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MECHANICAL VENTILATION WEANING STRATEGY AND PROBLEMS ASSOCIATED WITH EXTUBATION

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Abstract **- Weaning covers the entire process of liberating the patient from mechanical support and from the endotracheal tube.Discontinuation of mechanical ventilation and weaning represents a milestone in the progression to patient recovery in the Intensive Care Unit (ICU). Despite advances in mechanical ventilation weaning and respiratory support, the science of determining if the patient is ready for extubation is still very vague. The goal of this article is to summarize key developments in this important clinical area that the patients are weaned safely and as soon as possible, to improve their outcomes and avoid complications.**

keywords **- Mechanical Ventilation, Weaning, Extubation**

Introduction

The process of reducing ventilator support and resuming spontaneous ventilation is termed weaning. The weaning process differs for patients requiring short-term ventilation (#3 days) versus long-term ventilation (>3 days). Patients requiring short-term ventilation (e.g., after cardiac surgery) will experience a linear weaning process. Patients likely to require prolonged PPV (e.g., patients with COPD who develop respiratory failure) will most likely experience a weaning process that consists of peaks and valleys. Conceptually, preparation for weaning should begin when PPV is initiated and should involve a team approach (e.g., nurse, physician, patient, family, respiratory therapist, dietitian, physical therapist).

Phases of weaning

Weaning can be viewed as consisting of three phases

- Preweaning phase,
- Weaning process,
- Outcome phase.

Pre-weaning phase

The pre-weaning phase determines the patient's ability to breathe spontaneously. Assessment in this phase depends on a combination of respiratory and nonrespiratory factors. Weaning assessment parameters should include criteria to assess muscle strength (negative inspiratory force [NIF]) and endurance (spontaneous tidal volume [V_T], vital capacity [VC], minute ventilation [V_E], and rapid shallow breathing index [RSBI]). In addition, the patient's lungs should be reasonably clear on auscultation and chest x-ray. Nonrespiratory factors include the assessment of the patient's neurologic status, hemodynamics, fluid and electrolytes/acid-base balance, nutrition, and hemoglobin. It is important to have an alert, well-rested, and well-informed patient relatively free from pain and anxiety who can cooperate with the weaning plan. This does not mean complete withdrawal from sedatives or analgesics. Instead, drugs should be titrated to achieve comfort without causing excessive drowsiness.

Weaning process

Weaning is a term that is used in two separate ways. Firstly, it implies the termination of mechanical ventilation and secondly the removal of any artificial airway—Evidenced-based clinical guidelines recommend a spontaneous breathing trial (SBT) in patients who demonstrate weaning readiness. An SBT should be at least 30 minutes but no longer than 120 minutes and may be done with low levels of CPAP, low levels of PSV, or a "T" piece. Tolerance of the trial may lead to extubation. Failure to tolerate an SBT should prompt a search for reversible or complicating factors and a return to a nonfatiguing ventilator modality for the patient. The SBT should be reattempted the next day.

Additionally, the use of a standard approach for weaning or weaning protocols has been shown to decrease ventilator days. The components of the protocol are not as important as the use of a protocol to prevent delays in weaning. All methods can be delivered with the patient remaining connected to the ventilator circuit. The patient receiving SIMV can have the ventilator breaths gradually reduced as the patient's ventilatory status permits. CPAP or PSV can be added to SIMV. Another method involves PSV, CPAP, or both delivered without SIMV. PSV is thought to provide gentle, slow respiratory muscle conditioning and may be especially beneficial for patients who are deconditioned or have cardiac problems. Some patients may be weaned by simply providing humidified oxygen (T-piece or flow-by method).

Weaning is usually carried out during the day, with the patient ventilated at night in a rest mode. The rest mode should be a stable, nonfatiguing, and comfortable form of support for the patient. Regardless of the weaning mode selected, all team members should be familiar with the weaning plan. Additionally, regardless of the method used, it is important to permit the patient's respiratory muscles to rest between weaning trials. Once the respiratory muscles become fatigued, they may require 12 to 24 hours to recover.

The patient being weaned and the family should be provided ongoing psychologic support. The weaning process should be explained, and the patient and family informed of progress. The patient should be placed in a sitting or semirecumbent position and made comfortable. Baseline vital signs and respiratory parameters are measured. During the weaning trial, the patient must be monitored closely for noninvasive criteria that may signal intolerance and result in cessation of the trial (e.g., tachypnea, dyspnea, tachycardia, dysrhythmias, sustained desaturation [SpO_2 <91%], hypertension or hypotension, agitation, diaphoresis, anxiety, sustained V_T <5 ml/kg, changes in level of consciousness). Documentation of the patient's tolerance throughout the weaning process is important and should include statements regarding the patient's and the family's perceptions.

Outcome phase.

The weaning outcome phase refers to the period when weaning stops and the patient is extubated or weaning is stopped because no further progress is being made. The patient who is ready for extubation should receive hyperoxygenation and suctioning (e.g., oropharynx, ET tube). The patient should be instructed to take a deep breath, and at the peak of inspiration, the cuff should be deflated and the tube removed in one motion. After removal, the patient should be encouraged to deep breathe and cough, and the pharynx should be suctioned as needed. Supplemental oxygen should be applied and naso-oral care provided. The nurse must carefully monitor the patient's vital signs, respiratory status, and oxygenation immediately following extubation, within 1 hour, and per institutional policy. If the patient cannot tolerate extubation, immediate reintubation may be necessary.

Techniques of Weaning

- After a successful weaning trial/SBT, a decision is made to proceed with extubation.
- All necessary equipment should be available for extubation management and the rest of the equipment available nearby in case extubation does not go as planned.
- The patient should be in an upright sitting position.
- Both the ETT and oral cavity are suctioned - if there is subglottic suction, it should be utilized to remove all secretions above the ETT cuff. If no subglottic suction is available, use a small-bore catheter to insert on the side of the ETT and suction all secretions above the ETT cuff.
- The ETT is removed from the holder; when ready to be removed, ask the patient to take a deep breath and exhale. During exhalation, deflate the cuff, and smoothly take out the ETT.
- If an orogastric tube is present, it is also removed alongside the ETT. This decision should be made before extubation taking into consideration the need for oral medications and nutrition. Some patients may not be ready for oral intake and require a nasogastric tube placement upon removal of the orogastric tube.
- After the removal of the ETT, suction the oral cavity and ask the patient to take a deep breath and cough out all secretions.
- The patient should be placed on supplemental oxygen afterward.
- The patient should be observed very carefully over the next few hours.
- Frequent airway suction should be considered to prevent re-intubation.
- The timing of extubation (day, evening, night) is dependent on the institution and individual ICU, but the most critical factor to consider is the availability of adequate experienced personnel.

Post-Extubation Management

- The immediate post-extubation phase should be managed as carefully as the ventilated phase because the first 24 hours post-extubation is difficult and tenuous.

- Ensure adequate oxygenation: Consider nasal cannula, oxygen mask, full face mask, venturi mask as appropriate to ensure good O2 supply.

- In recent times, high flow oxygen systems have gained popularity in selected patients with hypoxemic respiratory failure and studies have shown to reduce the re-intubation rate.
- If needed consider CPAP/BPAP for selected high-risk patients to avoid re-intubation.
- Ensure adequate secretion management, encourage coughing and deep breathing, maintain airway hydration, and patent central airway.

- Use adequate bronchodilators as needed.
- Encourage sitting up position and mobility if no other contraindications exist.
- Carefully introduce oral feeding. In at-risk patients, continue enteral feeding with a nasogastric tube until the patient is deemed safe to swallow and tolerate food orally.

Problems associated with extubation

Trauma

Trauma to any of the structures forming the upper and lower airways is possible at tracheal extubation, but it has rarely been reported. Trauma to the larynx and vocal cords is particularly likely after a difficult extubation and it has been recommended that direct laryngoscopy should always be performed immediately after extubation to assess any laryngeal damage if attempts to remove a tracheal tube have been forceful and repeated. In addition, damage to the mobile structures in the upper airway as a result of excessive suction at the time of extubation should always be considered. The sequelae of trauma to the laryngeal structures may only become apparent at or soon after extubation, although the trauma may have occurred at an earlier stage of the intubation process. Dislocation of the arytenoid cartilages has been described after a difficult intubation, but has also followed uncomplicated tracheal intubation.The usual presentation is painful swallowing and voice change, but the condition may also present as acute respiratory failure because of upper airway obstruction immediately after extubation This injury should be considered in all patients who experience signs of upper airway obstruction in the early period after extubation. It has been suggested also that arytenoid dislocation may have been the cause of some of the cases described previously as "glottic oedema" occurring after tracheal extubation . Management requires immediate reintubation and the subsequent treatment involves either early reduction of the arytenoids by application of gentle pressure with a laryngeal spatula or prolonged tracheal intubation, or even tracheotomy, to prevent arytenoid movement and enable healing of the dislocated joint.

Tracheal collapse

Tracheomalacia may be primary or secondary (usually to thyroid pathology), but may produce upper airway obstruction only after tracheal extubation. Respiratory obstruction occurred after retraction of the tracheal tube 4—5 cm from the carina and was corrected only by reinserting the tube to within 1-2 cm of the carina. They recommended that, in such patients, tracheal extubation should be performed slowly. If ventilatory obstruction should occur, the tracheal tube should be repositioned and retained until surgical correction of the lesion is possible. Tracheomalacia may result from prolonged compression by an expanding thyroid goitre, particularly within the confines of the thoracic inlet. The Tracheal collapse usually occurs after extubation and requires emergency reintubation. The subsequent options include surgical resection of the affected segment of the trachea, internal or external tracheal support, or airway diversion below the affected trachea through a tracheostomy.

Airway obstruction

Laryngospasm, laryngeal oedema and vocal cord paralysis are important causes of upper airway obstruction occurring immediately after extubation. It is also important to remember causes of airway obstruction relating to foreign bodies such as throat packs, dentures and blood clots. All require immediate removal to relieve the obstruction. In some subjects, airway obstruction occurs as a consequence of the surgical procedure—for example, haemorrhage complicating thyroid surgery or other procedures in and around the neck It has been suggested that the upper airway obstruction in such patients may result from laryngeal and pharyngeal oedema secondary to venous and lymphatic congestion, rather than compression of the trachea by haematoma . In the case of postthyroidectomy bleeding, immediate release of the wound sutures may produce dramatic improvement, although definitive treatment requires tracheal intubation followed by surgical decompression and control of the source of bleeding.

Laryngospasm

Laryngospasm has been denned as an occlusion of the glottis by the action of the intrinsic laryngeal muscles. The structural and functional basis of the laryngospasm reflex has been essentially a protective reflex, mediated by the vagus nerves, which acts to prevent foreign material entering the tracheobronchial tree. Laryngospasm is the most common cause of upper airway obstruction after tracheal extubation. It is particularly frequent in children after upper airway surgery, for example after adenotonsillectomy, with which the incidence is approximately It is precipitated by local irritation of the vocal cords by secretions or blood, when the plane of anaesthesia is insufficient to prevent the laryngospasm reflex, but too deep to allow coordinated cough. Thus it is most likely to occur after tracheal extubation of a patient in a plane of anaesthesia somewhere between an awake and a deeply anaesthetized state.

Laryngeal oedema

Laryngeal oedema is an important cause of upper airway obstruction after tracheal extubation inchildren and, more particularly, in neonates and infants. The oedema may be localized to the supraglottic, retroarytenoidal or subglottic regions.

Supraglottic oedema. Oedema occurs in the loose connective tissue on the anterior surface of the epiglottis and on the aryepiglottic folds. The epiglottis may be displaced posteriorly by the swelling, blocking the glottic aperture on inspiration and resulting in severe acute upper airway obstruction.

Retroarytenoidal oedema. Oedema occurs in the loose connective tissue just below the vocal cords and behind the arytenoid cartilages. Movement of the arytenoid cartilages is thus restricted and this limits abduction of the vocal cords on inspiration.

Subglottic oedema. The subglottic region has fragile respiratory epithelium with loose submucosal connective tissue that is easily traumatized and prone to oedema. The non-expandable cricoid cartilage, which encircles the subglottic region, is the narrowest part of the airway in children and limits the outwards expansion of the oedema

Vocal cord paralysis

Vocal cord paralysis resulting from trauma to the vagus nerves or their branches is an important, although rare, cause of upper airway obstruction after extubation. Unilateral vocal cord paralysis is usually a benign condition which presents as hoarseness in the early postoperative period followed by recovery over several weeks. Bilateral vocal cord paralysis is a more serious condition which may present as upper airway obstruction immediately after extubation. The usual methods of relieving upper airway obstruction are not effective, although assisted ventilation with a facemask may overcome the upper airway obstruction. Laryngoscopy reveals motionless vocal cords which lie adducted with a very narrow glottis aperture. Immediate insertion of a tracheal tube eliminates the upper airway obstruction. Recovery is usual but often delayed, and a tracheostomy may be required temporarily.Vocal cord paralysis is described usually after surgical procedures involving the head and neck, the thyroid gland or the thoracic cavity. It has also been described in association with increased intracranial pressure, when it may present as upper airway obstruction after tracheal extubation Vocal cord paralysis has also occurred unexpectedly after surgery remote from the head and neck It has been suggested that tracheal intubation itself may result in peripheral nerve damage leading to vocal cord paralysis.

Pulmonary oedema associated with upper airway obstruction

The development of pulmonary oedema after an episode of acute upper airway obstruction is a phenomenon which is being described more frequently. There are numerous reports, in both children and adults, of pulmonary oedema complicating upper airway obstruction after tracheal extubationThe onset of the pulmonary oedema is usually within minutes of either development of acute upper airway obstruction or after relief of obstruction. Resolution usually occurs spontaneously over a period of a few hours. The essentials of management are maintenance of the airway by tracheal intubation, administration of supplementary oxygen and, if necessary, institution of positive pressure ventilation until the condition either aggressive haemodynamic monitoring or drug therapy. The pathogenesis of the pulmonary oedema is multifactorial, although the markedly negative intrathoracic pressure generated during an episode of acute upper airway obstruction is probably the dominant pathophysiological mechanism.

Laryngeal incompetence

Aspiration of gastric contents or foreign bodies at tracheal extubation may occur in patients whose protective laryngeal reflexes are obtunded by the residual effects of local or general anaesthetic agents.In addition, that laryngeal function is disturbed for at least 4 hour after tracheal extubation, even in alert postoperative patients. The mechanism of this laryngeal incompetence after extubation of the trachea is thought to be inability of the larynx to sense foreign material. The best protection against pulmonary aspiration is obtained by pharyngeal suction under direct vision, followed by extubation in the lateral position with head-down tilt.

Conclusion

It is important that critical care nurses have the skills and knowledge to care for patients who are undergoing weaning from mechanical ventilation. This is to ensure that patients are weaned safely and as soon as possible, to improve their outcomes and avoid an increase in patient mortality and morbidity through complication.

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