ICU MANAGEMENT & PRACTICE

ICU Volume 6 - Issue 4 - Winter 2006/2007 - Matrix Features

Evidence- Based Management of Acute Lung Injury and Acute Respiratory Distress Syndrome

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This article reviews the practices that are evidence-based in managing adult patients with acute lung injury and acute respiratory distress syndrome.

Introduction

Acute lung injury (ALI) and acute respiratory distress syndrome (ARDS) remain common causes for the admission of patients to the intensive care unit (ICU). Mortality, especially in patients with ARDS, remains high, in spite of improvements in intensive care management (Roca et al. 2006; Vasilyev et al. 1995). Several factors, such as trauma, sepsis and pneumonia, can lead to ARDS (Villar et al. 1999), and the management of these conditions will have an overall impact on the outcome of patients with ARDS, in addition to the management of acute respiratory failure (ARF). Many randomized controlled trials (RCTs) have been conducted over the last few decades to evaluate the effectiveness of practices used in managing patients with ARF. We aimed to review the practices that were evaluated by RCTs in managing patients with ALI and ARDS.

Practices Reviewed

The following practices were reviewed, and a summary is presented in table 1.

Mechanical ventilation: Mechanical ventilation remains the mainstay in managing patients with severe respiratory failure. However, there are several modes of mechanical ventilation and differing strategies that are used in clinical practice.

Mode of mechanical ventilation: The most commonly used modes are pressure controlled and volume controlled ventilation. The randomized controlled trial conducted by the Spanish Lung Failure Collaborative Group, comparing volume controlled and pressure controlled ventilation, showed a significant increase in hospital mortality (78% vs. 51%; p=0.02), development of extra-pulmonary organ failures (median 3.7 vs. 2.6; p=0.005) and renal failure (64% vs. 32%; p=0.009) among patients who were treated with volume controlled ventilation (Esteban et al. 2000).

Ventilator settings: Tidal volume and positive endexpiratory pressure (PEEP) settings during ventilation have been evaluated in several RCTs. The ARDS network trial, comparing lower tidal volumes (6 ml/kg) with traditional tidal volume (12 ml/kg), showed that in patients with ALI and ARDS, mechanical ventilation with a lower tidal volume resulted in decreased mortality (31.0%vs. 39.8%, p=0.007) and more ventilator-free days during the first 28 days after randomization [mean (+/-SD), 12+/-11 vs. 10+/-11; p=0.007] (ARDS 2000).

In a recent RCT, a Spanish group of investigators compared a higher PEEP / lower tidal volume ventilation (experimental group) strategy with a lower PEEP / higher tidal volume (control group) strategy in patients with ARDS (Villar et al. 2006). The study found that mortality decreased and ventilator-free days increased in the experimental group, as compared to the control group (see table 2).

Brower et al. compared the effects of high PEEP versus lowPEEP in patients with ARDS, while aiming for tidal volumes of 6 mls/kg and plateau pressure of < 30 cm of water, as proposed by the ARDS network in all patients (ARDS 2000; Brower et al. 2004). The clinical outcomes evaluated (mortality; numbers of ventilator-free and ICU-free days; number of days without circulatory, coagulation, hepatic or renal failure; or the incidence of barotrauma) were similar whether lower or higher PEEP levels are used (Brower et al. 2004). These results suggest that management of tidal volume is probably more important than PEEP strategy in improving the outcomes.

High frequency oscillatory ventilation (HFOV) : Derdak et al. compared the use of HFOV with conventional ventilation in patients with ARDS (2002). without the need for mechanical ventilation at 30 days was the primary endpoint. Although the use of HFOV was found to be safe, it did not improve survival without the need for mechanical ventilation at 30 days (36% and 31% in the highfrequency oscillation and conventional ventilation groups, respectively; p=0.686). Other comparisons, including hemodynamic variables, oxygenation failure, ventilation failure, barotraumas or mucus plugging did not differ significantly between the two groups.

Prone Ventilation: Gattinoni et al. evaluated the use of prone ventilation in patients with ALI and ARDS in a randomized controlled trial (Gattinoni et al. 2001). Prone ventilation was shown to improve oxygenation with no increased incidence of adverse events. However, the effects of improved oxygenation did not translate into a reduction in mortality. Subsequently, several other investigators evaluated the effects of prone ventilation using randomized controlled trials (Guerin et al. 2004; Mancebo et al. 2006; Varpula et al. 2003; Voggenreiter et al. 2005). Based on the results of these studies, it is clear that the use of prone ventilation is associated with improved oxygenation. In the study by Guerin et al., the incidence of ventilator- associated pneumonia (VAP) was lower in patients where prone ventilation was used (1.66 vs. 2.14 episodes per 100 patient-days of intubation; p=.045) (Guerin et al. 2004). In addition, there is some evidence to suggest that prone ventilation may reduce mortality. In the study by Mancebo et al., a trend towards reduced intensive care unit mortality was noted in patients ventilated in prone, as compared to supine, position (43% vs. 58%, p =0.12). Further multivariate analysis suggests that the use of supine ventilation is associated with increased mortality (OR, 2.53; p=0.03) (Mancebo et al. 2006).

Inhaled Nitric Oxide: The use of inhaled nitric oxide was shown to transiently improve oxygenation, but did not reduce mortality (Sokol et al. 2003; Taylor et al. 2004).

Surfactant: Has not been shown to reducemortality or improve oxygenation (Davidson et al. 2006; Tiruvoipati et al. 2006).

Corticosteroids: A small RCT published by Meduri et al. suggested that methylprednisolone at a dose of 2 mg/kg per day for 32 days could reduce mortality and improve lung injury and multiple organ dysfunction syndrome scores (Meduri et al. 1998). However, the ARDS network trial investigating the safety and efficacy of moderate-dose corticosteroids in persistent ARDS does not support the routine use of methylprednisolone for persistent ARDS, despite the improvement in cardiopulmonary physiology (Steinberg et al. 2006). Further, the results of this trial suggest that starting methylprednisolone therapy more than two weeks after the onset of ARDS might increase the risk of death.

Fluid Management: In a randomized study, Wiedemann et al. compared liberal versus conservative fluid management in patients with ALI. The conservative approach improved lung function and shortened the duration of mechanical ventilation and intensive care stay, but did not improve survival at 60 days (Wiedemann et al. 2006).

Pulmonary Artery Catheters: The use of pulmonary artery catheters in managing critically ill patients has not been shown to improve outcome (Harvey et al. 2005; Shah et al. 2005). RCTs evaluating the use of pulmonary artery catheters specifically in patients with ALI and ARDS suggest that there is no benefit in terms of reducing mortality. Furthermore, there is an increased incidence of catheter-related complications, such as arrhythmias, in patients managed with pulmonary artery catheters (Richard et al. 2003; Wheeler et al. 2006).

Tracheostomy: The role and timing of tracheostomy is not clearly established in patients with ALI and ARDS. However, early tracheostomy (performed within seven days after admission to the intensive care unit) was shown to shorten the duration of mechanical ventilation and length of ICU stay in a group of critically ill adult patients requiring mechanical ventilation. (Griffiths et al. 2005).

Conclusions

The management of ALI and ARDS is evolving, and evidence-based practice demands that we consider current studies to help determine which treatments produce the best patient outcome. Practices such as use of low tidal volume and higher PEEP and pressure-controlled ventilation could further improve survival. Prone ventilation and fluid restriction could be of use in patients with severe ARDS, by improving the oxygenation and prevention of VAP. Use of HFOV and the role and timing of tracheostomy in patients with ALI and ARDS need further evaluation.

Published on : Thu, 15 Aug 2013