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Revised Baux Score and updated Charlson comorbidity index are independently associated with mortality in burns intensive care patients

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ABSTRACT

Purpose: The purpose of the current study was to utilise established scoring systems to analyse the association of (i) burn injury severity, (ii) comorbid status and (iii) associated systemic physiological disturbance with inpatient mortality in patients with severe burn injuries admitted to intensive care.

Methods: Case notes of all patients with acute thermal injuries affecting ≥15% total body surface area (TBSA) admitted to the Burns Intensive Care Unit (BICU) at Chelsea and Westminster Hospital during a 10-year period were retrospectively reviewed. Revised Baux Score, Belgian Outcome in Burn Injury (BOBI) Score, Abbreviated Burn Severity Index (ABSI), APACHE II Score, Sequential Organ Failure Assessment (SOFA) Score and Updated Charlson Comorbidity Index (CCI) were computed for each patient and analysed for association with inpatient mortality.

Results: Ninety mechanically ventilated patients (median age 45.7 years, median % TBSA burned 36.5%) were included. 72 patients had full thickness burns and 35 patients had inhalational injuries. Forty-four patients died in hospital while 46 survived to discharge. In a multivariate logistic regression model, only the Revised Baux Score ($p < 0.001$) and updated CCI ($p = 0.014$) were independently associated with mortality. This gave a ROC curve with area under the curve of 0.920. On multivariate cox regression survival analysis, only the Revised Baux Score ($p < 0.001$) and the updated CCI ($p = 0.004$) were independently associated with shorter time to death.

Conclusion: Our data suggest that the Revised Baux Score and the updated CCI are independently associated with inpatient mortality in patients admitted to intensive care with burn injuries affecting ≥15% TBSA. This emphasises the importance of comorbidities in the prognosis of patients with severe burn injuries.

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1. Introduction

Serious burn injuries constitute a significant cause of morbidity and mortality. In the United Kingdom alone, burn injuries leading to substantial hospitalisation or death occurred at an annual incidence of approximately 5 cases per 100,000 population, contributing to 5.4% of all serious traumatic injuries [1]. Improvements in care of burn injuries [2,3] have been credited with decreasing the percentage of all patients hospitalised for burn injuries in the United Kingdom dying within 30 days of admission from 2% in 1991 to 0.91% in 2010 [3]. However, despite apparent improvements in overall survival in burn injuries, mortality in patients with severe burn injuries admitted to intensive care remains high [4–6], leading to the use of numerous prognostic models to predict mortality in these patients.

In patients with burn injuries covering at least 15% of total body surface area (TBSA), an acute phase response ensues [7–9], leading to widespread systemic inflammation and multiple organ dysfunction [10,11]. The patients' final outcomes then depend on physiological reserve, which decreases with age and comorbidities. Therefore, the prognostic models used to predict mortality in burn injuries are either burn injury-specific models that characterise burn injury severity or general models that evaluate patients' comorbid status and/or any associated systemic physiological disturbance [12,13].

Burn severity scores remain the mainstay of prognostication in clinical studies and on burns units [12]. The Revised Baux Score [14], the Belgian Outcome in Burn Injury (BOBI) Score [15], and the Abbreviated Burn Severity Index [16], are notable examples of such scores that have been externally validated [17–19]. The original Baux Score [20] is equivalent to the summation of the patient's age and the percentage of total body surface area (%TBSA) burned, and this is often quoted as the estimated percentage risk of death [12]. Osler et al. [14] evaluated the Baux Score in 39,888 patients from the National Burn Registry in the United States and added inhalational injury as a scoring component to yield the Revised Baux Score. The Belgian Outcome in Burn Injury (BOBI) Score [15] uses the same variables as the Revised Baux Score but in a different statistical model derived from 5246 Belgian patients. The Abbreviated Burn Severity Index (ABSI) [16] utilises gender and the presence of any full thickness burn in addition to the above variables. A major shortfall in these models, however, is that they do not account for comorbidities in patients with burn injuries [6] and tend to underestimate mortality in elderly [6,21] and/or intensive care patients [6].

One standardised method to score chronic comorbidities is the Charlson Comorbidity Index [22], which was originally developed to predict the 1-year all-cause mortality in patients admitted to hospital medical services based on the presence of any of 17 comorbidities. These comorbidities include congestive heart failure, chronic pulmonary disease, liver disease, diabetes and metastatic cancer [22]. The Charlson Comorbidity Index was updated by Quan et al. in 2011 [23] by re-evaluating the appropriate statistical weight assigned to each comorbidity in the original Charlson Comorbidity Index [22] based on the hazard ratio associated with the comorbidity in a test population in a contemporary healthcare setting. This analysis excluded 5 comorbidities that were found not to be associated with mortality and assigned new weights to 6 comorbidities. The updated index was subsequently validated for predicting inpatient mortality in patient cohorts across 6 different countries [23], but has not been evaluated in patients with burn injuries.

In general intensive care patients, the ''Acute Physiology and Chronic Health Evaluation' II (APACHE II) score [24] is widely used in the United Kingdom to predict mortality based on 12 physiological parameters in a context-dependent manner (e.g. non-operative, post-operative, post-emergency surgery). The APACHE II Score has been found to be significantly associated with subsequent mortality in burn injuries [25]. Alternatively, the Sequential Organ Failure Assessment (SOFA) score [26] measures organ dysfunction related to acute illness in each of six major organ systems and was originally developed in sepsis patients. The SOFA score has been shown to be highly associated with inpatient mortality in critically ill patients [27] and in patients with severe burn injuries [4,5].

The purpose of the current study was to utilise the above scoring systems to analyse the association of (i) burn injury severity, (ii) comorbid status and (iii) any associated systemic physiological disturbance with inpatient mortality in patients with severe burn injuries admitted to intensive care.

2. Methods

2.1. Patient cohort selection

Case notes of all patients admitted to the Burns Intensive Care Unit (BICU) at the Chelsea and Westminster Hospital from January 2004 to July 2013 were retrospectively reviewed. The study was conducted in accordance with the UK Good Clinical Practice (GCP) code of practice, Clinical Audit Patient Panel (CAPP) Reference Number 506. All patients above the age of 18 years with acute thermal injuries affecting $\geq$15% of total body surface area (TBSA) were included. The exclusion criteria were age below 18 years, admission to another facility for >24 h prior to arrival at our unit, multiple or head trauma, chemical burns, electrical burns, a diagnosis of necrotising fasciitis, and a diagnosis of Steven–Johnson syndrome/toxic epidermal necrolysis.

2.2. Data collection

Age, gender, percentage of total body surface area (%TBSA) burned, presence of inhalational injury (with typical history and clinical signs, and/or evidence on flexible bronchoscopy) and presence of any full thickness burn were recorded and incorporated as specified into the Revised Baux Score [14], BOBI Score [15] and ABSI [16] for each patient. The worst physiological variables within the first 24 h of admission were collected to calculate the admission APACHE II Score [24]. The SOFA Score [26] was taken as the maximum SOFA Score calculated within 24 h of admission. Comorbidities were tabulated to calculate the Updated Charlson Comorbidity Index (CCI) according to Quan et al. [23]. The date of inpatient mortality or hospital discharge was used to calculate time to death or survival time to hospital discharge.