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Extracorporeal life support is safe in trauma patients

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ABSTRACT

Introduction: The role of extracorporeal life support (ECLS) in the critically ill trauma patient is poorly defined, possibly leading to the underutilization of this lifesaving therapy in this population. This study examined survival rates and risk factors for death in trauma patients who received ECLS.
Methods: Data from the National Trauma Data Bank was retrospectively reviewed to identify trauma patients who received ECLS from January 2012 to December 2014. Clinical outcomes and risk factors for death were examined in these patients.
Results: Eighty patients were identified and included in the final analysis. Overall survival to hospital discharge was 64%. Survivors and non-survivors were similar in regard to age, gender, weight, and injury mechanism. Non-survivors had greater median injury severity scores (ISS) (29 non-survivors vs. 24 survivors, $p = 0.018$) and had a shorter median total hospital length of stay (8 days non-survivors vs. 32 days survivors, $p < 0.001$). Analysis of specific anatomic locations of traumatic injury, including serious head/neck, thoracic, and abdominal injuries, revealed no impact on patient survival. Multivariable logistic regression analysis identified increasing age and ISS as significant risk factors for mortality; whereas treatment at facilities that performed multiple ECLS runs over the study period was associated with improved survival.
Conclusions: Extracorporeal life support appears to be an effective treatment option in trauma patients with severe cardiopulmonary failure. Survival in trauma patients receiving ECLS is similar to that observed in the general ECLS population and this may represent an underutilized therapy in this population.

Introduction

The role of extracorporeal life support (ECLS) in the trauma patient remains unclear, despite the fact that the first-ever successful application of ECLS was to treat post-traumatic acute respiratory distress syndrome in 1971 [1]. Several case reports and small case series describe ECLS use in the trauma patient with various injury patterns and mixed outcomes [2–8]. Despite this, ECLS remains infrequently utilized in this patient population due in large part to the concern for risk of major hemorrhage [5]. Larger database studies have confirmed that ECLS is infrequently used in trauma patients; however, hospital survival is reported to be 49%, similar to the reported 58% survival in the general adult respiratory ECLS population [9,10]. An increasing severity of traumatic injuries, as assessed by the Injury Severity Score (ISS), has been found to be associated with the need for ECLS in trauma patients. However, patient and ECLS-related factors associated with adverse outcomes within the post-trauma ECLS population have not been defined. The purpose of the present analysis is to use a large, national trauma database to predict risk factors for mortality among trauma patients placed on ECLS.

Materials and methods

The study protocol was approved by our local institutional review board and waiver of consent was obtained. The National Trauma Data Bank (NTDB), administered by the American College of Surgeons, is the largest trauma registry in the United States. The NTDB was queried using annual reports from 2012 to 2014 to identify trauma patients placed on ECLS by using the ICD-9 procedure code 39.65 (extracorporeal membrane oxygenation [ECMO]). Only patients within the NTDB placed on ECLS were included in the final analysis. Therefore, patients placed on ECLS at participating institutions for other indications were not captured in this database. Demographic, trauma (including ISS and Glasgow

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Coma Scale), clinical, and outcome data was assessed for all patients. Hospital characteristics, including ICU size, total bed number, university vs. private setting, and number of trauma surgeons were also analyzed. Patient race was grouped into the following categories: 1) white; 2) black; 3) Asian; and 4) other. The mechanism of traumatic injury was stratified using ICD-9 codes and grouped as penetrating or blunt trauma. Procedural data was evaluated to determine the timing of ECLS initiation. Early ECLS was defined as commencement of extracorporeal support within 24 h of hospital admission; whereas late ECLS was defined as ECLS onset greater than 100 h after hospital admission. Comorbid conditions as included per NTDB collection guidelines were recorded and analyzed. Data on complications that preceded ECLS or occurred during ECLS were pooled and compared between survivors and non-survivors.

Abbreviated Injury Scale (AIS) scores were analyzed and used to group patients by injury to the following anatomic locations: 1) head and neck; 2) thorax; 3) abdomen; and 4) other. Only AIS severity scores of 3 or greater (defined as "serious" injury or greater) were included in this analysis. ICD-9 codes were then reviewed and used to analyze specific injury patterns in various locations. Complication data were assessed using standard NTDB collection definitions.

Statistical analysis

Data are summarized as percentages for categorical variables, and median with interquartile range (IQR) for continuous variables. The primary outcome measure was survival to hospital discharge or transfer. Categorical variables were analyzed with the Chi-square or Fisher's exact test while non-normally distributed data were analyzed using the Mann-Whitney test or Kruskal-Wallis test. Logistic regression was used to examine the potential association between clinical factors and mortality. Variables that neared significance in the univariate analysis ($p < 0.2$) were considered for inclusion in a forward stepwise logistic regression model. Stata SE 12 software (Stata Inc., College Park, TX) was used for analysis. The authors had full access to the data and take responsibility for its integrity.

Results

A total of 80 patients were identified during the study period and included in the final analysis. Overall survival to hospital discharge or transfer was 64% (n = 51). The mortality rate was 36% (95% Confidence Interval (CI) = 26–48%, n = 29). Patient demographics, hospital characteristics, and injury characteristics are shown in Table 1. A total of 43 unique facilities placed patients on ECLS during the study period. Only two of these centers performed more than five ECLS runs during the study period. There was a trend toward older age in non-survivors (median age: 34 years non-survivors vs. 24 years survivors, p = 0.08). Patient gender, weight, and race were not statistically significantly different between survivors and non-survivors. Facilities that performed multiple ECLS runs during the study period tended to have a greater proportion of survivors (77% (n = 39) survivors vs. 59% (n = 17) non-survivors, p = 0.158) as did facilities that performed more than five ECLS runs (22% (n = 11) survivors vs. 7% (n = 2) non-survivors, p = 0.154). Hospital size, as assessed by total number of beds or number of intensive care unit (ICU) beds, did not statistically significantly impact survival. No statistically significant difference was observed between survivors and non-survivors with regard to blunt vs. penetrating mechanism of injury. Median injury Severity Score (ISS) was higher in non-survivors (29 non-survivors vs. 24 survivors, p = 0.018).

Patient comorbidities are shown in Table 2. No statistically significant difference existed between survivors and non-survivors in regard to any of the comorbidities recorded. Emergency department and procedural data are shown in Table 3. Emergency department duration and vital signs were not statistically significantly different between groups. Survivors and non-survivors had a similar median length of time between hospital admission and ECLS initiation (46 h survivors vs. 45 h non-survivors, p = 0.803). No statistically significant survival related

Table 1
Demographic data, hospital characteristics, and injury characteristics according to survival status.

	Survivors (n = 51)	Non-survivors (n = 29)	Total (n = 80)	p-value
Age (years)	24 (19–36)	34 (19–50)	26.5 (19–41.5)	0.08
Gender (% male)	44 (86%)	24 (83%)	68 (85%)	0.906
Weight (kg)	84 (70–100)	93 (69–106)	85.5 (70–105)	0.822
Race				
White	28 (55%)	16 (55%)	44 (55%)	0.696
Black	11 (22%)	9 (31%)	20 (25%)	
Asian	8 (16%)	3 (10%)	11 (14%)	
Other	4 (8%)	1 (4%)	5 (7%)	
Hospital Characteristics				
Hospital performed > 1 ECLS case	39 (77%)	17 (59%)	56 (70%)	0.158
Hospital performed > 5 ECLS cases	11 (22%)	2 (7%)	13 (16%)	0.154
Total hospital beds > 600	33 (65%)	23 (79%)	56 (70%)	0.264
>35 ICU beds	24 (47%)	12 (41%)	36 (45%)	0.139
11–35 ICU beds	19 (37%)	16 (55%)	35 (42%)	
1–10 ICU beds	8 (16%)	1 (4%)	9 (11%)	
University hospital	43 (84%)	23 (79%)	66 (83%)	0.782
>8 Trauma surgeons	14 (28%)	10 (35%)	24 (30%)	0.68
Injury Characteristics				
Penetrating trauma	7 (14%)	2 (7%)	9 (12%)	0.656
Blunt trauma	41 (80%)	25 (86%)	66 (83%)	
Other mechanism	3 (6%)	2 (7%)	5 (7%)	
ISS AIS	24 (10–30)	29 (21–38)	25 (16.5–33)	0.018
GCS at admission	3 (3–14)	3 (3–14)	3 (3–14)	0.535
Alcohol involved	14 (28%)	6 (21%)	20 (25%)	0.696

Abbreviations: kg, kilogram; ICU, intensive care unit; ISS, injury severity score; AIS, abbreviated injury score; GCS, Glasgow coma scale.