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The effect of preexisting respiratory co-morbidities on burn outcomes☆

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ARTICLE INFO

Article history:
Accepted 27 August 2016
Available online xxx

Keywords:
Burns
Respiratory disease
Charlson co-morbidity index
Mortality
Mechanical ventilation

ABSTRACT

Introduction: Burns cause physiologic changes in multiple organ systems in the body. Burn mortality is usually attributable to pulmonary complications, which can occur in up to 41% of patients admitted to the hospital after burn. Patients with preexisting comorbidities such as chronic lung diseases may be more susceptible. We therefore sought to examine the impact of preexisting respiratory disease on burn outcomes.

Methods: A retrospective analysis of patients admitted to a regional burn center from 2002–2012. Independent variables analyzed included basic demographics, burn mechanism, presence of inhalation injury, TBSA, pre-existing comorbidities, smoker status, length of hospital stay, and days of mechanical ventilation. Bivariate analysis was performed and Cox regression modeling using significant variables was utilized to estimate hazard of progression to mechanical ventilation and mortality.

Results: There were a total of 7640 patients over the study period. Overall survival rate was 96%. 8% (n=672) had a preexisting respiratory disease. Chronic lung disease patients had a higher mortality rate (7%) compared to those without lung disease (4%, $p<0.01$). The adjusted Cox regression model to estimate the hazard of progression to mechanical ventilation in patients with respiratory disease was 21% higher compared to those without respiratory disease (HR=1.21, 95% CI=1.01–1.44). The hazard of progression to mortality is 56% higher (HR=1.56, 95% CI=1.10-2.19) for patients with pre-existing respiratory disease compared to those without respiratory disease after controlling for patient demographics and injury characteristics.

Conclusion: Preexisting chronic respiratory disease significantly increases the hazard of progression to mechanical ventilation and mortality in patients following burn. Given the increasing number of Americans with chronic respiratory diseases, there will likely be a greater number of individuals at risk for worse outcomes following burn.

1. Introduction

Burn results is significant morbidity and mortality worldwide. In the United States, an estimated 486,000 burns occurred in 2015 [1]. Following major burns, mortality is usually attributable to pulmonary complications, which can occur in up to 41% of patients admitted to the hospital after burn [2–4]. Previous

☆ Research reported in this manuscript was supported by the National Institute of Health under award number: 5T32GM008450-22.

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http://dx.doi.org/10.1016/j.burns.2016.08.029
0305-4179/

studies over the last three decades have shown the effect of burns on the respiratory system occurs in three phases [5–9].

These three phases are the early or resuscitative phase (first 48h), the post-resuscitative phage (2–7 days), and the late phase (beyond 7 days) after burn. Phase I is seen within minutes to hours as acute respiratory distress secondary to thermal injury from smoke inhalation, carbon monoxide poisoning, or secondary to airway obstruction. Pulmonary edema that occurs is seen as precursor to the development of ARDS in burn. The Phase II includes patients that were asymptomatic for the initial 24–48h; however, develop symptoms of tachypnea and hypoxemia within 5 days after burn. Patients develop atelectasis, acute respiratory distress Syndrome (ARDS), analgesic related respiratory suppression, or ventilatory failure. Lastly, phase III develop late complications such as pneumonia and pulmonary emboli [8,9].

With increase in longevity of the US population, there is a concomitant rise in the number of people with health related comorbidities, particularly chronic respiratory diseases. There is a broad spectrum of respiratory diseases but they can be broadly classified as either obstructive or restrictive respiratory disease [10]. Examples of obstructive lung diseases include chronic bronchitis and emphysema, asthma, cystic fibrosis, and bronchiectasis. In contrast, restrictive lung diseases such as sarcoidosis, interstitial lung disease, pulmonary fibrosis, hypoventilation syndrome due to obesity, and amyotrophic lateral sclerosis are characterized by reduce lung volume making it difficult to fully expand to fill lungs with air [10].

Current burn mortality prediction models such as the Baux score utilize age, % total body surface area (TBSA) of burn, and presence of inhalation injury but do not account for pre-existing comorbidities such as respiratory diseases. The contribution of pre-existing chronic respiratory diseases (PCRD) on burn outcomes is currently undefined. We hypothesize that patients with PCRD will have an increased progression to mechanical ventilation and mortality following burn.

2. Methods

This is a retrospective study of all burn patients admitted to the University of North Carolina Jaycee Burn Center from 2001 to 2012. The North Carolina Jaycee Burn Center at UNC was established in 1981 and averages more than 1200 acute admissions per year. The burn center is a single unit, 36-bed facility that has been verified by the American Burn Association for pediatric and adult care.

The medical records of subjects identified by the UNC Burn database query were reviewed to verify baseline demographic data, injury characteristics, and provide detailed information on medical comorbidities. Pre-existing comorbidities was obtained from information reported by patient, family, or others that intimately know the patient's history upon admission to the burn center. This are entered into the medical records. Subsequently, two dedicated burn registry nurses that collect, review and validate this data, enter the data into the University of North Carolina Burn Registry. The burn registry data is then uploaded to the National Trauma Data bank (NTDB) of the American College of Surgeons. It includes 27 different preinjury comorbidities. Smoking status for all the patients in the database was also recorded. Injury characteristics of interest included burn etiology, %TBSA burn, presence of inhalation injury, and intubation status on admission to the burn center. Inhalation injury diagnosis was based on history, physical examination, and/or bronchoscopic examination. The number of days on mechanical ventilation in the intensive care unit was included. All patients in the ICU were treated with the prevailing standard of care (i.e., ventilator management, fluid resuscitation, etc.) at a large academic burn center at the time of admission

To examine the effect of baseline medical comorbidities on outcome, a Charlson Comorbidity Index (CCI) score was calculated for each patient. The standardized Charlson Index has been reported to accurately predict the probability of mortality within 1 year for a number of medical conditions [11,12]. The score is the weighted sum of comorbid conditions. There are 17 comorbid conditions included in the score and each is assigned a weight from 1 to 6 points. The weighted sum of all comorbid conditions is the patient's Charlson score (Table 1). The CCI was also modified for this study to exclude respiratory disease to elicit the independent effect of respiratory disease on burn outcome. By removing pre-existing respiratory diseases from the CCI, we avoid controlling twice for respiratory disease in our cox proportional statistical analysis, as chronic respiratory disease was a separate independent variable. We validated the modified CCI by comparing the predictive probability of mortality of CCI with the mCCI and there was no statistical significant differences noted, as both were equally predictive (Supplementary material Figs. 1 and 2).

The outcomes of interest in this study included in-hospital mortality and need for mechanical ventilation. Patients who had withdrawal of care were included in the analysis as they

Table 1 – Charlson Comorbidity Index score system.

Comorbidity	Score
Myocardial infarction	1
Congestive heart failure	1
Peripheral vascular disease	1
Cerebrovascular disease	1
Dementia	1
Chronic pulmonary disease	1
Rheumatologic disease	1
Peptic ulcer disease	1
Mild liver disease	1
Diabetes without chronic complications	1
Diabetes with chronic complications	2
Hemiplegia or paraplegia	2
Renal disease	2
Any malignancy, including leukemia and lymphoma	2
Moderate or severe liver disease	3
AIDS/HIV	6
Metastatic solid tumor	6
Maximum comorbidity score	33

Please cite this article in press as: L.T. Knowlin, et al., The effect of preexisting respiratory co-morbidities on burn outcomes, Burns (2016), http://dx.doi.org/10.1016/j.burns.2016.08.029