Endotracheal Extubation

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The following text summarizes information provided in the video.

OVERVIEW
Endotracheal extubation refers to the removal of an endotracheal tube from the trachea. This procedure is commonly performed in operating rooms, postanesthesia care units, and intensive care units. This review focuses on extubation of the trachea after general anesthesia and short-term intubation; extubation after long-term intubation involves additional considerations that are beyond the scope of this review.

Endotracheal tubes are initially placed to secure an airway for the administration of anesthetic agents, to provide airway protection, or to provide positive-pressure mechanical ventilation; these indications are not mutually exclusive. Once endotracheal intubation is no longer needed, extubation is indicated. However, the decision to extubate a patient must be made carefully, particularly because respiratory and airway-related complications are more likely to occur after endotracheal extubation than after endotracheal intubation. Although many of the problems related to endotracheal extubation are minor, serious complications can arise. These complications include cardiovascular stress, pulmonary aspiration, hypoxemia, and even death. Respiratory failure can occur almost immediately or later after extubation.

To minimize the possibility of complications related to the removal of an endotracheal tube, a plan for airway management is required. It is important to anticipate the possibilities of difficulties in airway management, cardiopulmonary instability, and the need to reintubate the trachea.

INDICATIONS
Endotracheal extubation is indicated when the clinical conditions that required airway protection with an endotracheal tube or that required mechanical ventilation are no longer present.

CONTRAINDICATIONS
Endotracheal extubation is contraindicated when the patient’s ability to protect the airway is impaired (i.e., the patient does not have protective airway reflexes) or when the patient cannot maintain adequate spontaneous respiration (i.e., the patient has persistent weakness in the respiratory muscles, hypoxemia, or hypercarbia). Extubation may also be contraindicated in certain patients in the presence of cardiovascular instability, metabolic derangements, or hypothermia.

Quantitative values such as respiratory rate, tidal volume, and oxygen saturation are useful indicators of patient readiness for extubation, but all pertinent and available information must be considered. Ultimately, good clinical judgment is required. Particular caution is needed when the patient’s requirements for oxygenation, ventilation, or both are high, when the patient has a history of airway obstruction, or when there has been previous difficulty in ventilating or intubating the patient.
Equipment and Medications

Equipment selection is guided by the need to prevent complications and to maintain airway patency, oxygenation, and ventilation. The equipment needed to continuously monitor the patient’s vital signs should be on hand, as should a suction device for the removal of airway secretions. Supplemental oxygen and an appropriately sized face mask with a bag-valve device should also be close at hand. Oropharyngeal and nasopharyngeal airways should be readily available in case they are needed to improve airway patency. A laryngoscope, endotracheal tubes, and stylets should be on hand in case immediate reintubation of the trachea is necessary. An induction agent, such as propofol, and a muscle relaxant, such as succinylcholine, can facilitate emergency reintubation.

If it is difficult to achieve ventilation with a face mask (Fig. 1), or if reintubation is difficult, a supraglottic rescue device, such as a laryngeal mask airway, may provide adequate oxygenation and ventilation. In the rare event that it is not possible to ventilate or reintubate the patient after extubation, establishing immediate airway access by performing a cricothyroidotomy may be necessary.

Routine Extubation

Endotracheal extubation is usually performed when patients are awake or have emerged from general anesthesia. Make sure that adequate pain control is established. If the patient is awake, a visual-analogue scale can be used to determine whether the degree of analgesia is adequate. Cardiovascular stability, normal acid-base status, normothermia, and intact protective airway reflexes should be present. If neuromuscular blockade was induced, the blockade must be fully reversed.

In preparation for extubation, the ventilator should be adjusted to ensure that adequate respiratory effort is present with minimal support. Oxygenation should be maximized, with 100% inspired oxygen delivered through the breathing circuit. Place the patient in a semirecumbent position to reduce the work of breathing and improve oxygenation; moving the patient from a supine to a semirecumbent position increases functional residual capacity, allowing for longer periods of apnea before oxygen desaturation occurs. Make sure that the tidal volume, respiratory rate, and inspiratory force are at appropriate levels before beginning extubation.

Suction the patient’s endotracheal tube with a disposable catheter or an in-line suction device, and then carefully remove any tape or securing device in preparation for extubation. Avoid inducing abrupt head and neck movements, which may cause the endotracheal tube to stimulate the trachea and trigger coughing. A patient with an injury to the cervical spine may require additional neck support. Carefully suction any oropharyngeal secretions (Fig. 2), avoiding trauma to the teeth and the airway. To minimize the risk that the patient will bite the endotracheal tube, which could cause occlusion of the tube or result in dental injury, a bite block or an oral airway may be used.

Patients emerging from general anesthesia often make forceful, uncoordinated movements just before they are ready for extubation. Therefore, it is vital to protect the position of the endotracheal tube to keep the patient from accidentally self-extubating, which could cause hypoxemia. In addition, the patient’s fingernails or objects such as the pulse oximeter sensor could cause abrasions to the corneas if the patient’s arms and hands are not secured.

When the patient is ready for extubation, attach a syringe to the pilot balloon and completely deflate the cuff of the endotracheal tube. To maximize alveolar recruitment during endotracheal extubation, positive-pressure ventilation with oxygen can be provided with a bag-valve device. After extubation, immediately...
verify that the airway is patent and that adequate spontaneous ventilation is occurring. Observe the face mask for the rhythmic condensation of exhaled breath. Phonation and speech after extubation are reassuring signs that injury to the vocal cords and acute glottic edema have largely been prevented. Continue to provide supplemental oxygen through the face mask until the patient has fully recovered.

EXTUBATION OF MORBIDLY OBSESE PATIENTS
When extubating morbidly obese patients with obstructive sleep apnea, readiness to support ventilation and maintain airway patency are very important. Before extubation, make sure the patient is fully awake and able to respond appropriately to commands. Upright positioning of the patient is strongly recommended so that the excess body tissue on the chest and against the diaphragm is displaced caudad, which will reduce the work of breathing and increase the functional residual capacity. After extubation, the patient should be kept in a semirecumbent position and should be monitored closely for acute airway obstruction.

DIFFICULT EXTUBATION
The extubation of patients in whom intubation or the placement of a face mask was difficult requires special consideration, because managing the consequences of unsuccessful extubation can be extremely challenging. Surgical factors (e.g., the need for a patient to spend a long time in the prone position or the need for direct surgical manipulation of the airway) and medical factors (e.g., angioedema) may increase the difficulty of airway ventilation or intubation. If continued intubation is deemed safer than mechanical ventilation, adequate sedation and cardiopulmonary monitoring should be maintained. The plan should be documented and clearly communicated to the patient's medical team.

SERIOUS COMPLICATIONS OF EXTUBATION
Although few extubation-related complications are life-threatening, hypoxemia is the common pathway to severe complications. In the period immediately after extubation, early respiratory insufficiency may be caused by poor ventilation or residual neuromuscular blockade. Bronchospasm and severe coughing can also impair adequate ventilation and can be treated with topical or intravenous local anesthetic agents, intravenous opioids, or bronchodilators, as indicated. Acute upper-airway obstruction may be caused by laryngospasm, especially in children. Vocal-cord dysfunction is a rare cause of airway obstruction and sometimes requires immediate reintubation. The possibility of vocal-cord dysfunction should be investigated if there is a suspicion of injury to the recurrent laryngeal nerves. Patients with laryngeal edema due to prolonged intubation or direct compression of the glottis can present with delayed airway obstruction and inspiratory stridor. Impairment of the airway and swallowing reflexes can pose a risk of pulmonary aspiration. Manipulation of the airway is usually noxious for patients, causing increased myocardial demand; pretreatment with opioids or beta-blockers can reduce this catecholamine-mediated stress. If the medical indications that led to intubation have not been adequately resolved, progressive decompensation may occur after extubation, ultimately leading to reintubation. A tracheostomy is indicated if safe extubation cannot be achieved in 7 to 14 days.

SUMMARY
Endotracheal extubation should be performed without causing trauma, while maintaining adequate oxygenation and ventilation. The equipment needed to provide
suction, ventilation, and reintubation should be readily available. If extubation is judged to be unsafe, the procedure should be postponed and the patient reevaluated. Most complications related to extubation are preventable.

Before performing extubation, the clinician must carefully prepare the medical resources needed to address reasonably foreseeable complications. A failed extubation can lead to a precipitous deterioration in the patient’s condition, and attempts to improvise solutions under these challenging circumstances are rarely satisfactory.

No potential conflict of interest relevant to this article was reported.
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