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ORIGINAL ARTICLE

After implementation of a lung protective ventilation strategy, what are the outcome improvement predictors in acute respiratory distress syndrome?

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KEYWORDS

Acute respiratory distress syndrome;
Improvement factors;
Lung protective ventilation;
Lower tidal volumes (Vt);
Limits plateau pressure (Pplat);
Predictors

Abstract *Aim of the study:* To identify outcome improvement factors in ARDS patients managed with lung protective ventilation and defined according to the Berlin diagnostic criteria.

Patients and methods: A retrospective observational study was conducted in a total of 41 ARDS patients who were diagnosed according to the Berlin ARDS criteria. Demographic, clinical, laboratory, and radiological criteria were assessed for all patients, and sputum, blood, and urine samples were obtained on the first day of hospitalization and on the day of ventilator-associated pneumonia diagnosis. In addition, fluid balance was assessed by the end of the first week of ventilation. Significant factors associated with survival improvement and predictors of mortality were identified using the bivariate analysis. ROC curves were created to evaluate the accuracy of some of the factors affecting survival.

Results: In this study 25 variables were significantly correlated with mortality. The non-surviving patients had tachypnea and tachycardia; lower diastolic blood pressure, PaO_2/FiO_2, PO_2, O_2sat, and HCO_3 values; and higher FiO_2 and PCO_2 values. Additionally, they had lower serum Na and higher K, pH, and creatinine levels. The level of CRP and GCS score were significantly lower in the non-surviving patients. However, the average fluid balance in the non-surviving patients was positive. Additionally, 4 non-surviving patients (33.3%) developed hospital-acquired pneumonia. A

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good general condition, indicated by a GCS score was the most accurate improvement prediction factor, then proper oxygenation. In contrast, a delay in ICU admission, increase in serum creatinine level, and a positive fluid balance were accurate predictive factors of mortality.

Conclusions: Early diagnosis and ICU admission, a PaO_2/FiO_2 ratio maintained above 90, a GCS score above 9, a negative fluid balance, a serum creatinine level less than 1.5 mg/dl, and the prevention of HAP were factors associated with an improved outcome in ARDS.

Introduction

Worldwide, acute respiratory distress syndrome (ARDS) is among the major causes of morbidity and mortality in intensive care units (ICUs). The mortality rates in various studies vary from 30% to 70%, even with optimal conventional therapies [1,2]. Despite advances in our understanding of the pathophysiology and treatment of ARDS, mortality remains high; approximately 30–60% of patients die before hospital discharge [3–5]. Lung protective ventilation, a strategy that aims to achieve lower tidal volumes (Vt) and limits plateau pressures (Pplat) to less than 30 cm H_2O, was the only clinical intervention that demonstrated a mortality benefit in large randomized trials [6].

Recently, the American–European conference and workshop revisited the definitions of acute lung injury and ARDS and specifically re-evaluated the American–European consensus conference definition from 1994. The result of this workshop has been referred to as the Berlin definition of ARDS. The authors recommended that patients be categorized into three different classifications according to their PaO_2/FiO_2 ratio: (A) mild ARDS, PaO_2/FiO_2 <300 but >200 mmHg; (B) moderate ARDS, PaO_2/FiO_2 <200 but >100 mmHg; and (C) severe ARDS, PaO_2/FiO_2 <100 mmHg. As expected, mortality progressively declined in each of these groups. Using a receiver operating curve, this revised definition yielded a small but significant improvement in the area under the curve from 0.53, derived from the American–European Consensus Conference (AECC) definition, to 0.57, although the absolute difference is small [7].

Although ARDS is well studied worldwide, no local data are available to document the factors associated with mortality in ARDS and the outcome differences in patients with pulmonary and extra-pulmonary ARDS. Early identification of these factors will aid in the assessment of prognosis, improve treatment, and facilitate timely management. Furthermore, to the best of our knowledge, no published studies on mortality predictors have been conducted in Saudi Arabia since the implementation of a lung protective ventilation strategy. Thus, we conducted a retrospective study of these variables to identify the early predictors of mortality in ARDS after the adoption of a lung protective ventilation strategy and the use of the new diagnostic criteria implemented based on the Berlin definition of ARDS. We hypothesized that this ventilation strategy would attenuate the predictive value of previously identified pulmonary-specific measures.

Therefore, the aim of this study was to identify the factors that affect survival and to detect the predictors of mortality in ARDS patients managed with lung protective ventilation.

Subjects and methods

Location

The study was conducted in the Adult Intensive Care Unit at the Saudi German Hospital Al-Madinah, KSA.

Patients

A review of 41 medical records and physiological data was completed for adult patients admitted to the Adult Intensive Care Unit at the Saudi German Hospital Al-Madinah, KSA, between 2012 and 2014. The patients met the diagnostic criteria for ARDS according to the Berlin Definition 2012. These criteria were as follows: (i) respiratory symptoms must have begun within one week of a known clinical insult, or the patient must have new or worsening symptoms during the past week; (ii) bilateral opacities consistent with pulmonary edema must be present on a chest radiograph or computed tomography (CT) scan, and these opacities must not be fully explained by pleural effusions, lobar collapse, lung collapse, or pulmonary nodules; and (iii) the patient's respiratory failure must not be fully explained by cardiac failure or fluid overload (an objective assessment, e.g., echocardiography, to exclude hydrostatic pulmonary edema is required if no risk factors for ARDS are present); and (iv) moderate to severe impairment of oxygenation must be present, as defined by the ratio of arterial oxygen tension to the fraction of inspired oxygen (PaO_2/FiO_2). The severity of the hypoxemia defines the severity of the ARDS:

- Mild ARDS – a PaO_2/FiO_2 of >200 mmHg, but $\leqslant 300$ mmHg, with ventilator settings that include positive end-expiratory pressure (PEEP) or continuous positive airway pressure (CPAP) $\geqslant 5$ cm H_2O.
- Moderate ARDS – a PaO_2/FiO_2 of >100 mmHg, but $\leqslant 200$ mmHg, with ventilator settings that include PEEP $\geqslant 5$ cm H_2O.
- Severe ARDS – a PaO_2/FiO_2 of $\leqslant 100$ mmHg with ventilator settings that include PEEP $\geqslant 5$ cm H_2O [7,8].

All patients had pulmonary ARDS. The primary causes include the following: pneumonia, aspiration pneumonia, inhalation injury, and lung contusions.

All patients with a history or clinical evidence of congestive cardiac failure; patients with bronchogenic carcinoma, pulmonary metastasis, or any neoplasm at ICU admission; or patients who died within 24 h of ARDS diagnosis were excluded from the study.