Acute respiratory distress syndrome in trauma patients: ICU mortality and prediction factors

Abstract  Objectives: To study the factors that influence the intensive care unit (ICU) mortality of trauma patients who develop acute respiratory distress syndrome (ARDS) and to evaluate determinants of length of ICU stay among these patients. Design: Study on a prospective cohort of 59 trauma patients that developed ARDS. Setting: ICU of a referral trauma center. Fifty-nine patients were included during the study period from 1994 to 1997. Methods: The dependent variables studied were the mortality and length of ICU stay. The main independent variables studied included the general severity score APACHE III, the revised trauma and injury severity scores (RTS, ISS), emergency treatment measures, the gas exchange index (PaO₂/FIO₂) recorded after the onset of ARDS and the development of multiple system organ failure (MSOF). Univariate and multivariate analyses were performed. Results: The mean age of patients was 42.1 ± 16.7 years, 49 patients (83%) were male, the mean APACHE III score was 52.7 ± 33.7 points, the ISS 28.5 ± 11.4 points and the RTS 8.9 ± 2.5 points. ICU length of stay was 28.5 ± 24.5 days and the mortality rate 31.7% (19 deaths). Mortality was associated with the following: PaO₂/FIO₂ ratio on the 3rd, 5th and 7th days post-ARDS; high volume of crystalloid/colloid infusion during resuscitation; the APACHE III score; and the development of MSOF. According to the multivariate analysis, the mortality of these patients was correlated with the PaO₂/FIO₂ ratio on the 3rd day of ARDS, the APACHE III score and the development of MSOF. This analysis also showed days on mechanical ventilation to be the only variable that predicted ICU length of stay. Conclusions: The ICU mortality of trauma patients with ARDS is related to the APACHE III score, the gas exchange evolution as measured by the PaO₂/FIO₂ on the 3rd day and the progressive complications indicated by the onset of MSOF. The length of ICU stay of these patients is related to the number of days on mechanical ventilation.

Key words  Trauma patients · Acute Physiology and Chronic Health Evaluation (APACHE) · Acute respiratory distress syndrome (ARDS) · Length of stay
Introduction

Since Ashbaugh et al. first described the acute respiratory distress syndrome (ARDS) in 1967 [1], there have been many advances in surgical critical care and intensive care medicine. Nevertheless, no significant decrease in mortality has been definitively demonstrated over this period, and the studies that report such a decrease have been small series of ARDS patients [2, 3]. The mortality of trauma patients who develop ARDS is lower than that of ARDS in patients with other primary diseases, and recent studies suggest that there has been a significant decrease in the mortality of trauma patients with ARDS over the past few years [3, 4]. ARDS is a common complication in severe trauma patients, worsens their prognosis and increases their morbidity, mortality and lengths of hospital stay. ARDS has multiple etiologies and may be the first manifestation of a systemic inflammatory response syndrome (SIRS). The etiologies of ARDS in trauma patients include chest injury, multiple transfusions, long bone fractures, aspiration of gastric content, pelvic fracture, abdominal trauma, head injury or sepsis, among others. Mortality in ARDS has been highly associated with the development of multiple system organ failure (MSOF), which may be the best predictor of mortality. Traumatic ARDS represents a specific subset of ARDS patients in terms of prognosis and clinical evolution, as demonstrated by different authors [5, 6].

There is currently debate about the value in the ARDS setting of mortality prediction scales commonly used in intensive medicine, such as the APACHE system. The determinants of the length of ICU stay of these patients have not been well-defined. The present study aims were (1) to study the factors that influence the mortality of trauma patients with ARDS and (2) to study the factors that influence the intensive care unit (ICU) length of stay of these patients.

Material and methods

Setting

The study was conducted in a regional Trauma and Neurosurgery-Neurology ICU of 12 beds that admitted 420 patients last year, including 220 trauma patients. We prospectively studied all trauma patients over 14 years old that met ARDS criteria during their ICU stay. The period of study was from April 1994 to April 1997.

Variables studied

As independent variables we recorded the following:

1. Demographic data (age and sex).
2. Severity indexes: the Acute Physiologic and Chronic Health Evaluation score (APACHE III) assessed on the 1st day of admission [7]; the Injury Severity Score (ISS), a widely used index in trauma research that measures the extent of injury to all body regions, recorded at ICU discharge [8]; and the Revised Trauma Score (RTS) and Glasgow Coma Scale (GCS), both determined at hospital admission [9].
3. Gas exchange index after the development of ARDS, recording the worst PaO2/FIO2 ratio during the ICU stay and the PaO2/FIO2 on the 1st, 3rd, 5th and 7th days after the onset of ARDS.
4. Emergency treatment (resuscitation/surgery): need for initial re-suscitation with more than 2,000 ml of fluids during the 1st h after hospital admission and the requirement of multiple transfusion or emergency surgery during the first 24 h.
5. Metabolic and infectious complications: the appearance of pneumonia or MOF.
6. The timing of the onset of ARDS: first 24 h, 24–48 h, 48–72 h or 72 h after ICU admission.
7. Days on mechanical ventilation.

The dependent variables considered were the ICU mortality and ICU length of stay.

Definitions

Acute respiratory distress syndrome was defined according to the criteria established by the American-European consensus conference [10], as respiratory failure of acute onset with a PaO2/FIO2 lower than 200 mmHg and the presence of bilateral radiological pulmonary infiltrates with a pulmonary wedge pressure (PCWP) less than 18 mmHg or no clinical or radiological evidence of elevated pressure in the left atrium. Acute lung injury (ALI) included all of the above but a PaO2/FIO2 below 300 mmHg. Sepsis, septic shock and SIRS were defined using the criteria of the American College of Chest Physicians Society of Critical Care Medicine Consensus Conference [10]. MOF was defined according to the criteria of Knaus and Wagner [11]. Pneumonia was defined as evidence of primary lung infection from clinical criteria (fever, purulent secretions, deterioration of gas exchange) and evidence of bacterial or fungal infection diagnosed by tracheal aspirate or from bronchosalveolar lavage specimens, when the microbiological cultures reached 106 and 108 CFU/ml, respectively. This diagnosis was confirmed by the presence of persistent radiographic pulmonary infiltrate (> 24 h) [12].

Hypovolemia at admission was assessed by signs of hypotension and tachycardia, flat neck veins and a low central venous pressure. Multiple transfusion was defined as emergency resuscitation requiring the infusion of 15 or more units of blood within 24 h [13]. Severe head injury (SHI) was defined by a GCS score of less than 9 or by the following: anisocoria or progression towards pupillary dilation; unequal motor response or unilateral motor disorder; open skull fracture or crushing of the skull. Severe trauma was defined by an ISS score of more than 25.

The predicted mortality was calculated using the APACHE III formula as customized for the Spanish population of critical care patients and published by our group (PAEEC study) [14]. The standard mortality rate (SMR) was the observed mortality as a ratio of the predicted mortality.

The modality and settings of the controlled mechanical ventilation in all patients during this time period were selected by the intensivist to optimize ventilation with the intent of using tidal volumes of 6–10 ml/kg, positive end-expiratory pressure (PEEP) levels of 15 cmH2O or less, while maintaining airway pressure levels of 45 cmH2O or less.