Ventilator Strategies for Chronic Obstructive Pulmonary Disease and Acute Respiratory Distress Syndrome

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KEYWORDS

• Respiratory failure • Hypoxia • ARDS • COPD • APRV
• Airway pressure release ventilation • ALI • PEEP

KEY POINTS

- Identification of high-risk patients for pulmonary complications is an important part of determining outcomes.
- Low tidal volume ventilation is the only ventilator strategy that has been shown in prospective randomized trials to improve mortality in ARDS and COPD.
- Once COPD patients are intubated the minute ventilation should be titrated to Ph and not to the $Paco_2$.
- A restrictive fluid schedule that maintains perfusion but aims at keeping patients fluid neutral has been associated with shorter ICU and ventilator days in ARDS.
- In ARDS several studies show APRV to have physiologic benefits and to improve some measures of clinical outcome, such as oxygenation, use of sedation, hemodynamics, and respiratory mechanics. None have shown a survival benefit when compared with conventional lung protective ventilation.

INTRODUCTION

Worldwide 52 million people have been diagnosed with COPD. The incidence and the complications that it has caused are increasing.[1] In 1990 it was the 6th most common cause of death worldwide but is expected to be the third most common by the year 2020.[2] Patients with COPD often require respiratory support for a variety of reasons including exacerbations of the disease, complications related to other medical conditions and elective and emergent surgical interventions. In these surgical situations if the clinical situations allows the best time to optimize the patient to prevent complication is pre-operatively. When mechanical ventilation becomes necessary in this challenging population morbidity can be minimized with the application of evidence-based approaches.

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Acute respiratory distress syndrome (ARDS) is defined by the acute onset of hypoxemia and bilateral infiltrates after a trigger. The definition has changed over time to its current status. Although it only effects about 5% of mechanically ventilated patients, 75% of those present with a moderate or severe form.[3] Unlike COPD, the incidence of ARDS is decreasing secondary to the decrease in the numbers of triggers secondary to the institution of such interventions, such as limited resuscitations, early source control, restrictive transfusion strategies, ventilator care bundles, and lung-protective ventilation.[4]

This article discusses the basic concepts of mechanical ventilation in patients with COPD and ARDS, reviews predisposing factors to the development of complications, and discusses current strategies for the recognition and prevention of these adverse effects in the application of mechanical ventilation in this population.

PREDICTING PULMONARY COMPLICATIONS

Ventilator strategies can play a pivotal role in the deciding the outcome of patient once pulmonary complications have developed. The issue is that by far the best means to improve pulmonary-related morbidity is to prevent it from happening. A large part of that preventive piece is to recognize high-risk groups so that at the very least preparations can be made. Virtually all of the interventions described herein have been shown to be at least partially protective if instituted before pulmonary complications have developed. For example, low tidal volume ventilation is a proven ventilator strategy for the treatment of both COPD and ARDS, and has also been shown to minimize the risk of the development of ARDS. In high-risk patient populations, it would only stand to reason that strict adherence to low tidal volume protocols be observed.

The risk of postoperative pulmonary complications (PPCs) increases nearly up to 3-fold for patients with a moderate or severe systemic disease (American Society of Anesthesiology class III) and up to 5-fold in moribund patients (American Society of Anesthesiology class IV).[5] The individual risk does not only relate to a patient's comorbidities, but is also influenced by the type and/or duration of surgery, and it may also be modified by the corresponding type of anesthesia.[6] Therefore, an American Society of Anesthesiology class IV patient undergoing a short, low-risk procedure under regional anesthesia might have a lower risk of PPCs than a patient without comorbidities planned to undergo a long-lasting, high-risk surgical procedure under general anesthesia. Tailoring the type of anesthesia to the patient is an important step in avoiding PCC.

Active smokers have an increase in tracheobronchial secretions and a decrease in mucociliary clearance. They depend on coughing for the removal of secretions, and they may need longer weaning from mechanical ventilation on the intensive care unit (ICU).[7] Smoking is also associated with pulmonary and cardiac diseases. Smokers have been included in all studies on intraoperative lung-protective ventilation strategies. Whether smokers benefit more than nonsmokers from any specific ventilator settings remains unclear.[8,9]

Advanced age, specifically an age of greater than 65 years, approximately doubles the risk of PPC not only owing to "accumulating comorbid conditions,"[10] but as an independent predictor of outcome based on age-related changes in the lungs, which are summarized in **Table 1**.[2,11,12]

In an animal model of mechanical ventilation with high tidal volumes, older lungs developed more severe pulmonary injury than younger ones.[13] It seems that elderly patients are more vulnerable to high tidal volumes, and that, in turn, they may benefit more from lung-protective mechanical ventilation than younger ones.[14]