Just the Berries

Use of CPAP and BiPAP in acute respiratory failure

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Level I evidence shows that continuous positive airway pressure (CPAP) and bilevel positive airway pressure (BiPAP) are effective for preventing intubation and saving the lives of carefully selected patients with acute respiratory failure.[1-3] This article attempts to review this evidence.

We began by searching the literature, using OVID, looking for all randomized studies of congestive heart failure and respiratory failure. Use of CPAP and BiPAP for sleep apnea or chronic respiratory failure will not be explored.

Which machine?

The CPAP and BiPAP machines have been used much of this century; newer machines are descendants of the intermittent positive pressure breathing (IPPB) machines used from the 1940s to the 1960s. The current machines are designed to deliver a positive pressure of between 4 and 25 cm of water. Patients are attached to machines by either a nasal mask or a full-face mask. Ventilators can deliver this type of noninvasive ventilation, but now many machines for this express purpose can be purchased for less than $3000 for CPAP and about $10 000 for BiPAP.

A CPAP machine delivers continuous positive air pressure, usually at about 10 cm of water, that is delivered throughout the respiratory cycle and has been described as similar to breathing with your head stuck out of a moving car. There are many reasons this might improve breathing: by counteracting intrinsic positive end expiratory pressure (PEEP), by decreasing preload and afterload in congestive heart failure (CHF), by improving lung compliance in CHF, and by decreasing the work of breathing.

Intrinsic PEEP is the concept that, in patients with severe chronic obstructive pulmonary disease (COPD), the lung does not fully empty due to the obstruction in the airway, which results in positive pressure in the airways at the end of expiration. Therefore, to breathe in, patients with COPD must first overcome this positive airway pressure before they can generate a negative pressure to inhale more air. In patients with respiratory failure due to COPD, pressure is often about 5 cm of water, but it can be higher. When CPAP is begun, the usual starting level is 10, although patients can start at 5 and work up. Oxygen can be delivered at flow rates high enough to maintain O_2 saturation above 90%.

A BiPAP machine delivers CPAP, but also senses when an inspiratory effort is being made and delivers a higher pressure during inspiration. When flow stops, the pressure returns to the CPAP level. This positive pressure wave during inspirations unloads the diaphragm, which decreases the work of breathing. This form of ventilation has been used for years for patients with chronic respiratory failure due to neuromuscular problems or chest wall abnormalities. For patients with respiratory failure, a

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common technique is to begin with the expiratory level at 5 and the inspiratory level at 15. Levels are adjusted based on patient comfort, tidal volume achieved, and blood gas levels.

As use of BiPAP machines has increased, their cost has gone down. More types of masks are now available, and this variety has improved patient comfort and compliance. Use of BiPAP machines is often called noninvasive face-mask ventilation because the trachea is not intubated so there is less trauma to the airway and, more importantly, there is a lower incidence of nosocomial infections.[4]

For acute respiratory failure, however, compliance might be a problem. Respiratory technologists should be prepared to stay with patients while they get used to the machine. They might have to try several masks to provide effective ventilation that is comfortable for a patient. Patients must always be shown how to remove the masks in case of panic or vomiting. If a patient has a decreased level of consciousness or copious secretions, cannot protect the airway, or is unstable hemodynamically, intubation should be used.

Benefits

Many randomized, prospective studies now show the benefit of noninvasive ventilation for respiratory failure. Not only has it been shown to be an effective therapy, but there is also evidence that it contributes to reducing time in hospital, lowering the number of complications, and decreasing mortality compared with immediate intubation and ventilation.[5]

One study showed that using CPAP reduced intubation from 74% to 16%, decreased major complications from 48% to 16%, and shortened length of stay in hospital from 35 days to 23 days. Mortality was decreased from 29% to 9%.[3] It should be noted that only one third of patients could be randomized and only between 50% and 80% of patients are compliant with treatment. Still, level 1 evidence certainly supports use of BiPAP in patients with a probability of having pulmonary carbon dioxide (pCO_2) levels >50, acidity <7.35, and a relative risk (RR) of >30.

Evidence from randomized controlled trials also shows that CPAP improves oxygenation and hypercapnia and reduces the rate of endotracheal intubation in pulmonary edema.[6-8] If tolerated, BiPAP seems even more effective with faster reduction of pCO_2 and improved oxygen levels, pH, and RR. Unfortunately, patients using BiPAP had more myocardial infarctions (MI) than those using CPAP. Until further studies are done, it is recommended that CPAP be tried first. If BiPAP is attempted, it should be initiated cautiously, watching for hypotension.[9]

There is still controversy over how and why CPAP works in CHF. It clearly reduces the work of breathing by improving atelectasis and ventilation-perfusion ratios. Some studies have suggested it also improves preload and afterload and that there is actually an improvement in cardiac index. Of even more interest, studies out of Toronto by Bradley[10] suggest that up to 50% of patients with CHF have sleep apnea. For these patients, use of CPAP not only improves sleep, but leads to an improvement in ejection fraction that lasts into the daytime hours when patients are awake. It is postulated that CPAP reduces preload and also afterload. It is possible that obstructive sleep apneas put a severe strain on the heart by markedly increasing afterload, leading to hypertension.

Conclusion

For patients who present to an emergency department with acute respiratory failure but a normal level of consciousness, no major secretion problems, and hemodynamic stability, a trial of BiPAP or CPAP should be attempted before considering intubation or a mechanical ventilator.

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