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Research Article

MECHANICAL VENTILATION STRATEGIES IN INFECTIVE AIRWAY DISEASES

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ABSTRACT

Introduction: Mechanical ventilation (MV) strategies in Infective Airway Diseases (IAD) are an important area of concern for an intensivist or clinician.
Objective: To evaluate MV strategies in IAD based on literature survey.
Method: Literature survey on 'Mechanical Ventilation' and 'Infective Airway Disease' was undertaken using PubMed & MEDLINE search. Methodological filters were applied to limit retrieval to evidence based clinical data. Incomplete methodology, results in abstract form, duplicate publications were excluded. Data extraction forms were piloted and used to obtain uniform quality of data. Data presented as recommendations (Grade A & B) using a narrative approach.
Results and Conclusion: Bibliographic 'human' databases accessed in full-text revealed 36 citations; of which 27 full-text articles with clinical data were included and summarized: A minimum amount of positive end-expiratory pressure (PEEP); guided by guided by FiO2 requirement should be set to prevent lung collapse at end-expiration. Role of noninvasive positive-pressure ventilation (NIPPV) in sepsis related acute lung injury (ALI) / acute respiratory distress syndrome (ARDS) is still undefined. Small tidal volume ventilation, limitation of end-inspiratory plateau pressure is beneficial and may be facilitated by permissive hypercapnia. Prone positioning should be considered in the severest of ARDS patients. The ideal fluid management strategy in ARDS is unknown. Daily spontaneous breathing trials may reduce the duration of MV. The role of High-Frequency Oscillatory Ventilation (HFOV) and Airway Pressure Release Ventilation (APRV) in infective ARDS is uncertain.

INTRODUCTION

Nearly 50% of patients with infective airway diseases are at an increased risk of developing Acute Lung Injury or Acute Respiratory Distress Syndrome (ALI/ARDS). Mechanical Ventilation (MV) may be lifesaving in these situations, as they allow provision of adequate tissue oxygenation, reduce the respiratory muscle effort and avert hemodynamic embarrassment. Over the last 20 years, many clinical evidences have highlighted the harmful consequences of invasive mechanical ventilation such as Ventilator associated pneumonia (VAP) and excessive mechanical stress leading to perpetuation of lung injury.

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Unavailability of robust clinical trial data fails to provide enough evidence-based data on the status of MV in reactive or infective airway diseases, although few literature based recommendation provide some guidance in the management of a typical patient with infective airway disease, but all such recommendations need to be modified on the basis of individual physiological response.

MATERIALS AND METHODS

Literature search: Online literature was assessed using PubMed & MEDLINE database. Search strategy consisted of controlled vocabulary and keywords. Main search concepts were 'Infective Airway Disease', and 'Mechanical ventilation'. Methodological filters were applied to limit retrieval to 'Human' study data. Retrieval was limited to 'English' articles

Selection criteria & methodology: Reviewers independently screened citations of preliminary selected full-text articles on MV strategies in infective airway disease. In cases of insufficient information, full-text article with abstract was ordered. Only full-text publications (n = 27) were inlcuded. Additional information was accessed using *Google Scholar* searched engine.

Exclusion criteria: Studies with incomplete methodology; presented preliminary results in abstract form; duplicate publications, editorials were excluded.

Data extraction strategy: Data extraction forms were piloted and independent extraction of clinical effectiveness data for each article was undertaken. Relevant features & outcomes from the included studies were tabulated. Any disagreement between reviewers was discussed until consensus was reached.

Critical appraisal of individual studies: Quality of human trials was assessed following *CONSORT* guidelines.

Data analysis method: Because of clinical heterogeneity across the selected studies, a formal analysis was not conducted. The findings are described using a narrative approach.

RESULTS AND DISCUSSION

Electronic literature search yielded a total of 36 citations, of which 6 citations were excluded, and 30 potentially relevant articles were shortlisted. 27 articles were available for full-text review. Grade A & B recommendations were extracted from the articles and summarized, to cater to following emphatic questions:

How can changes in positive end-expiratory pressure (PEEP) improve outcomes in sepsis related ALI/ARDS?

Recommendation

Adequate oxygenation to maintain pulse-oxymetric saturation > 90% is recommended. PEEP should set at minimum to prevent lung air collapse at the end of expiration. Setting PEEP based on severity of oxygenation deficit and guided by the FiO2 required to maintain adequate oxygenation is an acceptable approach (Parissopoulos et al., 2015). For patients supported by mechanical ventilation or who are appropriate candidates for a pressurized face mask, PEEP or continuous positive airway pressure may be used to increase mean and/or end-expiratory airway pressures, allowing the reduction of the oxygen concentrations below potentially toxic levels (FiO2 < 0.60) (Guideline, 2002; Update, 2002).

Noninvasive positive pressure ventilation (NIPPV): A safer alternative in IAD?

Recommendation

Role of NIPPV in sepsis related ALI/ARDS is undefined, however use of NIPPV in immunosuppressed patients without hypotension should be considered. Patients with shock, altered mental status, or increased airway secretions should not be treated with NIPPV.

NIPPV is indicated in patients with sepsis-induced ALI/ARDS with a normal mental status who are likely to recover within 48–72 hrs (Conti *et al*., 1998; Plant *et al*., 2000)

What is the role of MV in acute respiratory failure (ARF) related to lung infection or sepsis?

Recommendation

The early placement of an endotracheal tube is justified to limit the work of breathing, protect the threatened airway, or prevent cardio-respiratory arrest. Common indications for institution of mechanical ventilation may include profound tachypnea (respiratory rate > 40), fatigue or failure of respiratory muscles (use of accessory muscles), refractory hypoxemia on high levels of inspired FiO2, compromised cardiac performance, life-threatening metabolic acidosis, and altered mental status (International Consensus Conferences in Intensive Care Medicine, 2001)

Should 'permissive hypercapnia' be used in patients with ALI/ARDS in the setting of upper respiratory tract infections?

Recommendation

Hypercapnia (allowing PaCO2 to increase above normal, so-called permissive hypercapnia) can be tolerated in patients with ALI/ARDS if required to minimize plateau pressures and tidal volumes. No upper limit for PaCO2 has been established. Some authorities recommend maintaining pH at7.20 –7.25, but this has not been prospectively established (Hickling *et al*., 1994; Bidani *et al*., 1994)

Strategies like (i) small tidal volume ventilation or (ii) pressure-limited ventilation strategies, be associated with better outcome in IAD?

Recommendation

High tidal volumes that are coupled with high plateau pressures should be avoided in ALI/ARDS. Clinicians should use as a starting point a reduction in tidal volumes over 1 to 2 hrs to a "low" tidal volume (6 mL/kg·lean body weight) as the goal in conjunction with the goal of maintaining end-inspiratory plateau pressures of < 30 cm H_2O (Stewart, 1888; Brochard *et al*., 1998; Brower *et al*., 1999).

Does prone positioning affect (i) gas exchange or (ii) outcome in sepsis related ALI, and (iii) should prone positioning be used for patients with ARDS requiring potentially injurious levels of FiO2 or plateau pressure?

Recommendation

Prone positioning should be considered in the severest of ARDS patients. In facilities with adequate experience, prone positioning should be considered in patients requiring potentially injurious levels of FiO2 or plateau pressure who are not at high risk for adverse positional changes (Stocker *et al*., 1997; Lamm, 1994; Jolliet *et al*., 1998; Gattinoni *et al*., 2001; Chatte *et al*., 1997).

What should be the fluid management strategy in sepsis-related ALI/ ARDS?

Recommendation

The ideal fluid management strategy in ARDS is unknown. Avoiding administration of fluids in excess of those amounts needed to maintain appropriate vital organ perfusion is the key. Use of colloids in hypoproteinemic patients with ALI/ ARDS is recommended. The ability to achieve a negative fluid balance in patients with shock is associated with improved mortality rates, and fluid gains in trauma patients with ARDS have been associated with increased mortality risk (Alsous *et al*., 2000; Navarrete-Navarro *et al*., 2001).

What is the role of corticosteroids in sepsis related ARDS?

Recommendation

Use of high-dose corticosteroids routinely in patients at risk for or in the exudative phase of ALI/ ARDS is discouraged. Corticosteroids may be indicated for ARDS of suspected allergic origin and for those with inadequate adrenal reserve, even in the early phase. Lower-dose intravenous methyl-prednisolone only in patients with persistent ARDS without infection is recommended. Large multiple-center, randomized trials have failed to show a benefit for the use of high-dose corticosteroids to treat patients at risk for or with ALI/ARDS (Bone *et al*., 1987; Luce *et al*., 1988).

Do daily spontaneous breathing trials or weaning protocols reduce the duration of MV?

Recommendation

All clinically stable intubated patients who are arousable, without high ventilation or end-expiratory pressure requirements, and who require levels of FiO2 that can potentially be safely delivered with a face mask or nasal cannulae should undergo spontaneous breathing trials to evaluate ability to be liberated from the ventilator, thereby reducing the incidence of Ventilator Associated Pneumonia (VAP). Spontaneous breathing trial options include a low level of pressure support, continuous positive airway pressure, or a T piece. Recent studies demonstrate that daily spontaneous breathing trials reduce the duration of MV (Esteban, 1999; Esteban, 1997).

Does High-Frequency Oscillatory Ventilation (HFOV) (i) affect gas exchange or (ii) improve outcomes in patients with sepsis induced ALI/ARDS?

Recommendation

The role of High-Frequency Oscillatory Ventilation (HFOV) in infective ARDS is uncertain. Both should be reserved for controlled clinical trials or as rescue therapy after proven lung protective strategies have failed. Several studies have suggested that high frequency oscillation used as salvage may improve oxygenation but does not improve mortality rates (Fort *et al*., 1997; Derdak, 2002).

By what way can Airway Pressure Release Ventilation (APRV) (i) affect gas exchange or (ii) improve outcomes in patients with sepsis related ALI/ARDS?

Recommendation

The role APRV is still uncertain. It should be limited to use in controlled clinical trials or as rescue therapy in patients who have failed traditional lung protective strategies. Several studies have suggested improved oxygenation compared with pressure-controlled ventilation and in conjunction with prone positioning (Varpula, 2003; Kaplan *et al*., 2001).

Conclusion

Current mechanical ventilation modalities in infective airway diseases are based on select number of studies. The status of such recommended strategies merit further exploration.

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