Chapter 2: Airway Management and Ventilation

Objectives:

Upon completion of this topic, the physician will be able to explain and demonstrate the principles of airway management.

Specifically, the physician will be able to:

A. Recognize those conditions associated with airway and ventilatory compromise in the acutely injured as well as the stabilized trauma victim.

B. Discuss the principles of airway intervention and ventilatory management.

C. Demonstrate basic and advanced methods of airway intervention.

D. Perform transtracheal insufflation and surgical cricothyroidotomy during the surgical practicum.

E. Demonstrate one-man and two-man techniques for ventilating a patient.
I. Introduction

The upper and lower airway are of concern in any patient sustaining multiple trauma, because injury to either the upper or lower airway can compromise ventilation. Therefore, both areas require attention. An airway must be secured, oxygen delivered via a face mask with a reservoir device, and ventilatory support provided. **Supplemental oxygen must be administered to all trauma patients.**

Early preventable deaths from airway problems after trauma are frequently due to:

1. The multiplicity of signs and symptoms, which may overwhelm the physician's senses and delay airway management.

2. Failure to recognize subtle or even obvious indicators for airway intervention in patients with airway and ventilatory compromise.

3. Faulty judgment in selecting the correct airway maneuver.

4. Limited experience with airway skill provision.

II. Airway and Ventilatory Compromise

A. Awareness

Airway compromise may be acute, insidious, progressive, and recurrent. Altered consciousness represents the single most frequent indication to provide an airway with endotracheal intubation. The unconscious, head-injured patient, the patient obtunded from alcohol and/or drugs, and the patient with thoracic injuries may have compromised ventilatory effort. In these patients, endotracheal intubation is intended to: 1) provide an airway, 2) deliver supplementary oxygen, and 3) support ventilation. **Preventing hypercarbia is critical in managing the trauma patient, especially if the patient has sustained a head injury.** (See Chapter 6 - Head Trauma.)

**Trauma to the face and/or neck,** with actual compromise to the airway lumen, is another indication for airway intervention. The mechanism for this injury is exemplified by the unbelted passenger/driver who is thrown into the windshield and dash. Trauma to the midface may produce fractures-dislocations with compromise to the nasal and oral pharynx. Fractures of the mandible may result in the loss of normal mastication muscle support and subsequent obstruction of the hypopharynx by the tongue. Facial fractures may be associated with hemorrhage and increased secretions, causing additional airway compromise. Injuries to the neck may affect the airway as a result of direct trauma to the larynx, the supporting structures of the airway (mandible), or hemorrhage with secondary compression.

B. Recognition

The most important question one can ask the trauma patient is, "How are you?" Failure to respond implies an altered level of consciousness. A positive, appropriate **verbal** response indicates that the airway is patent, ventilation intact, and brain perfusion adequate.
Any inappropriate response may suggest airway/ventilatory compromise.

1. **Look** to see if the patient is agitated or obtunded. Agitation suggests hypoxia, and obtundation suggests hypercarbia. Cyanosis indicates hypoxemia due to inadequate ventilation. **Remember**, patients who refuse to lie down quietly may be attempting to clear their secretions by sitting up.

2. **Listen** for abnormal sounds. Snoring, gurgling, and gargling sounds may be associated with partial occlusion of the pharynx. Hoarseness (dysphonia) implies laryngeal obstruction. The abusive/abrasive patient may be hypoxic and should not be presumed intoxicated.

3. **Feel** for the movement of air with the expiratory efforts and quickly determine if the trachea is midline.

### III. Management

Management objectives for airway compromise include: 1) securing an intact airway, 2) protecting the jeopardized airway, and 3) providing an airway if none is available. Basic, advanced, and surgical airway intervention techniques must be applied with the full realization that the patient may have a cervical spine injury. The neck must be securely immobilized until the possibility of a spinal injury has been ruled out with suitable roentgenographic studies, or the injury has been recognized and appropriately managed. A patient wearing a helmet is no exception. If a cervical spine injury is present, the helmet should be removed appropriately and safely.

#### A. Basic Life Support

For the patient with an altered sensorium, the tongue prolapses backward and obstructs the hypopharynx. This simple obstruction can be readily corrected by the chin-lift or jaw-thrust maneuver. The airway can then be maintained with an oral or pharyngeal airway.

1. **Chin lift**

   The fingers of one hand are placed under the mandible, which is gently lifted upward to bring the chin anterior. The thumb of the same hand lightly depresses the lower lip to open the mouth. The thumb may also be placed behind the lower incisors and, simultaneously, the chin gently lifted. The chin-lift maneuver should not hyperextend the neck. The chin lift is the method of choice for the trauma victim because it does not risk compromising a possible cervical spine fracture, or converting a fracture without cord injury into one with cord injury.

2. **Jaw thrust**

   The jaw-thrust maneuver is performed by grasping the angles of the lower jaw, one hand on each side, and displacing the mandible forward. When this method is used with the mouth-to-face mask (using the type of equipment that prevents backward flow of air and secretions), a good seal and adequate ventilation are achieved.
3. Suction

Blood and secretions should be removed with a rigid suction device (tonsil suction tip). Patients with facial injuries may have associated cribiform plate fractures, and the routine use of the soft suction catheter or the nasogastric tube inserted through the nose may be complicated by passage of the tubes into the cranial vault.

4. Oropharyngeal airway

The oral airway is inserted into the mouth behind the tongue. This technique is facilitated by using a tongue blade to depress the tongue and then inserting the airway posteriorly. The airway must not push the tongue backward and block, rather than clear, the airway.

An alternative technique is to insert the oral airway upside-down, so its concavity is directed upward, until the soft palate is encountered. At this point, the airway is rotated 180 degrees, the concavity is directed caudad, and the airway is slipped into place over the tongue. This method should not be used for children, because the rotation of the airway may damage the teeth.

5. Nasopharyngeal airway

The nasal airway is simply inserted into one nostril to provide adequate passage into the hypopharynx. The nasal airway may be inferior to the oral airway, but unlike the oral airway, the responsive patient tolerates it well. It should be lubricated, then inserted into the nostril that appears to be unobstructed. If obstruction is encountered during introduction of the airway, stop and try the other nostril.

B. Advanced Airway Intervention

The urgency of the situation and the circumstances surrounding the need for airway intervention often dictate specific route and method to be used. Oral and nasal endotracheal intubation are the methods used most frequently. The potential for concomitant cervical spine injury is of major concern in the patient requiring an airway. The algorithm that appears at the conclusion of this chapter exemplifies a scheme by which the decision for the appropriate route of airway management can be made.

1. Endotracheal intubation

For the unconscious patient who has sustained blunt trauma and needs an airway, first determine the urgency for that airway. If there is no immediate need, then a roentgenogram of the cervical spine should be obtained. A normal lateral cervical spine roentgenograph is reassuring and allows safe oroendotracheal intubation with midline immobilization of the head and neck. However, a normal lateral cervical spine film does not rule out a cervical spine injury. Spinal immobilization should be maintained until removed by the neurosurgical or orthopedic consultant. If no cervical spine fractures are noted, oral endotracheal intubation should be performed. If a fracture is seen or suspected, nasoendotracheal intubation may be performed according to clinical judgment.
If the immediate need for an airway precludes radiographic evaluation of the cervical spine, and if the patient is breathing, nasoendotracheal intubation should be attempted. If the patient is apneic, orotracheal intubation with inline manual cervical immobilization should be attempted.

Malpositioning of the endotracheal tube must be considered in all patients who arrive at the hospital with an endotracheal tube presumably positioned properly. The tube may have been inserted into a mainstem bronchus, or dislodged during patient transport from the field or another hospital. Placement can be checked quickly by listening for equal breath sounds bilaterally, and listening over the stomach to determine unintentional esophageal intubation.

If the patient’s condition permits, fiberoptic endoscopy may facilitate difficult oral or nasoendotracheal intubation. The endoscopic techniques may be used for selected cases of maxillofacial and cervical spine injury, and for stocky patients with short necks. If these injuries or conditions preclude oral or nasal endotracheal intubation, the physician may proceed directly to surgical techniques: needle or surgical cricothyroidotomy.

The esophageal obturator airway is an ineffective device with which to establish an airway. However, physicians may encounter patients in whom an esophageal obturator airway (EOA or EGTA) has been inserted. If an unconscious patient has an EOA or EGTA in place, the patient must be endotracheally intubated before removing it. Replacement with an endotracheal tube is not necessary if the patient regains consciousness. In fact, suction should be obtained, the head turned to the side if a neck injury has been excluded, the cuff deflated, and the EOA removed.

C. Surgical Airway Intervention

Inability to intubate the trachea is the only indication for creating a surgical airway.

When edema of the glottis, fracture of the larynx, or severe oropharyngeal hemorrhage obstructs the airway and an endotracheal tube cannot be placed through the cords, a surgical cricothyroidotomy may be performed to allow air passage. Insertion of a needle through the cricothyroid membrane or into the trachea is an acceptable alternative to a surgical cricothyroidotomy. An emergency tracheostomy, done under emergency conditions, is difficult to perform, is often associated with profuse bleeding, and may require too much time to perform.

1. Jet insufflation of the airway

Needle cricothyroidotomy is an acceptable alternative method to the surgical route and is preferable in an emergency situation for a child under the age of 12 years.

Use of the jet insufflation technique can provide up to 45 minutes of extra time so that intubation can be accomplished on an urgent rather than an emergent basis.

The jet insufflation technique is performed by placing a large-caliber plastic cannula, #12- to 14-gauge in the trachea below the level of the obstruction. The cannula is then
connected to wall oxygen at 15 liters/minute (40 to 50 psi) with either a Y-connector or a side hole cut in the tubing attached between the oxygen source and the plastic cannula. Intermittent ventilation, one second on and four seconds off, can then be achieved by placing the thumb over the open end of the Y-connector or the side hole. The patient can be adequately ventilated for only 30 to 45 minutes using this technique. During the four seconds that the oxygen is not being delivered under pressure, some exhalation will occur. Because of this inadequate inhalation, carbon dioxide may accumulate and limit the use of this technique.

Jet insufflation may also be used for foreign body obstruction in the glottic area. Not only can ventilation and oxygenation be performed, but the high pressure may expel the impacted material into the hypopharynx, where it can be readily removed.

2. Surgical cricothyroidotomy

Surgical cricothyroidotomy is easily performed by making a skin incision that extends through the cricothyroid membrane. A curved hemostat may be inserted to dilate the opening and a small endotracheal tube or tracheostomy tube (preferably 5 mm to 7 mm) can be inserted. When the endotracheal tube is used, the cervical collar can be reapplied. One must be alert to the possibility that the endotracheal tube can become malpositioned. Should long-term tracheal intubation be required, the cricothyroidotomy can be replaced with a tracheostomy. Care must be taken, especially with children, to avoid damage to the cricoid cartilage, which is the only circumferential support to the upper trachea. Therefore, surgical cricothyroidotomy is not recommended for children under 12 years. (See Chapter 10 - Pediatric Trauma.)

D. Oxygenation and Ventilation

The primary goal of ventilation is to achieve maximum cellular oxygenation which is promoted in the trauma patient by providing an environment rich in oxygen (using high-flow oxygen at 10 to 12 liters/minute and a tight-fitting mask), and sustained gas exchange at the alveolar capillary membrane through improved ventilatory efforts.

1. Oxygenation

High-flow oxygen delivery via a nasal cannula or simple plastic face mask fails to provide and FIO₂ of at least 0.85, and therefore should not be used for the trauma patient. However, a tight-fitting, oxygen reservoir face mask with high-flow oxygen delivery can deliver an FIO₂ of 0.85.

2. Ventilation

The hypoxic and/or apneic patient must be ventilated and oxygenated before intubation is attempted.

Ventilation can be achieved by mouth-to-face mask (using the type of equipment that prevents backward flow of air and secretions), or bag-valve-face-mask. Frequently, only one person is present to provide ventilation; under these circumstances, mouth-to-face mask ventilation is the preferred method. Studies suggest that one-person ventilation
techniques, using a bag-valve mask, are less effective than two-person techniques in which both hands can be used to assure a good seal.

Intubation of the hypoventilated and/or apneic patient may not be successful initially and may require multiple attempts. Prolonged efforts to intubate without intermittent ventilation must be avoided. The physician should practice taking a deep breath when intubation is first attempted. When the physician must breathe, the attempted intubation should be aborted, and the patient ventilated.

With intubation of the trachea accomplished, assisted ventilation should follow, using positive-pressure breathing techniques. A volume- or pressure-regulated respirator can be employed, depending on availability of equipment. The physician should be alert for the complications secondary to changes in intrathoracic pressure, which can convert a simple pneumothorax to a tension pneumothorax, or even create a pneumothorax secondary to barotrauma.
IV. Summary

A. An altered level of consciousness is the most common cause of upper airway obstruction.

B. Beware of a cervical spine injury during airway management.

C. The chin lift is the preferred manual method to open the airway.

D. Oral and nasopharyngeal airways maintain a patent airway.

E. If a cervical spine injury is radiologically absent, oral intubation may be performed.

F. When a cervical spine injury is certain or suspected, nasotracheal intubation should be performed.

G. Beware of malpositioning of the endotracheal tube.

H. Inability to intubate requires the utilization of surgical airway techniques.

I. Intermittent ventilation between attempts at intubation and postintubation ventilation are vital concerns.