Extubation of the Trachea

Though a wealth of literature is focused on the field of tracheal intubation, few reviews have well contemplated the area of extubation after completion of surgery, or prolonged ventilatory support. Indeed, the period of extubation may be far more treacherous than that of intubation (Table 1A).

**Routine Extubation.** Extubation of the trachea must not be considered a benign procedure. It is not simply the elimination or reversal of tracheal intubation. Extubation is fraught with its own set of potential complications (Table 1B). Appropriately trained personnel and equipment should be immediately available at the time of extubation. This may range from a postanesthetic care unit nurse or respiratory therapist with a set of laryngoscopes to a surgeon prepared to perform an emergency tracheostomy.

Most adult patients are extubated after the return of consciousness and spontaneous respiration, the resolution of neuromuscular block, and the ability to follow simple commands (Table 2). The patient is asked to open the mouth and a suction catheter is used to remove excessive secretions and/or blood. The airway pressure is allowed to rise to 5–15 cm of H$_2$O to allow for a “passive cough,” and the endotracheal tube is removed after the cuff (if present) is deflated. If coughing or straining is contraindicated or hazardous (e.g., increased intracranial pressure), extubation may be performed while the patient is in a surgical plane of anesthesia. In patients at risk for gastric contents aspiration (e.g., full stomach) or upper airway obstruction, the clinician needs to assess the relative risk of each potential morbidity. For the latter risk, and possibly the former, a maneuver has been described in which an LMA is placed posterior to the ETT, which is then removed. This obviates the problem of upper airway obstruction, and may offer some protection against regurgitation and aspiration. Because of the risks of atelectasis and diffusion hypoxia, the ability to administer oxygen should be available at the time of extubation.

**Difficult Extubation.** The patient who presented as a difficult airway at the time of anesthetic induction must be considered a difficult airway at the time of extubation, even when corrective surgery was performed in the interim (e.g., uvulopharyngoplasty in the obstructive sleep apnea patient). As a cause of ventilatory compromise, laryngospasm deserves special attention because of its prevalence in children and because it accounts for 23% of all critical postoperative respiratory events in adults. Laryngospasm may be triggered by respiratory secretions, vomitus, or blood in the airway; pain in any part of the body; and pelvic or abdominal visceral stimulation. The cause of airway obstruction during laryngospasm is the contraction of the lateral cricoarytenoids, the thyroarytenoid, and the cricothyroid muscles. Management of laryngospasm consists of the immediate removal of the offending stimulus (if identifiable), administration of oxygen with continuous positive airway pressure, and, if other maneuvers are unsuccessful, the use of a small dose of short-acting muscle relaxants. Negative-pressure pulmonary edema may result from any airway obstruction in a patient who continues to have a voluntary respiratory effort. Negative intrathoracic pressure is transmitted to the alveoli, which are unable to expand owing to the more proximal obstruction. Fluid is entrained from the
pulmonary capillary bed. Negative-pressure pulmonary edema is treated as any other form of noncardiogenic edema.

**IDENTIFICATION OF PATIENTS AT RISK AT EXTUBATION.** A number of well known clinical situations may place patients at increased risk for complication at the time of extubation. Table 3 lists the risk factors for extubation complications. However, the clinician should evaluate every patient in terms of potential problems, in the same manner that they are prepared for the unanticipated difficult intubation.

**APPROACH TO THE DIFFICULT EXTUBATION.** When there is a suspicion that a patient may have difficulty with oxygenation or ventilation after tracheal extubation, the clinician may choose from a number of management strategies. These may range from the preparation of standby reintubation equipment to the active establishment of a route or guide for reintubation and/or oxygenation. When the patient’s intubation is without difficulty and there is no substantial reason to believe that an interim insult to the airway has occurred, extubation may be accomplished in a routine fashion, with a heightened state of readiness for reintubation. When there has been difficulty with intubation or there is a clinical suspicion that reintubation will be difficult, extubation over a guiding stylet may be a successful technique. Any number of devices can be used as a stylet (Table 4).

A popular test to predict airway patency after extubation is the detection of a leak upon deflation of the ETT cuff. A recent investigation has cast doubt on the reliability of this test as a predictor of airway incompetence: though the absence of an airway leak on cuff deflation was not predictive of subsequent ventilatory failure after extubation, no patient with a positive leak test (leak around the ETT cuff) developed problems after extubation. Another technique may be the use of an FOB to view the tracheal structures during the removal of the ETT. If extubation is tolerated, the FOB can be slowly withdrawn into the subglottic region. If secretions do not obstruct the objective lens, the vocal folds and other structures may be visualize and evaluated. A number of obturators are available for use in trial extubation (where they may be left in place in the airway for extended periods) or endotracheal tube exchange (e.g., failure of the ETT cuff). It is beyond the scope of this text to describe all the commercially available catheters. The Cook Airway Exchange Catheters (Cook Critical Care, Bloomington, IN) are manufactured with external diameters of 2.7, 3.7, 4.7, and 6.33 mm. The smallest diameter catheter (which can fit within a 3.0-mm id ETT) is 45 cm long, whereas the others are 83 cm in length. They all have a central lumen and rounded, atraumatic ends. The catheters are graduated from the distal end. The proximal end is fitted with either a 15-mm or a Luer-lock Rapi-Fit adapter, which can be quickly removed and replaced for ETT removal or change. With these adapters an oxygen source can be used to provide insufflated or jet-ventilated oxygen if the patient fails extubation and/or if reintubation over the catheter fails. The Cardiomed endotracheal ventilation catheter (Gromley, Ontario, Canada) designed by Richard Cooper, M.D., a Canadian anesthesiologist, is 85 cm in length, and has inner and outer diameters of 3 and 4 mm, respectively. An integral Luer-lock fitting adapter is found at the proximal end, whereas the blunted distal end incorporates eight helically arranged side holes in addition to the distal end hole. The arrangement of these holes is meant to center the catheter during oxygen insufflation, and prevent traumatic “whipping” within the trachea. The use of this catheter for ETT exchange, tracheal reintubation, oxygen insufflation, jet ventilation, and end-tidal CO₂ detection after extubation has been documented by the inventor.