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Understanding the Three Principal Goals of Clinical Airway Management

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Introduction

There are three main goals of clinical airway management- appropriate oxygenation, appropriate ventilation, and protection of the airway from injury. Let's briefly look at each of these goals.

Oxygenation

Oxygenation is controlled via the concentration of oxygen (fraction of inspired oxygen - $Fi0_2$) delivered to the patient, although "PEEP" adjustment can be equally important to improve oxygenation in ventilated patients with acute lung injury (PEEP or positive end expiratory pressure, is the minimum lung distending pressure over expiration during positive pressure ventilation; it is usually set between 2 and 5 cm H_2O in patients with normal lungs). The minimum oxygen concentration used during general anesthesia is usually 0.3 (30%) and can be increased to 1.0 (100%) by decreasing the concentration air administered (or of nitrous oxide (N_2O) in patients where this is used during general anesthesia). As a rough rule one adjusts $FI0_2$ (and PEEP in specialized settings) to keep arterial oxygen saturation above 94% (using a pulse oximeter) or keeping the arterial oxygen tension (PaO_2) between 100 and 150 mm Hg in patients where arterial lines are available for arterial blood gas analysis.

Ventilation

In spontaneous ventilation (negative pressure ventilation), negative pressure inside the lungs from diaphragmatic flattening draws in air. It is important that clinicians recognize when a patient is not adequately ventilating; reasons could include inadequate respiratory effort (e.g., from excessive opioids, partial or complete airway obstruction (e.g., from airway edema) or both. If the patient is not breathing adequately one generally starts with a simple maneuver such as a chin lift or jaw thrust to help open the airway, with positive pressure ventilation with a bag-mask device being the next step if this intervention proves to be ineffective. Concurrently, in cases of suspected airway obstruction, the clinician physician must take measures to alleviate the obstruction. Prolapse of the tongue into the posterior pharynx due to loss of tone in the submandibular muscles is a frequent cause in unconscious patients. While a chin lift or jaw thrust is often sufficient adequate chest ventilation, some cases require that an artificial airway be placed (discussed later). Also, if one hears "gurgling" with breathing the oropharynx should be suctioned.

With positive pressure ventilation (PPV) gas is forced into the lungs using a positive pressure source such as a manual resuscitator or an automatic ventilator. PPV is often facilitated with muscle relaxation ("paralytics") but it is not generally necessary. With conventional ventilators, ventilation is determined by adjusting two parameters: tidal volume (TV) and respiratory rate (RR). To ventilate a typical patient using a ventilator, start with TV=7-10ml/kg and RR=10/min and then adjust according to obtained end-tidal CO_2 levels ($ETCO_2$) (obtained via capnography) or from arterial carbon dioxide tension ($PaCO_2$) measurements. On some older anesthesia machines the tidal volume delivered depends on the total fresh gas flow (FGF), often set between 1 and 6 liters/min (flows of 1-2 liters/min are most economical).

Protection of the Airway from Injury

A final important goal of clinical airway management is preventing lung injury that may result from various causes such as [1] gastric contents spilling into the lungs (aspiration pneumonitis) [1], [2] retention of secretions that may lead to pneumonia, or [3] partial lung collapse (atelectasis). The prevention of aspiration in unconscious patients (generally those under general anesthesia or patients with a head injury) is usually achieved by using a cuffed endotracheal tube; unintubated patients may develop deadly aspiration pneumonitis and ARDS (adult respiratory distress

syndrome) [2] if stomach contents spill into the lungs (especially if the pH is <2.5 or volume >25ml). Patients at risk of aspiration with the induction of general anesthesia are usually managed with either a rapid sequence induction (RSI) or with awake intubation.

Finally, note that lung ventilation itself can sometimes be the cause of lung injury ("ventilator-associated lung injury") [3,4]. Numerous studies have proven that imprudent lung ventilation can cause inflammatory damage to the lungs from repetitive closing and reopening of the alveoli, barotrauma (trauma from excessive pressure), and volutrauma (trauma from excessive lung expansion). Even worse, induced systemic inflammatory changes from imprudent ventilation may even cause dysfunction or failure in other organs.

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