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ORIGINAL ARTICLE

Comparing visual and objective skin assessment with pressure injury risk

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Abstract

Contemporary approaches to pressure injury (PI) risk identification rely on the use of risk assessment tools and visual skin assessment. Objective biophysical measures that assess skin hydration, melanin, erythema and lipids have not been traditionally used in PI risk; however, these may prove useful as a risk assessment tool. The relationship between subjective visual assessments of skin condition, biophysical measures and PI risk warrants investigation. This study used a descriptive correlational design to examine the relationship between measures of skin hydration, colour (melanin and erythema) and lipids at PI-prone areas amongst geriatric persons ($n = 38$), obtained using biophysical skin measures and visual skin assessment. Twice daily measures of epidermal hydration, colour and lipids were assessed using the SD202 Skin Diagnostic (Courage + Khazaka GmBH, Cologne, Germany) over pressure-prone areas of the body of study participants over seven consecutive days. Concurrent visual assessment of skin hydration and colour was performed. Results obtained using the SD202 Skin Diagnostic were compared with results gathered from visual assessment and examined for their association with participants' PI risk based on scores of the Norton Risk Assessment Scale. While epidermal hydration and skin colour reading scores did not vary significantly over the data collection period, lipid readings could not be registered on any occasion. With the exception of skin dryness, skin parameters via both objective and subjective means had significant, positive correlations. Statistically significant correlations emerged between visual assessment of skin wetness at the sacrum ($r = -0{\cdot}441$, $P < 0{\cdot}01$) and ischia ($r = -0{\cdot}468$, $P < 0{\cdot}01$) and Norton Risk Assessment Scale scores. It was found that the objective assessment of epidermal hydration (skin wetness) was also significantly associated with PI risk at the sacrum ($r = -0{\cdot}528$, $P < 0{\cdot}01$), as well as the right ischia ($r = -0{\cdot}410$, $P < 0{\cdot}05$) and left ischia ($r = -0{\cdot}407$, $P < 0{\cdot}05$). Erythema, when assessed objectively, was significantly correlated with PI risk at the sacrum ($r = -0{\cdot}322$, $P < 0{\cdot}05$). Such findings indicating that the finer measures afforded by the SD202 Skin Diagnostic in the assessment of the subtle red hues displayed in erythematous skin may provide an additional advantage over traditional, clinician assessment.

Introduction

A pressure injury (PI) is defined as 'a localised injury to the skin and/or underlying tissue usually over a bony prominence, as a result of pressure, or pressure in combination with shear' (1, p. 12). PIs are a too common occurrence in aged care residents, with reported annual incidence rates of 2·2–24% (2,3). About 70% of all PIs occur in persons aged more than 70 years (4). The treatment and management of PIs extracts considerable national health care expenditure at Australian public hospitals (5–7), with predicted economic costs amounting to $AUD 285 million (8).

Key Messages

- pressure injuries (PIs) represent a significant health problem and have been attributed to increased mortality rates

- the early detection and management of PIs may prevent their progression into more severe ulcers
- traditionally, clinicians have relied on visual assessment of the skin to ascertain a patient's/client's risk of PI development
- this study reports on the use of a novel approach using biophysical skin diagnostic devices in the cutaneous assessment of PI-prone areas in order to examine the relationship between objective and visual assessment, and their association with PI risk
- the findings highlight the opportunity of using objective biophysical measures as an aid in PI risk identification

Efforts to minimise the incidence of PIs would, therefore, not only enhance the quality of life of those affected but also reduce the resultant cost of care. Clinical skin inspection, particularly over pressure-prone areas such as sacrum, ischia, greater trochanters and malleoli (9,10), forms an essential component of PI risk assessment (11–16). In documenting the skin condition of pressure-prone areas, skin descriptors such as 'erythematous' (17,18) and 'wet/macerated' are commonly used (11,18–21), given the well-recognised role of these clinical characteristics in signalling tissue damage associated with imminent PI development (14,22–25).

For example, epidermal hydration, the percentage of water content within the epidermis (26), plays a pivotal role in the homeostasis of the skin (27–29). Over-hydration of the skin, however, can lead to maceration (30,31) and, thus, reduced epidermal barrier function (32,33) and skin breakdown (19). Under-hydrated or dry skin associated with trans-epidermal water loss from the stratum corneum (34) is equally susceptible to superficial breakdown because of its relative inelasticity and increased fragility to the external effects of pressure, shear and friction (35).

Skin colour is determined, in part, by levels of haemoglobin (36) and melanin (37). The assessment of skin colour at pressure-prone areas can provide a direct reflection of several underlying physiological processes reflective of pressure-induced damage (38). Erythema has been identified as a key sign of pressure-induced skin damage (16,34,39–41), with several studies demonstrating non-blanching erythema to mark the onset of Stage I PIs (40,42–44).

Skin surface lipids are a mixture of sebum, a naturally occurring oily secretion, and keratinocyte membrane lipids. Epidermal lipid deficiencies are often evident in ageing skin (45,46) and have been shown to impact lipid constituents and, thus, the barrier function of the stratum corneum (47,48).

While these skin conditions have been associated with PI risk, visual assessment of skin hydration and colour has been documented in clinical PI studies (49,50) as subject to misinterpretation by assessors, leading to inaccurate data collection. For example, assessors' perception of skin redness may differ significantly (51). In order to achieve a more accurate assessment of these skin parameters, assessment methods that would remove the variability associated with subjective observation should be considered for their potential role in PI assessment. There are biophysical instruments available that enable specialised assessment of these skin parameters (52,53) and, in turn, could lead to more accurate recognition of PI risk, from which appropriate preventive measures could be instigated.

The aim of this research study was to examine the association between measures of skin hydration, colour and lipids at pressure-prone areas as obtained using a biophysical skin measure and visual assessment, and to compare these measures with PI risk scores obtained using a validated risk assessment tool.

Methods

Participants in this study were aged care facility residents in metropolitan Victoria, Australia. The research protocol was approved by the institutional ethics committee review board of the affiliated university. The study was conducted using a descriptive-correlational framework. Convenience sampling was used to recruit eligible residents accommodated at the facility wards. Arrangements for consent on behalf of potential participants to participate in the study were sought from their designated representatives by the facility's Director of Nursing. Data were collected between July and August 2014.

Primary measures

Biophysical measures were obtained using the SD202 Skin Diagnostic Courage + Khazaka GmBH, Cologne, Germany (54). The SD202 Skin Diagnostic is a battery-powered device that combines the sensor technology of a Corneometer, Mexameter and Sebumeter, allowing direct measurements of skin properties of epidermal hydration, melanin and erythema and lipids, respectively. The sensitivity, repeatability and reproducibility of these equipments have been investigated in both in vivo and in vitro tests, yielding very high results (55) indicating these instruments to be very reliable (56). Device readings are presented as arbitrary units ranging from 0 to 99, with low scores indicative of low hydration, melanin, erythema and lipids, while high scores are suggestive of higher hydration, melanin, erythema and lipids.

A single researcher performed all SD202 Skin Diagnostic measures, once in the morning and once in the evening, for seven consecutive days. In accordance with the research study protocol, nine pressure-prone areas were tested: the sacrum, right and left ischium, right and left trochanter, right and left calcaneus and right and left lateral malleolus. No change to participant routine skin care was implemented prior to and after measurements, with existing skin care practices remaining in place for the duration of the study as per the facility policy.

On each occasion, three consecutive lipid readings were taken at each anatomical testing site approximately 20 mm apart to avoid testing the same skin contact point. Following lipid measurements, three consecutive readings of epidermal hydration, assessed using the Corneometer, and three consecutive readings of melanin and erythema, respectively, obtained by the Mexameter, were recorded at the nine anatomical testing sites. An average of the three consecutive readings obtained for each measure at the nine anatomical testing sites was calculated.

Secondary measures

Visual skin assessment was performed by the Research Student immediately prior to obtaining SD202 Skin Diagnostic measures. Participants' skin hydration (skin dryness and skin wetness and/or maceration), pigmentation and the presence of erythema at the nine anatomical testing sites were visually assessed, once in the morning and once in the evening, across seven consecutive days. Participants' skin condition was recorded using dichotomous categories of 'yes' or 'no' for skin dryness and skin wetness and/or maceration. Erythema was graded as either 'nil' or 'light-to-moderate', and melanin was recorded as either 'light' or 'medium', as per the SD202 Skin Diagnostic Reading Reference Guide. Participants' skin condition, with respect to these skin parameters, was assessed by the Research Student who had previously undergone the necessary training in clinical cutaneous assessment.

The Norton risk assessment scale (57) was used to determine each participant's PI risk, which was calculated by the same Registered Nurse at the facility on the first and on the final day of data collection. Score parameters of 9 or less indicate significant risk; 10–13 signify high risk; 14–17 suggest medium risk and 18–20 highlight low PI risk (57). The Norton risk assessment scale has been shown to have fair validity (58) and good reliability within acute care settings (59–61).

Statistical analysis

All statistical analyses were performed using the IBM Statistical Package for the Social Sciences (SPSS) Statistics, Release Version 22.0.0 (Armonk, NY). Demographic data were explored using descriptive statistics and frequencies. Assumptions of statistical tests of normality, linearity and homoscedasticity were initially examined prior to proceeding with statistical data analyses. Pearson's product moment correlation coefficients (r) were calculated to analyse the strength of linear relationships between continuous and dichotomous variables.

One-way repeated measures analysis of variance (ANOVA) was used to assess the variation between SD202 Skin Diagnostic measures taken at the nine anatomical testing sites during morning and evening sessions, across the seven consecutive days. Differences in scores obtained by the Norton risk assessment scale on day 1 and day 7 of data collection were assessed using a paired sample t-test. Relationships and mean differences were considered significant at $P < 0{\cdot}05$ (62).

Results

Demographic profile of the participants ($n = 38$) is presented in Table 1. Ages of the participants ranged from 63 to 103 years. The mean baseline Norton risk assessment scale score of 13·9 [standard deviation (SD) = 4·2)] indicated a 'medium-to-high' level of PI risk (57).

Scores obtained with the SD202 Skin Diagnostic were considered across the seven consecutive days, in the morning and evening, to assess the degree of fluctuation in skin hydration, melanin and erythema. No significant differences were observed for any of the measures at any anatomical testing site across the 14 measures, with the exception of erythema at the sacrum (Wilks' $\lambda = 0{\cdot}432$, $F(13,25) = 2{\cdot}530$, $P = 0{\cdot}022$) and melanin at the right ischia (Wilks' $\lambda = 0{\cdot}441$, $F(13, 25) = 2{\cdot}441$, $P = 0{\cdot}027$). Although the erythema mean values were statistically significant, they fluctuated at the sacrum with no discernible pattern, with the highest mean reported to be 33·0 (SD = 13·2) and the lowest mean 30·3(SD = 13·5). Similarly, variation between melanin mean values at the right ischia was clinically limited, with the highest mean reported to be 15·0 (SD = 5·0) and the lowest mean 13·9 (SD = 5·0).

Table 1 Demographic profile and pressure injury risk of study participants

	Total ($n = 38$)
Age (years) [M (SD)]	80·2 (9·2)
Sex (% female)	63·2
Norton risk assessment scores (baseline) [M(SD)]	13·9 (4·2)
Basal metabolic index [M(SD)]	19·5 (2·9)
Within normal range (%)	73·7
Underweight (%)	26·3
Mobility	
Ambulant or slightly limited mobility (%)	55·3
Restricted mobility or immobile (%)	44·7
Continence	
Continent (%)	50·0
Incontinent or occasionally incontinent (%)	50·0

As shown in Table 2, epidermal hydration, as measured using the SD202 Skin Diagnostic showed the greatest variation by anatomical location and between participants. The lower limb regions – trochanters, calcanei and malleoli – were characterised by very low average readings of epidermal hydration with limited variance. In contrast, the pelvic region – sacrum and ischia – was found to have a high level of epidermal hydration on average and a large range of scores, indicating that participants had variably dry and excessively moist skin. There was limited variation between melanin mean scores reported across the anatomical testing sites. Mean erythema values were highest at the right and left calcanei and lowest at the right and left trochanters.

The Sebumeter recorded lipid readings of 0·0 at every occasion, irrespective of the anatomical testing site. As a result, analyses of skin lipids in relation to PI risk could not be conducted.

Based on visual skin assessment, the trochanters, calcanei and malleoli were found to be the driest of all anatomical testing sites, while skin wetness was found to be the highest at the sacrum (73·7%), followed by the ischia (65·8%), right trochanter (10·5%) and left trochanter (7·9%). Erythema was frequently observed at the left calcanei (81·6%) and right calcanei (78·9%) and occurred least at the trochanters (23·7%).

There was no difference between Norton Risk Assessment Scale scores calculated at baseline data collection and those calculated on the final day of data collection (M = 13·9, SD = 4·2). As a result, a paired sample t-test could not be performed.

Table 2 Descriptive results of baseline SD202 Skin Diagnostic measures ($n = 38$)

		Epidermal hydration		Melanin		Erythema	
Anatomical location		M(*SD*)	Min-Max	M(*SD*)	Min-Max	M(*SD*)	Min-Max
Sacrum	am	65·4 (29·6)	14·0–99·0	15·2 (6·5)	2·0–19·0	30·7 (12·3)	9·0–78·0
	pm	62·7 (24·9)	16·0–99·0	15·2 (6·3)	2·0–17·0	30·2 (13·5)	11·0–81·0
Right ischium	am	47·9 (27·1)	16·0–99·0	13·8 (5·0)	2·0–16·0	30·3 (14·5)	8·0–76·0
	pm	47·3 (25·2)	18·0–99·0	14·2 (5·4)	3·0–18·0	31·2 (15·8)	14·0–82·0
Left ischium	am	47·0 (24·5)	17·0–99·0	13·8 (5·0)	4·0–17·0	30·2 (15·6)	9·0–78·0
	pm	45·6 (25·8)	16·0–99·0	14·2 (5·4)	4·0–18·0	30·4 (14·7)	12·0–86·0
Right trochanter	am	24·3 (15·2)	12·0–54·0	11·7 (3·6)	2·0–21·0	18·6 (6·9)	6·0–62·0
	pm	24·0 (14·3)	12·0–49·0	11·4 (3·6)	2·0–19·0	18·0 (6·5)	6·0–68·0
Left trochanter	am	24·3 (15·0)	10·0–41·0	11·1 (3·8)	2·0–16·0	18·5 (6·2)	6·0–60·0
	pm	23·8 (14·8)	12·0–46·0	11·0 (3·6)	2·0–18·0	18·1 (6·1)	7·0–63·0
Right calcaneus	am	2·3 (5·5)	0·0–14·0	8·7 (4·5)	1·0–12·0	33·0 (15·5)	1·0–76·0
	pm	2·2 (5·5)	0·0–10·0	9·5 (4·3)	2·0–12·0	33·0 (15·5)	3·0–78·0
Left calcaneus	am	2·4 (6·1)	0·0–10·0	9·7 (4·3)	2·0–11·0	32·8 (17·0)	2·0–70·0
	pm	2·3 (6·1)	0·0–12·0	9·8 (3·8)	2·0–13·0	33·4 (15·7)	3·0–81·0
Right malleolus	am	6·7 (10·9)	0·0–14·0	10·9 (4·4)	3·0–18·0	29·3 (14·6)	2·0–59·0
	pm	7·1 (10·5)	0·0–12·0	10·9 (4·5)	2·0–18·0	28·5 (13·1)	2·0–63·0
Left malleolus	am	7·9 (11·5)	0·0–12·0	10·6 (4·8)	2·0–18·0	27·9 (15·4)	2·0–52·0
	pm	7·7 (10·8)	0·0–11·0	10·6 (4·2)	1·0–17·0	27·6 (13·8)	4·0–58·0

Table 3 Baseline correlations between SD202 Skin Diagnostic measures and visual skin assessment ($n = 38$)

	Hydration (dry) (*r*)	Hydration (wet) (*r*)	Melanin (pigment) (*r*)	Erythema (*r*)
Sacrum	n/a	0·827**	0·555**	0·704**
Right ischium	n/a	0·734**	0·354**	0·634**
Left ischium	n/a	0·681**	0·487**	0·676**
Right trochanter	−0·192	0·589**	0·589**	0·808**
Left trochanter	−0·141	0·611**	0·423**	0·757**
Right calcaneus	−0·013	n/a	0·555**	0·783**
Left calcaneus	−0·122	n/a	0·430**	0·656**
Right lateral malleolus	−0·190	n/a	0·593**	0·575**
Left lateral malleolus	−0·239	n/a	0·616**	0·435**

n/a, not applicable.
** $P < 0.01$.

Table 4 Association of visual assessment of skin dryness and skin wetness and SD202 Skin Diagnostic results of epidermal hydration to Norton risk assessment scale scores ($n = 38$)

	Visual assessment (dry) (*r*)	Visual assessment (wet) (*r*)	SD202 hydration (*r*)
Sacrum	n/a	−0.441**	−0.528**
Right ischium	n/a	−0.468**	−0.410*
Left ischium	n/a	−0.468**	−0.407*
Right trochanter	0.185	−0.167	−0.066
Left trochanter	0.185	−0.167	−0.152
Right calcaneus	−0.098	n/a	0.066
Left calcaneus	−0.044	n/a	0.047
Right lateral malleolus	0.227	n/a	−0.193
Left lateral malleolus	0.159	n/a	−0.287

n/a, not applicable.
* $P < 0.05$; ** $P < 0.01$.

Association of SD202 skin diagnostic measures to visual skin assessment

No significant correlations were observed between visual assessment of skin dryness and SD202 Skin Diagnostic measures of epidermal hydration at the trochanters, calcanei and malleoli (see Table 3). However, statistically significant strong positive correlations were found between visual assessment of skin wetness and SD202 Skin Diagnostic measures of epidermal hydration at the sacrum, ischia and trochanters ($P < 0{\cdot}01$).

Statistically significant strong positive correlations emerged between visual assessment and SD202 Skin Diagnostic measures of skin pigmentation (melanin) ($P = 0{\cdot}01$) and erythema ($P = 0{\cdot}01$) across all anatomical testing sites . In general, with the exception of skin dryness, the reported correlations are reflective of a strong association between SD202 Skin Diagnostic assessment and visual assessment of epidermal hydration (skin wetness), melanin and erythema, across all anatomical testing sites.

Association of objective and subjective skin assessment to PI risk

Statistically significant correlations emerged between visual assessment of skin wetness at the sacrum ($r = -0{\cdot}441$, $P = 0{\cdot}01$) and ischia ($r = -0{\cdot}468$, $P = 0{\cdot}01$), and Norton risk assessment scale scores (see Table 4), in which lower Norton risk assessment scale scores indicated a higher risk. These results indicate that increased skin wetness at the sacrum and ischia was associated with higher PI risk at these particular pressure-prone areas. It was found that epidermal hydration, when objectively assessed, was also significantly associated with PI risk at the sacrum ($r = -0{\cdot}528$, $P = 0{\cdot}01$), as well as at the right ischia ($r = -0{\cdot}410$, $P = 0{\cdot}05$) and left ischia ($r = -0{\cdot}407$, $P = 0{\cdot}05$). Erythema, when assessed objectively, was significantly correlated with PI risk at the sacrum ($r = -0{\cdot}322$, $P = 0{\cdot}05$) (see Tables 4 and 5).

Table 5 Association of visual assessment and SD202 Skin Diagnostic results of skin pigmentation and erythema to Norton risk assessment scale scores ($n = 38$)

	Visual assessment pigmentation (r)	SD202 melanin (r)	Visual assessment erythema (r)	SD202 erythema (r)
Sacrum	−0.030	0.047	−0.224	−0.322*
Right ischium	−0.099	−0.160	−0.056	−0.268
Left ischium	−0.099	−0.254	−0.163	−0.314
Right trochanter	−0.186	−0.242	−0.184	−0.138
Left trochanter	−0.186	−0.209	−0.127	−0.158
Right calcaneus	−0.169	0.212	−0.176	−0.170
Left calcaneus	−0.169	0.147	−0.081	−0.215
Right lateral malleolus	−0.214	−0.218	0.027	−0.247
Left lateral malleolus	−0.214	−0.255	0.169	−0.256

*$P < 0.05$.

Discussion

The aim of this pilot study was to consider the association between objective and subjective methods in the assessment of skin hydration, skin colour and skin lipids at pressure-prone areas, and to examine the association of these skin parameters to PI risk among geriatric aged care residents. In order to do that, biophysical and visual measures were obtained and compared with each other, as well as with PI risk scores.

The skin lipid parameter (measured using Sebumeter) scores could not be obtained on any occasion. A plausible explanation for the difficulty in assessing lipid measures is that the Sebumeter lacked adequate sensitivity to detect lipids at the nine anatomical testing sites, or that the stratum corneum at these particular anatomical areas had very little lipid content. The current study findings are similar to those of Rayner, Carville (63), who also noted poor ability of Courage + Khazaka Sebumeter to detect lipids at the skin surface of elderly persons.

For the majority of participants, the lower limb region – calcanei and lateral malleoli – showed low readings of epidermal hydration and displayed minimal skin wetness, indicating these regions to be quite under-hydrated/dry. In contrast, the pelvic region – sacrum and ischia – showed a high level of epidermal hydration on average and a large range of scores, indicating that participants had variably dry and excessively moist skin. The results highlight the need for a skin care regime that restores skin hydration at the lower limb areas in particular, with individual assessment of hydration at these anatomical areas being particularly important. The results suggest that weekly assessment using a biophysical device, if not less frequent, is sufficient to evaluate the current levels of hydration (skin dryness) and erythema unless a clinical change or condition indicates more frequent assessment.

No significant correlations were observed between visual assessment of skin dryness and SD202 Skin Diagnostic measures of epidermal hydration (skin dryness) at the trochanters, calcanei and malleoli. This suggests that visual assessment of skin dryness at these particular anatomical locations might not be a valid indicator of skin status. In these instances, it may be concluded that the SD202 Skin Diagnostic may be used to facilitate the assessment of skin hydration at the lower limbs.

In contrast to skin dryness, on all occasions, the assessor's perception of skin wetness was almost aligned with the SD202 Skin Diagnostic assessment of epidermal hydration at the sacrum and ischia. A cogent explanation for this is that the sacrum and ischia have a relatively large surface area and, thus, cutaneous manifestations at this particular region are magnified, as opposed to the extremities that have small surface areas, such as the calcanei and malleoli (12,64). Another possible explanation may be related to general routine hygiene practices, in which nurses are more inclined to inspect the skin at the pelvic region (sacrum and ischia) for the presence of wetness or moisture associated, for example, with urinary incontinence (65), in comparison to skin areas less frequently exposed to sources of wetness or moisture, such as the extremities (calcanei and malleoli) (24,66).

Statistically significant positive correlations were evident between both visual inspection and SD202 Skin Diagnostic measures of erythematous skin across all the nine anatomical testing sites. It can be claimed therefore that, generally, there were no major differences between objective and subjective assessment of erythema. Although no data relating to persistent or transient erythema among participants were collected, readings remained relatively consistent over the course of the data collection period. Similar to erythema, statistically significant positive correlations emerged between objective and subjective measures of skin colour (melanin/skin pigmentation). However, while there was high agreement between both assessment methods in this respect, results beyond this cannot be assumed as there was minimal variance in participants' skin pigmentation.

In general, with the exception of skin dryness, there was no major difference between SD202 Skin Diagnostic assessment and visual assessment of epidermal hydration (skin wetness), melanin and erythema. However, the SD202 Skin Diagnostic may be considered as a useful additional clinical aid for those medical or nursing personnel who may be novice or inexperienced in accurate visual assessment of skin dryness at the lower limbs.

Objective and subjective assessment of PI risk

It was found that elevated epidermal hydration (objective) and increased skin wetness (subjective) were significant indicators of heightened PI risk in reference to the sacrum and right and left ischia. This highlights that neither assessment method is superior to the other with respect to informing PI risk based on epidermal hydration/skin wetness at a person's mid-section/pelvic area. These findings are consistent with those of Romanelli and Flanagan (67), who acknowledged that the presence of skin wetness at pressure-prone areas, such as the sacrum and ischial tuberosities, dramatically heightened the risk of PI development in susceptible individuals. Kwong *et al.* (68) and Baldwin (69) found that continual contact with continence-associated moisture at the ischial tuberosities created alterations in the mechanical properties of the skin, leading to skin maceration, a precursor of PI development.

No direct association between melanin/skin pigmentation and risk of PI development was found. Higher scores of erythema at the sacrum, on the other hand, when assessed using

the SD202 Skin Diagnostic did correspond to a greater level of PI risk ($P = 0{\cdot}05$).

Visual inspection of erythema at any of the anatomical sites was not found to be associated with PI risk. Therefore, with respect to erythema assessment, the SD202 Skin Diagnostic, focusing specifically on measures of erythema at the sacrum, can more accurately facilitate identification of PI risk than current visual techniques.

Limitations

There are several limitations to this study. First, the study results are based on a relatively small participant sample recruited from only one aged care facility in Australia. As such, external validity is limited and the results cannot be generalised beyond a residential aged care population (70,71). Furthermore, a single assessor collected and recorded SD202 Skin Diagnostic measurements which, therefore, did not permit assessment of inter-rater reliability (72).

A 7-day data collection time frame, comprising morning and evening assessment sessions, was undertaken in order to determine fluctuation in skin parameter measures across the nine anatomical testing sites. Monitoring of skin parameters over an extended period of time, even months or years, is required to assess for longer term changes in skin condition and to capture changes in PI risk, by which PI development can be quantified.

Erythema has been reported to be difficult to observe in patients with darkly pigmented skin (73,74). It would have been valuable to investigate the capacity of Mexameter in identifying erythema in persons with darker skin tones. However, as the sample was primarily of Caucasian ethnicity, this was not possible. As such, conclusions as to whether the SD202 Skin Diagnostic would be reliable in this respect cannot be drawn.

Future studies should consider not only visual assessment of the skin but also its tactile assessment, particularly in the case of erythematous skin. Given the ample evidence of the importance of tactile assessment in differentiating between short-term reactive hyperaemia and persistent skin redness associated with deep tissue injury (12,16), tactile skin assessment should be incorporated in the suite of clinical assessment.

Conclusion

These findings highlight that the clinical skills and experiences of a Registered Nurse in visual skin assessment of pressure-prone areas are important. In general, with the exception of skin dryness, strong associations emerged between SD202 Skin Diagnostic assessment and visual assessment of epidermal hydration (skin wetness), melanin and erythema, across all anatomical testing sites. However, there are also some early findings indicating that the finer measures afforded by the SD202 Skin Diagnostic in the assessment of the subtle red hues displayed in erythematous skin may provide an additional advantage over clinician assessment. Although some supportive evidence has been generated, larger studies with a longer monitoring duration are required to fully examine the application of the SD202 Skin Diagnostic in PI risk assessment among geriatric aged care residents.

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