underestimated the risk to heels in 52% of the study population as identified by the specific foot risk assessment.

The combination of high-risk feet and elevated PI risk factors increases the likelihood of developing heel PIs during hospital admission. Foot risk factors should be formally included as part of a holistic PI risk assessment. All patients with current foot ulcer(s), and amputation(s) should be managed as high risk for heel PIs, regardless of Braden score and patients with established complications of diabetes, PAD, neuropathy as determined by a validated method or previous foot PI should receive proactive heel PI prevention and close monitoring, regardless of Braden score. Braden score alone should not be the basis of implementation of foot PI prevention strategies but augmented with the recognition of the presence of specific foot risk factors. WINT

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