Editorial

Postextubation management of patients at high risk for reintubation

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Introduction

Extubation of patients with acute respiratory failure requiring invasive mechanical ventilation requires careful clinical assessment with attention to the pros and cons related to early *vs.* delayed extubation. These patients should have had significant resolution of their underlying medical problem(s) which resulted in respiratory failure, have satisfactory oxygenation, and good weaning parameters, including a rapid shallow breathing index less than 105 breaths/minute/liter (1,2). Finally, they need assessment of upper airway anatomy for the possibility of significant laryngeal edema. Patients undergoing extubation probably fall into two large heterogeneous categories, low risk patients and high risk patients. High risk patients frequently have significant comorbidity, prolonged intubation periods, and poor weaning trials. Some patients have significant respiratory impairment prior to hospitalization, and in these patients it may be quite difficult to determine whether or not they are at their baseline. Reintubation of these patients increases morbidity and mortality which has exceeded 40% in some studies (3,4). Postextubation management usually includes conventional oxygenation with facemasks. Alternative approaches use noninvasive ventilation and high flow nasal cannula oxygenation. High flow nasal oxygen delivery has been used in multiple clinical settings, especially for oxygen supplementation in patients with acute hypoxemic respiratory failure (5-7). Hernández *et al.* recently reported a randomized controlled trial comparing noninvasive ventilation with high flow nasal cannula oxygenation after extubation in high risk patients recovering from acute respiratory failure (8).

Study summary

This study cohort included 604 patients with planned extubation who were at high risk for reintubation. High risk factors included older age, APACHE 2 greater than 12, body mass index greater than 30 kg/m^2, inadequate secretions management, difficult or prolonged weaning, more than one comorbidity, heart failure as an indication for mechanical ventilation, moderate to severe COPD, airway patency problems, and prolonged mechanical ventilation. Patients were randomized to either noninvasive ventilation or high flow nasal cannula oxygen for 24 hours. Primary outcomes were reintubation or persistent postextubation respiratory failure within 72 hours. Twenty-two and eight tenths percent of patients in the high flow nasal cannula group required intubation; 19.1% of patients in the noninvasive ventilation group required reintubation. Postextubation respiratory failure occurred in 26.9% of patients in the high flow nasal cannula group and 39.8% of patients in the noninvasive ventilation group. The authors concluded that oxygen delivery using high flow nasal cannula was non-inferior to non-invasive ventilation in postextubation patients at high risk for reintubation. In addition, adverse events were less frequent in the high flow

nasal cannula group.

This study included a large number of patients with trauma, including traumatic brain injury, and undergoing surgery, including urgent abdominal and neurosurgical procedures. Medical patients included patients with pulmonary diseases and respiratory failure and patients with cardiac disease and respiratory failure. Consequently, this study involved both medical and surgical patients. In addition, the study included patients with hypoxemic respiratory failure, hypercapnic respiratory failure, and primary failure of neuromuscular function. The underlying pathophysiology associated with the respiratory failure has a potential to influence the response to postextubation management and potentially requires subgroup analysis to determine differences in outcomes. The second outcome in this study was the frequency of postextubation respiratory failure within 72 hours. This was defined as the presence and persistence of any of the following criteria: respiratory acidosis (pH <7.35), hypercapnia ($PaCO_2$ >45 mmHg), SPO_2 less than 90% or PaO_2 less than 60 mmHg on FiO_2s higher than 0.4, respiratory rate greater than 35, decreased level of consciousness, agitation, and clinical signs suggesting respiratory muscle fatigue and increased work of breathing. It is unclear whether or not these parameters needed to be present throughout the 72-hour period. Approximately 33% of all study patients met these criteria, and 15.8% of patients in this category from both groups were reintubated. Many patients with advanced disease might meet these definitions even in a stable clinical state. Consequently, some of these abnormalities might be expected following extubation for acute respiratory failure but eventually improve and resolve. The time frame for such improvement can be unclear.

Critique

Question: Does this randomized controlled trial comparing high flow nasal cannula oxygenation with noninvasive ventilation in high risk postextubation patients inform/direct medical management? Answer: Possibly.

The study protocol does not seem consistent with the usual approach to the care of these patients. They were automatically taken off noninvasive ventilation or high flow nasal cannula oxygenation at 24 hours independent of their clinical status. The median time for the use of noninvasive ventilation was 14 hours. The median time to reintubation was 21.5 hours in the noninvasive mechanical ventilation group and 26.5 hours in the high flow nasal cannula oxygenation group. These times suggest that patients frequently deteriorated when transferred to conventional oxygen therapy. Consequently, it is difficult to know whether an additional 12–24 hours of noninvasive ventilation or high flow nasal cannula oxygenation would stabilize the patient and give him/her time to recover from the primary disorder.

The definition of postextubation respiratory failure is not altogether clear. It was defined as the presence and persistence of any of the following criteria: respiratory acidosis with a pH less than 7.35 and a PCO_2 greater than 45 mmHg, O_2 saturations less than 90% or PO_2s less than 60 mmHg on FiO_2 greater than 0.4, respiratory rates greater than 35, decreased levels of consciousness, agitation, or clinical signs of respiratory muscle fatigue. It is unclear how they defined persistence. Does this represent these abnormal clinical parameters throughout the study? Or does it represent these abnormalities for a defined period of time, such as 1 hour, during the study? In our experience many patients with COPD have blood gas parameters demonstrating respiratory acidosis and yet are at their baseline and/or improving. Oxygen saturations less than 90% require attention but do not necessarily represent failure of the ongoing medical management. High respiratory rates and evidence of respiratory muscle fatigue represent serious clinical signs of respiratory dysfunction and demand attention but do not necessarily indicate that intubation is imminent, and changes in medical management (e.g., diuresis) might correct this problem. Is it reasonable to use these definitions in a dynamic process, such as the resolution of acute respiratory failure during a given period of time (72 hours in this study) in which patients are not receiving sustained treatment? To suggest that 24 hours of either high flow nasal cannula oxygen delivery or non-invasive ventilation should prevent these clinical features during the next 48 hours would imply that these interventions have sustained therapeutic benefit or that 24 hours of treatment is adequate regardless of the underlying disease.

This study included both medical and surgical patients, and both groups included patients with potentially reversible causes of acute respiratory failure. Examples include respiratory infections, exacerbations of COPD, heart failure, and abdominal surgery. It is not clear whether or not reintubation occurred disproportionately in medical or surgical patients. A relatively large number of patients had postextubation respiratory failure secondary to an inability to clear secretions. The primary causes for the

initial respiratory failure and the potential causes for postextubation respiratory failure raise the question as to whether or not 1 more day of mechanical ventilation would allow sufficient recovery so that these problems become less important and management easier. Of course, these are difficult management decisions which must balance additional mechanical ventilation with possible complications against extubation with the possibility of reintubation. Several studies have suggested that the reintubation represents a high risk situation and that these patients often have worse outcomes (3,4).

Other relevant studies

Hernández completed a similar postextubation randomized trial comparing high flow nasal cannula oxygenation with conventional oxygenation in patients who were considered at low risk for reintubation (9). This study included 527 patients. Reintubation within 72 hours occurred in 4.9% patients on high flow nasal cannulas and in 12.2% of patients on conventional oxygen. As in the study on high risk patients, the treatment assignments were stopped at 24 hours, and the patients were transferred out of the ICU. The time to reintubation was 19 hours in the high flow and 15 hours in the conventional therapy group. Maggiore *et al.* studied the effect of high flow nasal oxygen *vs.* Venturi mask oxygen in 105 patients postextubation (10). Patients on high flow nasal cannula required less reintubation (4% *vs.* 21%) and had higher PaO_2/FiO_2 ratios and less discomfort. These two studies indicate that reintubation occurs less frequently using high flow nasal cannula oxygenation in low risk patients and provides more comfort.

The study with high risk patients compared high flow nasal cannula oxygen delivery with non-invasive ventilation. Is non-invasive ventilation a standard of care in high risk patients? Two recent meta-analyses report information relevant to the use of noninvasive ventilation in postextubation patients. Glossop *et al.* analyzed four randomized controlled trials which included 479 postextubation patients (11). The odds ratio for reintubation was 0.72 (95% CI, 0.51–1.02; P=0.28) using non-invasive ventilation. Lin analyzed eight trials including 1,080 patients who were immediately randomized to either standard medical therapy or noninvasive ventilation following extubation (12). There was no reduction in reintubation using noninvasive ventilation. However, in a subgroup of patients who passed spontaneous breathing trials, there was a reduction in reintubation (odds ratio =0.65; 95% CI, 0.46–0.93; P=0.02). These two meta-analyses indicate that there is limited information on the use of noninvasive ventilation immediately postextubation (13). In addition, the overall results do not identify an important reduction in this rate of reintubation. It is likely that most patients do not need noninvasive ventilation and that more studies are needed to identify the subgroup of patients who might benefit.

Conclusions

High flow nasal cannula can provide improved oxygenation in patients with adequate respiratory drive and adequate respiratory muscle strength. In addition, the low level of PEEP and increased humidification can improve gas exchange and the management of respiratory secretions. Consequently, high flow nasal cannula oxygenation can support gas exchange in most postextubation patients and give them more time to recover from the primary cause of acute respiratory failure. High flow nasal cannula oxygenation systems provide better humidification of the upper and lower respiratory tract. This may improve the patient's ability to mobilize secretions and, in addition, may have direct effects on the larynx and facilitate edema resolution. Studies comparing high flow nasal cannula oxygen delivery and conventional oxygen with face masks should also evaluate laryngeal function. This might be accomplished by voice assessment and ultrasound measurements (14-16). The termination of high flow nasal cannula oxygenation support should be based on clinical parameters and not arbitrary time limits.

The Hernández study demonstrates that noninvasive ventilation and high flow nasal cannula oxygenation do work in the majority of patients who are at high risk for reintubation following extubation. However, the treatment time in this study (24 hours) does not provide information as to which patients will recover or deteriorate with prolonged use of either noninvasive ventilation or high flow nasal cannula oxygenation. These subgroups of patients need more study so that clinicians allow sufficient time for recovery but do not delay reintubation. In addition, physicians working in medical intensive care units need studies on patients with medical disorders and not on mixed medical-surgery patients, and these studies should consider the underlying pathophysiology of the respiratory failure. Many hospitals use high flow nasal cannula oxygenation in patients who are not in intensive care units (17). This allows transfer of patients out of the ICU, but, of course, these patients need careful follow-up, preferably with protocols

for reintubation by specialists in respiratory medicine.

In summary, this Hernández study helps us understand the management of high risk postextubation patients (8). We wish that their management strategy had allowed for longer periods of high flow nasal cannula use. Finally, analysis of studies using noninvasive mechanical ventilation indicates that this approach requires repeated consideration of the pressures being used, volumes delivered, FiO_2 required, O_2 saturations, and patient status. Neither high flow nasal cannula oxygenation nor noninvasive mechanical ventilation should be ordered just as a routine.

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None.

Footnote

Conflicts of Interest: The author has no conflicts of interest to declare.

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