European Trauma Care Course
AIRWAY AND VENTILATION

INTRODUCTION
With the possible exception of spinal immobilisation, control of the airway is the first priority in the initial care of the trauma victim. Inability to oxygenate the brain is the fastest killer of the trauma victim. In all the trauma victims oxygen must be administered. Although the principles of airway management are well established, the timing of intervention and which technique to use are influenced by personal experience.

After acute trauma the possibility of a cervical spine injury must always be considered. This may be an unstable fracture or dislocation that can be aggravated by inexpert or uncontrolled manipulation of the neck. Approximately 1 in 300 of car crash victims occupants sustain cervical injuries. Management of the airway should be carried out without manipulation of the neck until a spine injury has been ruled out.

The goal of this chapter is to allows a better understanding of the problems related to the management of the airway and its complications.

MANAGEMENT OF THE AIRWAY
Airway compromise can occur unexpectedly in any trauma victim and may be partial or complete, permanent, progressive or recurrent. Assessment and continuous reassessment of the airway is important - especially in patients with an altered level of consciousness. For these victims the endotracheal intubation should be considered for the following reasons.

a) establish a patent airway
b) deliver the required oxygen level and minute ventilation
c) prevent aspiration
d) prevent hypercarbia (especially for the head injured victims)

Patients with trauma to the face and facial fractures (particularly of the mandible) are at risk from airway obstruction and must be treated very aggressively. An appropriate response to the physician’s questions indicates a patent airway, good ventilation and adequate brain perfusion, but these conditions may change moment by moment.

During the first evaluation of the patient (primary survey) the physician must watch for the signs of airway obstruction - if the patient is agitated (hypoxia) or obtunded (hypercarbia), if there is cyanosis or the patient uses the accessory muscles of ventilation, if the trachea is midline, and by listening for snoring, gurgling, stridor, dysphonia or abnormal breath sounds and feeling for air movement with the respiratory effort.

The techniques to establish a patent airway are different but after the immobilisation of the cervical spine the same procedures must always be performed.

The absolute indication for aggressive airway management is airway...
obstruction. Airway obstruction may be due to foreign bodies (dentures, gastric contents or fragments from maxillofacial injury), but the most common cause in the unconscious patient is a mechanical obstruction by the tongue due to poor muscle tone.

Clearing the airway is an obvious prerequisite to more complex techniques for airway management. Absolute indications for invasive airway management include acute airway obstruction, penetrating neck trauma with haematoma (expanding), apnea and hypoxia, and severe head injury. Relative indications include chest trauma, a combative patient with life-threatening injuries, maxillofacial injury, pulmonary contusion etc.

Definitive airway intervention in trauma victims must protect the patient from airway obstruction and aspiration, and allow adequate oxygenation and ventilation.

**TECHNIQUES**

**Chin lift and jaw thrust.**
The chin lift manoeuvre can be performed by placing two fingers of one hand under the mandible and gently lift upward to bring the chin anterior. In the unconscious victim the thumb of the same hand must depress the lower lip to open the mouth. During this manoeuvre the neck should not hyperextened.

The jaw thrust is performed by manually elevating the angles of the mandible to obtain the same effect.

**Oropharyngeal airway**
This is a mechanical adjunct to the manoeuvre described above. The oral airway must be inserted into the mouth behind the tongue. The oral airway is inserted upside down (with the concavity upward) until the soft palate is encountered. At this point the airway can be rotated 180 degrees. This procedure is not recommended for the children because of the possibility of teeth's damage. An alternative method can be to use the blade of a laryngoscope to depress the tongue and then introduce the airway in the normal position.

**Nasopharyngeal airway**
This device is inserted via a nostril and passed into the posterior oropharynx and is preferred for responsive patients (it is better tolerated with less vomiting).

**Orotracheal intubation**
This procedure via direct laryngoscopy is the mainstay of airway management in cardio pulmonary resuscitation (non trauma CPR). If there is no immediate need it is useful to obtain a lateral cervical spine X-ray. (a lateral cervical spine film does not exclude all cervical spine lesions !)

Because this technique may cause some cervical hyperextension it is better to maintain in-line manual stabilisation of the neck. Immobilisation is performed by an assistant holding the head in a neutral position. The advantage of this technique is that it can be rapidly performed under direct vision.

After the insertion of the tube, the cuff must be inflated and the position of the tube checked by verifying normal bilateral breath sounds and no sounds in the stomach or gurgling noises in the epigastrium with inspiration. A colorimetric
technique may help in detecting the end tidal carbon dioxide to verify the right positioning of the tube in the airway.

**Nasotracheal intubation**
The nasotracheal intubation is possible in spontaneously breathing patients but is contraindicated in the apneic patient and when a severe facial fracture or basilar skull fracture exist.

It does not require suppressing ventilatory efforts of spontaneously breathing patient but it is more time consuming than orotracheal intubation in an emergency and is contraindicated in maxillofacial trauma with instability of the midface or suspected fracture of the cribiform plate, when a misdirected tube may enter the frontal cranial fossa.

If the patient condition permits fiberoptic endoscopy may facilitate orotracheal and nasotracheal intubation

**SURGICAL AIRWAY**
When indications for intubation exist but the trachea can not be intubated, direct access to the tracheal lumen can be lifesaving.

**Percutaneous transtracheal ventilation**
This procedure can provide up 45 minutes of extra time so that intubation can be accomplished on an urgent rather than emergent basis.

For this technique a 12 or 14 Gauge needle must be inserted in the trachea lumen through the cricothyroid membrane. The plastic cannula is connected to oxygen at 10-15 litres per minute. Intermittent insufflation (one second on and four second off) can be obtain by placing the thumb over a Y connector tube. This technique is limited by the accumulation of the carbon dioxide (inadequate exhalation) especially in head injured patients.

**Surgical cricothyroidotomy**
Some authors have identified specific areas in which cricothyroidotomy fits into an algorithm for management of the airway. In the broadest sense this procedure is indicated in any patient who has a strong indication for intubation and in whom the trachea can not be intubated.

There are several minor technical variations on the performance of the procedure. The cricothyroid membrane is identified by palpation and a skin incision that extends across the cricothyroid membrane is performed. A small incision is made at level of the membrane and a curved haemostat may be inserted to dilate the incision. At this point a small (5-7 mm) endotracheal tube (or tracheostomy tube) is inserted.

Because of the smaller size and greater soft tissue compliance of the paediatric airway and the dependence on the cricoid to maintain patency of the tracheal lumen, cricothyroidotomy is not indicated in the patient under 12 years of age because the risk of subglottic stenosis.

**Tracheostomy**
With few exceptions tracheostomy is poor choice of airway in the trauma victims. The trachea resides deeper in the neck than is appreciated and it is surrounded by a lot of vessel (veins, arteries) and the location for the trachea incision is frequently obscured by the isthmus of the thyroid gland.
Errors and complications
Failure to identify the need for definitive airway control is a critical and frequent error committed by inexperienced personnel who are easily distracted by obvious dramatic injuries.

Performance of jaw thrust, chin lift and clearance of oropharyngeal foreign bodies may provide a clear airway; however these are not definitive procedures and obstruction may recur at any time. An unconscious trauma victim should be intubated immediately and failure to do so in the patient with an injury to the brain is a serious error of omission. Although nasotracheal intubation in an alert patient may induce uncontrollable movement, this may be the first choice for those physician who do not have confidence to pass an orotracheal tube. In the awake patients with maxillofacial injuries a sudden loss of airway patency may be caused by the accumulation of oropharyngeal secretions and blood. The intubation should be performed before complete compromise of the airway occurs as swelling progresses. As nasotracheal intubation is guided by the sound and flow of expired air it is useless in the apneic patient and is best used in the breathing, comatose patient with respiratory impairment.

The presence of a nasotracheal tube is linked to development of paranasal sinusitis even in the absence of injury to the midface and greatly increases the risk of infection, including meningitis. If the nasotrachelal route is used every effort should be made to replace it with an orotracheal tube as soon as possible.

Choosing the wrong blade for the laryngoscope may be a critical factor in the failure to intubate. A straight blade requires greater extension of the neck. If the most skilled member of the team is unable to place a tube in one or two attempts, then a surgical airway should be created rapidly.

Cricothyroidotomy
This is more easily performed than a tracheostomy. A vertical rather than horizontal incision may be used, as this is certain to cross the right membrane. Perhaps the most critical error to be avoided is performing a cricothyroidotomy confusing the thyroid and cricothyroid membranes, as placement of a tube through the former will position it in the pharynx above the vocal cords. Local haemorrhage, damage to the larynx and tracheal rings, and intubation of the pretracheal space with the development of a pneumothorax or surgical emphysema are complications encountered with surgical airway management. Local infection, subglottic stenosis, laceration of the oesophagus or trachea, and subcutaneous or mediastinal emphysema may also occur.

Breathing
It is appropriate to maintain an oxygen saturation above 95%. The acceptable saturation is dictated by the individual patient's condition. Maintaining the oxygen saturation at higher level than necessary to provide adequate delivery may lead to increased rates of oxygen free radical formation and aggravate reperfusion injury. A high concentration of inspired oxygen may also lead to absorption atelectasis, particularly in well perfused areas of the lung.

If the physical signs are consistent with a tension pneumothorax, then two large bore needles should be introduced into the pleural cavity through the second intercostal space in the midclavicular line. This procedure rather than a tube thoracostomy must be performed immediately in order to stabilize the
patient and avoid irreversible decompensation during the time needed to insert a chest tube. Decompression of a pneumo / haemothorax can rapidly improve the patient's condition by restoring venous return and allowing better ventilation. In the hypovolemic patient distention of the neck veins may be absent, and there may not be any improvements in the clinical condition.

Gastric distension may lead to vomiting and aspiration despite the presence of a cuffed tracheal tube. These potential complications can be avoided by means of a naso or orogastric tube placement.