MedicalAbstract

Vol. 1b
Article 101

Published 5.1.99

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Mask CPAP

Clinical Indications & Management

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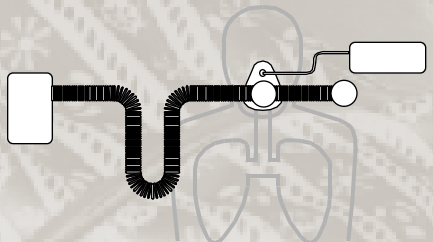

The use of continuous positive airway pressure (CPAP) by face mask predates the use of the iron lung and endotracheal intubation [1,2,3].

In the last 25 years, mask CPAP has found usefulness in a variety of clinical conditions. These uses are provided below.

General Indications

Successful use of mask CPAP requires appropriate selection of patients and proper application of equipment. Typically, patients who respond best to mask CPAP have hypoxemia secondary to reduced lung volumes (atelectasis) or wet lungs (cardiogenic pulmonary edema). We have previously published a list of indications for mask CPAP and contraindications to its use. These are updated below.

Indications

- $PaO_2/FIO_2 < 250$
- Spontaneous breathing with normal ventilatory drive
- Able to protect the upper airway
- Normocarbia or hypocarbia
- Etiology consistent with reduced lung volumes

Contraindications

- Untreated pneumothorax
- Uncontrolled vomiting
- Unstable facial fractures

Disease States

Mask CPAP has been shown to reduce the need for intubation, alleviate hypoxemia, and decrease the work of breathing in the following categories:

Acute Respiratory Failure – Several authors [4,5,6] have shown mask CPAP to increase PaO_2 and relieve tachypnea in patients with moderate respiratory failure ($PaO_2/FIO_2 < 250$). These studies demonstrate a success rate (intubation avoided) of 61-98%.

Pulmonary Contusion & Flail Chest – Lung contusion and rib fractures are associated with alveolar collapse and chest wall instability. Mask CPAP restores lung volume and stabilizes respiratory mechanics, improving oxygenation and ventilation. Adequate pain control is a critical adjunct to mask CPAP in this arena. Hurst et. al [7] showed a success rate of mask CPAP of 93% in patients with hypoxemia due to pulmonary contusion.

Cardiogenic Pulmonary Edema – Pulmonary edema resulting from congestive heart failure creates the classic wet lung. Bibasilar rales are evidence of the fluid filled lung and hypoxemia and tachypnea are usual findings. Mask CPAP in cardiogenic pulmonary edema, increases lung volume, improves oxygenation and reduces the work of breathing. As an added benefit, positive airway pressure reduces venous return, decreasing ventricular filling pressures and improving cardiac performance. Mask CPAP may also be indicated in cardiogenic pulmonary edema in the presence of hypercarbia, if the patient has a normal ventilatory drive. Mask CPAP has also been shown to reduce the myocardial infarction rate compared to bi-level ventilation in these cases. [8,9]

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Post-extubation Hypoxemia – Following extubation trauma and surgery patients may develop hypoxemia due to reduced lung volumes and stiff lungs. Mask CPAP has been shown to reduce the re-intubation rate in patients with hypoxemia following extubation in 90% of patients. [10]

Chronic Obstructive Pulmonary Disease – The air-trapping in COPD is attributed to small airway collapse prior to complete alveolar emptying. This phenomenon is commonly treated by pursed lip breathing. The effect is to maintain airway pressure above the pressure which causes airway collapse. The same effect can be seen with mask CPAP at low levels (<8 cm H_2O). Non-invasive ventilation is also highly successful in this arena, but must include low levels of CPAP/PEEP.

Post-operative Atelectasis – Post-operative atelectasis is a common finding following upper abdominal and thoracic operations. This malady is treated with a plethora of treatments including incentive spirometry, coughing & deep breathing, and intermittent positive pressure breathing. Mask CPAP is also effective in alleviating atelectasis and has the advantage of not requiring patient cooperation to increase lung volume. Several studies have shown a reduction in post-operative pulmonary complications with the use of CPAP compared to other techniques. [11-13]

Equipment

Mask CPAP should be applied with a light-weight, transparent, mask. It is not necessary to achieve an airtight fit. A leak is permissible and more comfortable for the patient. Humidification is probably unnecessary in most cases. The CPAP flow delivery device should provide high flows (> 2 x patient minute volume) and an adjustable inspired oxygen concentration (FIO_2). The valves used to supply CPAP should be threshold resistors, that is the CPAP level should remain constant regardless of the flow. It is not necessary to place a nasogastric tube in patients receiving mask CPAP, unless medically necessary.

Monitoring

During mask CPAP, monitoring the patient's respiratory rate is important. If the patient has a decrease in respiratory rate and becomes more comfortable, mask CPAP will likely be successful. If patient comfort fails to improve and respiratory rate remains elevated, endotracheal intubation may be required. Pulse oximetry is also helpful in titrating FIO_2 and evaluating patient response.

Complications

Complications with mask CPAP are uncommon. The following have been listed as potential complications of mask CPAP; aerophagia, gastric distension, aspiration of gastric contents, hypotension, barotrauma, hypoventilation, carbon dioxide retention, facial skin erosion, and pneumocephalus. The reported complication rate is low and most problems are associated with too tight a mask fit.

Summary

Mask CPAP can be a useful technique for improving oxygenation, alleviating tachypnea, and reducing the need for endotracheal intubation. Lung disease characterized by alveolar collapse, reduced lung compliance, hypoxemia, and tachypnea are most likely to respond.

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Lit. No.: 5096-Rev. B, 5/00 1M