Development of a new risk assessment scale for predicting pressure ulcers in an intensive care unit

Suriadi, Hiromi Sanada, Junko Sugama, Brian Thigpen and Muhammad Subuh

ABSTRACT

Aims and objectives: The study aimed to evaluate the predictive validity and accuracy of a new pressure ulcer risk assessment scale in two Indonesia intensive care units (ICUs).

Background: Several risk assessment scales have been designed to identify patients at risk of developing pressure ulcers in ICU. However, the relative weight of each variable that contributes to pressure ulcer development in these scales is not described to enable designing of a risk assessment scale. Currently, the risk factors contributing to pressure ulcer development include interface pressure, body temperature and cigarette smoking.

Design: A prospective cohort study was conducted in two ICUs in Pontianak, Indonesia.

Methods: A total of 253 patients were recruited to the study from both hospitals. Data collection included new risk assessment scale [i.e. the Suriadi and Sanada (S.S.) scale] scoring, demographic, pressure ulcer severity scores (based on the National Pressure Ulcer Advisory Panel) and skin condition measures. Using the S.S. scale, trained data collectors scored patients once and assessed the body temperature daily until patients were discharged. Additionally, daily data were also collected in relation to the patient’s skin condition and stage of pressure ulcer.

Results: Out of the 253 patients, 72 (28.4%) developed pressure ulcers. In ICU A, the incidence was 27%; pressure ulcers developed into stage I (41.7%), stage II (45.8%), stage III (10.4%) and stage IV (2.1%). In ICU B, the incidence was 31.6%; the development of pressure ulcers was 48% in stage I and 52% in stage II. Using the predictive validity test, the S.S. scale balanced sensitivity (81%) and specificity (83%) at a cut-off score of 4. The area under the receiver-operating characteristic curve was 0.888 (confidence interval: 0.84–0.93).

Conclusion: The S.S. scale was found to be a valid risk assessment tool to identify the patients at risk of developing pressure ulcers in Indonesia ICU.

Key words: Intensive care unit • Pressure ulcer • Risk assessment scale • S.S. scale • Validity

INTRODUCTION

The study was carried out in Indonesia where the incidence of pressure ulcers has been reported to be as high as 33.3% (Suriadi et al., 2006). The incidence of pressure ulcers is higher in Indonesia than in other Asian countries, where the incidence ranges from 2.1% to 31.3% (Sugama et al., 1992; Seongsook et al., 2004; Kwong et al., 2005). Other international studies have reported incidence rates of 7–29% in an intensive care unit (ICU) or acute care setting (Marrie et al., 2003; Whittington and Briones, 2004; Theaker et al., 2005).

This high incidence of pressure ulcers should be a major concern for health care providers who aim to prevent pressure ulcer formation and is a priority for
nursing research in Indonesia. Indeed, pressure ulcer development is one of the most serious problems and is associated with many serious complications (Marrie et al., 2003). The existence of pressure ulcers causes an increase in the incidence of infections, sepsis and additional surgical procedures, together resulting in increased hospital costs, prolonged lengths of hospital stays, excessive pain and unnecessary suffering in affected patients (Jiricka et al., 1995).

The first step in prevention is to correctly identify patients who are at risk of developing a pressure ulcer (Bergstrom et al., 1987a), using a valid pressure ulcer risk assessment scale and instituting appropriate preventative interventions (Bergman-Evans et al., 1994).

Alternative risk assessment scales exist, such as the Braden scale. The Braden scale consists of six subscales: sensory perception, moisture, activity, mobility, nutrition and friction/shear (Braden and Bergstrom, 1987). The Braden scale is one of the most intensively studied risk assessment scales used in identifying the risk of developing pressure ulcers; however, not all studies have shown that the sensitivity and specificity of the Braden scale is sufficient (Halfens et al., 2000).

In Indonesia, the Braden scale has been evaluated in a validity test and using a cut-off score of 12, the sensitivity was 80%, but the specificity was only 54% (Suriadi et al., 2004a). In Indonesia, the Braden scale has thus proved to be unsatisfactory because the scale has a low specificity, which may lead to costly overtreatment (Ramundo, 1995). A useful instrument with a high sensitivity and specificity, a good predictive value and ease of use in clinical practice is therefore required (Edwards, 1996; Streiner and Norman, 1998).

No specific risk assessment scale has been developed in an ICU based on prognostic research related to risk factors in the development of pressure ulcers. We developed a new risk assessment scale for ICU patients based on prognostic research in Indonesia and this article reports on the development and evaluation of this scale and its value in predicting the risk for pressure ulcers in ICUs in Indonesia. Firstly, we developed a new risk assessment scale or Suriadi and Sanada (S.S.) scale to predict the pressure ulcer development using statistical analysis from the previous study. Secondly, before starting the study, the tests for inter-rater reliability of the scale were conducted in the ICU patients. The main objective of this study was to evaluate the predictive validity and accuracy of a new pressure ulcer risk assessment scale (i.e. the S.S. scale) in an ICU.

**Developing a new risk assessment scale**

To develop this new risk assessment scale, data from a previous study involving 105 patients were used (Suriadi et al., 2006). The study had a prospective cohort design conducted in an ICU in Indonesia, where 35 of 105 patients developed pressure ulcers. We investigated risk factors that had a statistically significant difference between patients who did and those who did not develop pressure ulcers. The risk factors were analysed by using stepwise discriminant analysis (Morgan et al., 2003) and the three most important risk factors in the development of pressure ulcers were identified, namely interface pressure, body temperature and cigarette smoking. These three critical factors were incorporated into a new risk assessment scale for predicting pressure ulcers in ICU patients in Indonesia, known as the S.S. scale.

When developing the S.S. scale, previous data were analysed and categories were created for each risk factor based on cut-off scores and/or continuous variables (i.e. interface pressure and body temperature); risk factors were dichotomized (Morgan et al., 2003) using cut-off scores confirmed by receiver-operating characteristic (ROC) curve analyses (Suriadi et al., 2004b). Each risk factor or the subscale was divided into two categories. To develop scoring for the S.S. scale, logistic regression was calculated (Moons et al., 2002). The scores of each category were determined using regression coefficient values (Harrell, 1996). Scores in each risk factor were obtained from regression coefficient values using SPSS program. The interface pressure, in mmHg, had scores of 3 and 0, body temperature had scores of 4 and 0 and cigarette smoking had scores of 2 and 0. The S.S. scale is a summated rating scale made up of three subscale scores from 0 to 4 (but only one goes to 4). The total scores ranged from 0 to 9, with higher scores indicating a higher risk of pressure ulcer formation. A copy of the S.S. scale is presented in Table 1.

Two instruments were used to obtain data: a multi-pad pressure evaluator and a thermometer. A multi-pad pressure evaluator was used to measure the interface pressure. According to Sugama et al. (2002), the multi-pad measures interface pressure based upon changes in the air pressure within each of the three sensors, these changes being caused by the intensity of the applied force. The air pressure is converted to an electric voltage, sent to a computer via an analogue: digital converter and displayed on a monitor screen. The maximum value indicated by the three sensors reflects the interface pressure applied in that measurement session. Sugama et al. (2002) also reported the reliability of multi-pad evaluator being established through a comparison of both the intra- and inter-rater reliability of the interface pressure data generated by the eight nurses. Some of the nurses were familiar and the others were not familiar with the instrument. The comparison was made between the experienced (proficient group) and the
inexperienced (the novice group), and also the comparison was made among each group. The intra-rater reliability of the multi-pad pressure evaluator coefficient of variation was 6.4 ± 12.0% within the novice group and 4.3 ± 6.2% within the proficient group. Among the novice group, the inter-rater reliability of the interface pressure measurement was 11.4 ± 11.9% and among the proficient group 8.1 ± 7.8%. The test validity of the previous studies had shown that cut-off scores for discriminating between patients with and without pressure ulcer damage were approximately 40 mmHg or more for hospitalized elderly patients (Sugama et al., 2002) and 35 mmHg or greater for ICU patients (Suriadi et al., 2006). A digital thermometer was used to measure body temperature and the accuracy of this instrument is ± 0.1°C (C863®, Terumo Medical Products Co. Ltd, Tokyo, Japan, 2001).

The S.S. scale is unique in that it uses multi-pad pressure evaluator and thermometer to assess the risk for pressure ulcers as opposed to other scales. Moreover, the S.S. scale is a simple risk assessment scale developed especially for ICU patients in Indonesia.

Theoretical framework of the S.S. scale
The study was conceptualized within the context of the etiology of pressure ulcer development (Figure 1). Tissue ischaemia and tissue tolerance are the core

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**Table 1** S.S. scale: predicting the risk of pressure ulcers in intensive care unit patients

<table>
<thead>
<tr>
<th>Patient name:</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical record:</td>
<td>Unit:</td>
</tr>
<tr>
<td>Observer:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interface pressure</th>
<th>(3) Risk Interface pressure ≥ 35 mmHg (bony prominence; at sacrum).</th>
<th>(0) No risk Interface pressure &lt; 35 mmHg (bony prominence; at sacrum).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body temperature</td>
<td>(4) Risk Body temperature ≥ 37.4°C.</td>
<td>(0) No risk Body temperature &lt; 37.4°C.</td>
</tr>
<tr>
<td>Cigarette smoking</td>
<td>(2) Risk Cigarette smoking ≥ 10 cigarettes per day before this admission. Stopped smoking ≥ 10 cigarettes per day between 1 month and 1 year before this admission.</td>
<td>(0) No risk Cigarette smoking &lt; 10 cigarettes per day before this admission. Former; cigarette smoking &lt; 10 cigarettes per day, or ≥ 10 cigarettes per day and stopped smoking &gt; 1 year. And/or never smoking.</td>
</tr>
</tbody>
</table>

Total score

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METHODOLOGY
Research design and method
This study, a prospective cohort design, was conducted between October 2004 and July 2005. It was carried out to evaluate the predictive validity of the S.S. scale.

Participants
Selection criteria
Inclusion criteria were that the patients should be aged 18 years or more, admitted to the ICU at least 24 h before enrolment in the study, bedfast, no existing pressure ulcers at the time of enrolment, have the ability to give informed consent and Indonesian origin. If the patients were sedated, unconscious or unable to provide written consent, Indonesian ethics committee permits such information to be obtained from the patient’s family. It was exclusion criteria including active skin disease that would interfere with pressure ulcer assessment and previous enrolment in the study. Any patient who wished to withdraw from the study could do so at any time without any reason whatsoever. If a patient was physically incapable of participating (e.g. difficult to assess their skin condition on a daily basis because the patient could not be manipulated), refused to give consent or the length of the hospital stay was less than 72 h after initial data collection, the patient was not included or was withdrawn.

Sample size and power analysis
Calculations of sample size were conducted according to Hsieh (1989), who proposed the use of event proportions, odds ratios (ORs) and sample sizes, which can be obtained from published tables. To obtain a sample size which allowed for multiple logistic regression, the number from the table is divided by $1 - p^2$, where $p$ is the multiple correlation coefficient. Using statistical analysis, a previous study has shown that the probability of events at the mean value of the covariate is 0.19 and the regression coefficient is 0.43. To detect an OR of 1.6, we therefore needed 222 samples from the table, which were derived from Whittemore’s formula (Hsieh, 1989). To obtain samples for logistic regression, the value from the table was divided by the correlation coefficient value of 0.82 $(1 - 0.43^2)$, indicating a need for 252.4 samples. Following Whittemore’s formula, as presented by Hsieh, a sample size of 252.4 was sufficient to achieve a power of 0.80 (type II error) at the 0.05 (type I error) level of significance for three independent variables in regression analysis.

Setting
The study took place in the ICU of two hospitals in Pontianak, Indonesia. Six of 296 beds in hospital A and 15 of 300 beds in hospital B were allotted to the ICUs, respectively. The sample consisted of 174 patients in ICU A and 79 patients in ICU B.

Outcome measures
Pressure ulcers were staged to classify the degree of tissue damage observed (i.e. stages I-IV) according to the National Pressure Ulcer Advisory Panel (Ayello et al., 2003). Stage I is an observable pressure-related alteration of intact skin, the indicators of which were compared with an adjacent or opposite area on the body and may include changes in one or more of the following parameters: skin temperature (warmth or coolness), tissue consistency (firm or boggy consistency) and sensation (pain or pruritic). The ulcer appears as a defined area of persistent redness in lightly pigmented skin. In darker skin tones, the ulcer may appear with persistent red, blue or purple hues. Stage II tissue damage consists of partial thickness skin loss involving the epidermis or dermis. The ulcer is superficial and presents clinically as an abrasion, blister or shallow crater. A stage III ulcer is defined as full thickness skin loss involving damage or necrosis of the subcutaneous tissue that may extend down to, but not through, the underlying fascia. The ulcer presents...
clinically as a deep crater with or without undermining of the adjacent tissue. Stage IV ulcers involve full thickness skin loss with extensive destruction, tissue necrosis or damage to the muscle, bone or supporting structures, such as tendons or joint capsules.

Establishing inter-rater reliability
Inter-rater reliability is an estimate of the degree to which two or more independent raters or scorers are consistent in their judgements (Goodwin and Prescott, 1981). The procedure for establishing inter-rater reliability in this study was critical to achieving accurate sensitivity and specificity results.

In this study, inter-rater reliability was established prior to data collection. Two nurse practitioners in the ICU, who served as assessors for the study, had the same level of education and experience. They were oriented and informed about the purpose of the study, and received instructions on how to use the S.S. scale. This information was given both orally and in writing. Upon completion of the training programme, the nurse practitioners were asked to complete the S.S. scale for any patients newly admitted to the ICU. To strengthen inter-rater reliability, assessments were made at the same time and each patient was assessed independently by both nurse practitioners. Assessments were conducted at two intervals: 24 h after admission and 72 h after admission.

At the onset, the assessors obtained consent from the patients or their next of kin. A total of 16 patients were rated. The patients ranged in age from 20 to 80 years (mean = 46.88 years and the standard deviation = 15.74); 63% were males and 37% were females. The estimate inter-rater reliability between observers was computed using Pearson product moment correlation (Goodwin and Prescott, 1981; Bergstrom et al., 1987a). Correlations between assessors were $r = 1.00$ for the first assessment and $r = 1.00$ for the second assessment ($p < 0.001$).

Procedure and data collection for the main study
In the course of the study, two assessors were placed in each hospital, one in ICU A and one in ICU B. The researcher selected the patients for this study within 24 h after admission to the ICU, and checked for the presence of pressure ulcers. Then, two nurses being assessors used their assigned scale to independently assess the patients.

The study was reviewed and approved by the institutional ethical review committee and written consent of the study participants was required. The study was explained to all eligible participants. Where patients were unable to give their consent (such as in the case of unconsciousness, ventilation or sedation), the patient’s family members were asked for approval. The patient’s family received verbal and written explanations of the study and all procedures. All patients and families who wished to participate in the study signed a consent form. After consent and enrolment, the patients were assessed by two assessors using the S.S. scale.

To measure interface pressure, the multi-pad pressure evaluator was used; this measurement was taken at the level of the patient’s sacrum/coccyx. All the patients were provided standard equipment mattresses, which were commonly used in the ICU setting, and during pressure measurement the patients were first positioned in the lateral recumbent posture. The patient’s gluteal region was exposed and the area of maximum sacral bony prominence was determined by visual examination. A multi-pad pressure evaluator sensor covered with a disposable plastic bag was applied directly to the centre of the sacral bony prominence and the patient was then placed in a supine position. Three consecutive interface pressure measurements were then recorded.

The body temperature was measured in the patient’s axilla. Then, the assessor gathered cigarette smoking data and demographics. After the patient was first assessed using the S.S. scale, the assessment procedure for body temperature was repeated once a day in the morning until discharge from the hospital. The skin condition and/or degree of tissue damage of each patient were assessed daily by researcher. Skin assessment, including documentation of the anatomic location and stage, was then performed.

Data analysis
Descriptive and univariate analysis was used to calculate the characteristics of the patients with and without pressure ulcers and the characteristic differences between the patients in each unit. Each subscale of the S.S. scale that showed a statistically significant association with pressure ulcer development at a $p < 0.20$ in the univariate analysis was considered as a potential risk factor for inclusion in binary multivariate logistic regression analysis. Logistic regression (multivariate) was applied to measure the strength of association between variables and reported as an odds ratio (OR) and 95% confidence interval (CI) (Morgan et al., 2003). The analyses were performed using SPSS statistical software, version 11 (SPSS, Chicago, IL).

To evaluate the accuracy of the S.S. scale, diagnostic probabilities [sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and the likelihood ratio (LR)] were calculated for the range of
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the S.S. score (Ramundo, 1995; Curley et al., 2003). Sensitivity is the proportion of patients with the target disorder who have a positive test (i.e. the percentage of pressure ulcer positive patients whose scores are ≤ the cut-off). Specificity is the proportion of patients without the target disorder who have a negative test (i.e. the percentage of pressure ulcer patients whose scores are ≥ the cut-off). PPV is the proportion of the patients with a positive test who have the target disorder (i.e. the percentage of patients with scores ≤ the cut-off who developed a pressure ulcer). NPV is the proportion of patients with a negative test who are free of the target disorder (i.e. percentage with scores > the cut-off who do not develop a pressure ulcer). Curley et al. (2003) define the likelihood ratio as ‘the sensitivity divided by 1 – specificity, and can be interpreted as the ratio of the probabilities that a positive test results from a patient with pressure ulcers to that for a patient without pressure ulcers’. For patients with pressure ulcer development, the scores were obtained in the last assessment before pressure ulcers developed. For pressure ulcer negative patients, the mean scores were obtained.

An ROC is a graphical representation of sensitivity (i.e. true positives) on the y-axis versus 1 – specificity (i.e. false positives) on the x-axis over all the possible cut-off scores for a test. Therefore, the ROC provides a measure of the trade-off between the true positive rate versus the false positive rate over all possible dichotomous cut-off scores for a test. Area under the curve (AUC) of the ROC was calculated to assess the overall validity of the scale (Curley et al., 2003; Seongsook et al., 2004). The AUC is a commonly used summary measure of the ROC, with a higher AUC arising from more accurate tests. When the test has no diagnostic ability to predict the outcome, the AUC equals 0.5. The ROC approach is one method that can be used to confirm validity and is widely used for standardization of medical diagnosis, decision-making criteria or the development and standardization of a questionnaire or tool (Seongsook et al., 2004).

Incidence density is computed as the number of persons developing new pressure ulcers (numerator) divided by the total person-days [sum of all the days over which each patient participated in the study (denominator)] (Defloor et al., 2005a; Stausberg et al., 2005).

RESULTS

Characteristics of participants

There was a statistically significant difference in age between the patients admitted to ICU A and B. There were no statistically significant differences between the patients in ICU A and B with respect to the length of hospital stay, Glasgow Coma Scale score at the time of admission and gender (Table 2). The most common reasons for patient admissions to ICU A (n = 174) were stroke (44.3%), head trauma (17.2%) and postoperative care (8%), whereas for the 79 patients in ICU B these were stroke (27.8%), head trauma (16.5%) and postoperative care (30.4%).

Development of pressure ulcers

A total of 47 patients (27%) developed pressure ulcers in ICU A: 20 patients had stage I ulcers, 22 patients had stage II ulcers and 5 patients had stage III ulcers (Table 3). Only one of 47 patients had more than one pressure ulcer (Stages II and IV). The most common site for a pressure ulcer in ICU A patients was the sacrum (44 of 48 pressure ulcers locations, 91.6%). A total of 25 patients (31.6%) developed pressure ulcers in ICU B: 12 patients had a stage I ulcer and 13 patients had a stage II ulcer. The most common site for a pressure ulcer in ICU B patients was the sacrum (100%). There was thus a cumulative incidence of pressure ulcers of 27% and an incidence density of 0.060/100 person-days in patients in ICU A. The cumulative incidence of pressure ulcers was 31.6% and the incidence density was 0.059/100 person-days in patients in ICU B.

In the logistic regression model in Table 4, three subscales from the S.S. scale were associated with an increased risk of pressure ulcer development: (a) interface pressure (OR, 2.2; 95% CI: 1.6–2.9), (b) body temperature (OR, 2.0; 95% CI: 1.7–2.5) and (c) smoking (OR, 1.6; 95% CI: 1.1–2.5).

Table 2 Differences in demographics and clinical characteristics between patients in different intensive care units (n = 253)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Unit A (n = 174)</th>
<th>Unit B (n = 79)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years), mean (SD)</td>
<td>55.2 (18.4)</td>
<td>42.6 (18.8)</td>
<td>0.000</td>
</tr>
<tr>
<td>Length of stay (days), mean (SD)</td>
<td>8.6 (5.8)</td>
<td>7.3 (2.9)</td>
<td>0.091</td>
</tr>
<tr>
<td>Glasgow Coma</td>
<td>9.7 (1.3)</td>
<td>9.4 (1.9)</td>
<td>0.921</td>
</tr>
<tr>
<td>Scale on admission (score), mean (SD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male, n (%)</td>
<td>104 (59.8)</td>
<td>54 (68.4)</td>
<td>0.191</td>
</tr>
<tr>
<td>Female, n (%)</td>
<td>70 (40.2)</td>
<td>25 (31.6)</td>
<td></td>
</tr>
<tr>
<td>Medical conditions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stroke, n (%)</td>
<td>77 (44.3)</td>
<td>22 (27.8)</td>
<td></td>
</tr>
<tr>
<td>Head trauma, n (%)</td>
<td>30 (17.2)</td>
<td>13 (16.5)</td>
<td></td>
</tr>
<tr>
<td>Postoperative care, n (%)</td>
<td>14 (8.0)</td>
<td>24 (30.4)</td>
<td></td>
</tr>
<tr>
<td>Diabetes mellitus, n (%)</td>
<td>13 (7.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infection</td>
<td>14 (8.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>26 (15)</td>
<td>20 (25.3)</td>
<td></td>
</tr>
</tbody>
</table>

SD, standard deviation.
Validity of the S.S. scale

The sensitivities, specificities, PPV, NPV and LR were calculated for the S.S. scale scores, which ranged from 0 to 9 (Table 5). The predictive validity test presented that the S.S. scale cut-off score of 4 produced the best balance of sensitivity, specificity, PPV and NPV in ICU (sensitivity, 81%; specificity, 83%; PPV, 65% and NPV, 91%), respectively. The S.S. scale was found to be a moderate diagnostic tool with a LR of 5. In Figure 2, sensitivity was plotted versus 1 - specificity for each possible score of the S.S. scale to generate the ROC; the AUC was 0.888 (95% CI: 0.84–0.93).

DISCUSSION

This study aimed to evaluate the accuracy of the S.S. scale for predicting the risk of pressure ulcers in the ICU. Using a cut-off score of 4 in this study provided the best-balanced sensitivity and specificity and demonstrated excellence in the AUC (0.888). The most important point is that with a cut-off score of 4, the S.S. scale was able to identify most of the patients with and without pressure ulcers (sensitivity 81% and specificity 83%). It should be noted that the estimates of sensitivity and specificity in this study were a better combination of specificity and sensitivity than with other studies using the Decubitus Ulcer Potential Analyzer (DUPA), specifically 68.8% sensitivity and 64.9% specificity (Jiricka et al., 1995), 100% sensitivity and 54% specificity (Cubbin and Jackson, 1991), and 89% sensitivity and 61% specificity (Hunt, 1993; Seongsook et al., 2004).

The DUPA and Cubbin and Jackson scales were developed especially for ICU patients. The DUPA is a...
Development of a new risk assessment scale for ICU patients

Identification of patients at risk for pressure ulcers by using a risk assessment scale and initiating preventive measures is an important means of reducing the incidence of pressure ulcers (Ayello and Braden, 2002). The Braden scale was mentioned in the Agency for Health Care Policy and Research guideline as being an appropriate clinical tool for determining the risk for pressure ulcers (Ayello and Braden, 2002). Of the studies done in some countries, the scales have been developed and modified, such as the modified Braden, DUPA and Cubbin and Jackson scales (Jiricka et al., 1995; Seongsook et al., 2004; Kwong et al., 2005). Although these scales were studied with a validity test, they are not optimally sensitive and specific. In addition, the relative weight of risk factors and possible correlation with pressure ulcer development in the scales were not fully described. The risk assessment scales that have been developed may be suitable for some countries. Perhaps, this indicates that the choice of a risk assessment scale depends on the characteristics of each country, identifying risk factors for pressure ulcer development, and evaluating the predictability of the scale before using it in clinical practice.

An important finding is that the clinical usefulness of a diagnostic test is largely determined by its accuracy. In the S.S. scale, we identified the LR as a measure of diagnostic accuracy. On the basis of our results, the S.S. scale has a moderate diagnostic accuracy with a LR of 5.

The S.S. scale has provided more accuracy, or predictability, possibly reflecting a strong association between the subscales and pressure ulcers. The present study demonstrated a significantly positive strong relationship, which was determined by the OR. We believe that this subscale has a profound effect on the distribution of skin tissue damage.

The S.S. scale is a new model that uses two objective instruments, namely a multi-pad pressure evaluator that can measure the interface pressure value and a thermometer for measuring body temperature. High interface pressure is a factor in pressure ulcer development (Brienza et al., 2001). The results of our study showed that interface pressure has a dominant effect on pressure ulcers (OR, 2.2), followed by body temperature and cigarette smoking.

Our study has confirmed previous research by Sugama et al. (2002), which used the same instrument (the multi-pad pressure evaluator) for elderly patients and reported that a high interface pressure measured at the sacrum correlated with the occurrence of pressure ulcers. The findings from our study have provided clinical evidence for the usefulness of a multi-pad pressure evaluator. We postulate that the multi-pad pressure evaluator is very useful as one of the variables in the S.S. scale as a risk assessment of pressure ulcers in ICU patients in Indonesia.

Study limitations and clinical implications

There are some potential limitations of this study that require discussion. First, our study was carried out in two city hospitals in Indonesia. The demographics of Indonesian people are likely to differ from other countries in terms of race, skin type, body build, height, weight and culture. Other possible differences included the clinical setting, the patient’s condition, diseases and strategies of intervention. In order to consider such a risk assessment scale to be valid and to effectively assess the patients, it is essential to evaluate the validity of the predictive assessment scales before using it with patients (Seongsook et al., 2004). Second,
this scale involved an instrument, the multi-pad pressure evaluator, which is used to measure the interface pressure. Considering the censor size of the instrument, perhaps it is not completely suitable for use in other countries, especially outside Asia because of differences in body shape, size or body curvature. Figure 3. Third, in relation to cigarette smoking status, it may be that there are differences in the amount of tar and nicotine in the cigarettes and filter design that are used by smokers in differing country.

From the evidence presented in this study, it is considered that some of the advantages to using the S.S. scale as a risk assessment are its convenience for use in clinical practice and that it is well suited for ICU patients. Our study recommends using a cut-off score ≥4, which provides very useful information for prevention programme of pressure ulcers.

The prevention programmes involve repositioning as a primary measure in nursing intervention to prevent pressure ulcer development along with using alternative support surfaces with a low interface pressure value. Turning and repositioning a patient every 2 h may not be sufficient to prevent the development of pressure ulcers, without using an interface pressure-reducing device. Defloor et al. (2005b) reported that the combination of turning the patient every 4 h and the use of a pressure-reducing mattress decreased the incidence of pressure ulcers. We suggest the use of the S.S. scale as a means to identify high-risk patients who need preventive intervention for the development of pressure ulcers in the ICU and to choose an appropriate support surface. For a further study, we need to investigate the S.S. scale in prevention and the use of pressure-reducing devices. This study offers empirical evidence to support the use of the S.S. scale as an assessment for the risk of pressure ulcers in ICU patients in Indonesia.

CONCLUSION
The main conclusion of this study is that the S.S. scale can be beneficial to accurately predict patients who are at risk of developing pressure ulcers among ill patients in the ICUs in Indonesia. The predictive validity of risk assessment scales can be affected by the characteristic of the population. Therefore, it is necessary to evaluate the predictive validity of the scale before use, and to determine its cut-off score on various populations in different health-care settings.

WHAT IS KNOWN ABOUT THIS TOPIC
- Some risk assessment scales for specific ICU patients are available. The scales are mostly not designed on the basis of prognostic research.
- A risk assessment scale that identifies patients who are at risk for pressure ulcer is helpful if it reflects that risk factors contribute to pressure ulcer development.
- In Indonesia, it has been identified that the potential risk factors are associated with the development of pressure ulcers in ICU patients. The factors include interface pressure, body temperature and cigarette smoking. They are designed to function as a new risk assessment scale. This scale has produced better balance between sensitivity and specificity in validity test.
- The pressure ulcer development was higher on the sacrum than on other locations.

WHAT THIS PAPER ADDS
- An important finding is that preventive care for pressure ulcer development could be implemented based on the identification of pressure ulcer risk assessment scale tool.
- The new risk assessment scale for predicting pressure ulcer risk is available and it is effective to use particularly for ICU patients.
- There is a need to use a new risk assessment scale and pressure-reducing mattress to reduce incidence of pressure ulcer.
REFERENCES


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