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Validation of the burn intervention score in a National Burn Centre☆,☆☆

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ABSTRACT

The Linköping burn score has been used for two decades to calculate the cost to the hospital of each burned patient. Our aim was to validate the Burn Score in a dedicated Burn Centre by analysing the associations with burn-specific factors: percentage of total body surface area burned (TBSA%), cause of injury, patients referred from other (non-specialist) centres, and survival, to find out which of these factors resulted in higher scores. Our second aim was to analyse the variation in scores of each category of care (surveillance, respiration, circulation, wound care, mobilisation, laboratory tests, infusions, and operation).

We made a retrospective analysis of all burned patients admitted during the period 2000-15. Multivariable regression models were used to analyse predictive factors for an increased daily burn score, the cumulative burn score (the sum of the daily burn scores for each patient) and the total burn score (total sum of burn scores for the whole group throughout the study period) in addition to sub-analysis of the different categories of care that make up the burn score.

We retrieved 22301 daily recordings for inpatients. Mobilisation and care of the wound accounted for more than half of the total burn score during the study. Increased TBSA% and age over 45 years were associated with increased cumulative (model R^2 0.43, $p<0.001$) and daily (model R^2 0.61, $p<0.001$) burn scores. Patients who died had higher daily burn scores, while the cumulative burn score decreased with shorter duration of hospital stay ($p<0.001$).

To our knowledge this is the first long term analysis and validation of a system for scoring burn interventions in patients with burns that explores its association with the factors important for outcome. Calculations of costs are based on the score, and it provides an indicator of the nurses' workload. It also gives important information about the different dimensions of the care provided from thorough investigation of the scores for each category.

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1. Introduction

The implementation of a computerised registry and therapeutic intervention scoring system adapted specifically for burn care has been described by many authors [1–3]. The scoring systems designed for general intensive care do not reflect burn care accurately [4], however, and the management of the wound in particular is specific to the care of burns, and must be incorporated into the measurement of the workload [3,5–7]. In 2000 we published the intervention scoring system (burn score) used in our centre, [1] which was designed to include burn-specific items in a widely-used score [8], and was validated against the Therapeutic Intervention Scoring System (TISS) [1]. Every patient at the Linköping Burn Centre has been daily scored by a nurse, and the daily scores have been used to calculate the cost of care.

During past decades attention has been directed to the measurement of the workload in general intensive care, and numerous systems have been developed [9–19] to improve the quality of care and optimise the use of resources [16,20–22]. Initially the workload was scored according to therapeutic interventions, and was mainly related to the patient's illness [9–11], but over time the focus has moved from the patient to the nurse, and taken into account other aspects, such as the time spent on nursing activities [12,13,15]. Even human factors have been considered [14,20]. The Burn Score gathers both the nurses' activities and the patients' severity of injury and illness together to give a more accurate balance for the overall burn care provided.

Our aim was to validate the Burn Score by analysing the associations with burn-specific factors such as percentage of total body surface area burned (TBSA%), cause of injury, whether the patient was local or referred from outside that region, and survival. We analysed the factors that resulted in higher scores and consequently increased the workload and resources used. Our second aim was to analyse the variation in scores of each category of care measured by the burn score (surveillance, respiration, circulation, wound care, mobilisation, laboratory tests, infusions, and operation).

2. Methods

All admissions during the period 2000-2015 were included. We analysed data from the prospectively-maintained burn registry that is recorded daily by the nursing staff [1]. The study was approved by the Regional Ethics Review Board in Linköping (2013/341-31).

The study was done in the national burn centre in Linkoping, Sweden which serves about 5 million inhabitants. The burn centre serves the southern region of Sweden and the Uppsala university hospital burn centre serves northern Sweden. Patients could be local residents or referrals, and the severity of burns varied accordingly. Referrals were admitted in line with the national guidelines for burn care in Sweden.

The protocol in our Burn Centre includes early excision and grafting [1,23–25], revision of the wound every second day, standard ventilation [26,27], fluid management [28], and early enteral nutrition, and we recorded the variables: TBSA%, cause of injury, age, sex, patients who were referred from outside the region, duration of hospital stay, and survival. The patient's burn score covered surveillance (patients' vital signs monitoring, physical status including urine output, ECG monitoring, oxygen saturation and invasive cardiac function monitoring), respiration, circulation, wound care, mobilisation, laboratory tests, infusions, and operation (Supplementary Table S1). Each category is given a score from 0 to 4 except for the operation, which is calculated based on the operating time and type of dressing material (1 h = 2 points in the score).

Standard ventilation is defined as:

Pressure-controlled ventilation with positive end expiratory pressure (PEEP) of at least 5 cm H_2O. For recruitment maneuvers we used opening pressures of up to 55 cm H_2O and PEEP levels were adjusted thereafter accordingly. The aim was $<$30 cm H_2O for ventilatory plateau pressures and 6–8 ml/(kg min) for expiratory tidal volumes to reduce any risk of ventilator-induced lung injury.

The daily burn score refers to the score recorded for each patient every 24 h; the cumulative burn score refers to the sum of the daily scores for each patient; and the total score is the sum of scores for the whole group throughout the study period.

Our definition of "intensive care days" is when at least one of the following criteria was fulfilled: mechanical ventilation, inotropic support, or surveillance round the clock (a recorded score of 3 or 4 in the categories surveillance, respiration, and circulation). We defined mortality as death from any cause while an inpatient on the burn centre.

2.1. Data analysis and statistics

Data were analysed with the help of STATA (STATA v12.0, Stata Corp. LP, TX, USA), and presented as median (10–90 centiles) unless otherwise stated. The significance of differences between characteristics were examined with the help of the Mann Whitney *U* test and the chi square test, as appropriate, and multivariable regression was used to analyse the significance of factors associated with cumulative burn scores, and multivariable panel regression (panel variable by patient) was used for the analysis of the significance of differences in daily burn scores. Probabilities of less than 0.05 were accepted as significant.

3. Results

The scores of 1363 patients were analysed based on 22 301 daily inpatient recordings of burn scores. Table 1 shows personal and clinical data and median cumulative burn scores by the groups of those who survived and those who died. The highest score was in the category "wound care" (Table 1) which, together with mobilisation, made up more than half the total burn score during the study (Supplementary Fig. S1). The distribution of parts played by different categories of care while patients were in intensive care differed from those recorded for patients who were not in intensive care (Fig. 1).

The mean cumulative burn scores/TBSA% for patients who died among the TBSA% $<$ 10% were nearly five times that of survivors. In groups that ranged from 10% to 50% TBSA% the