Airway Management in Trauma

Gregory Sund, Matthew Kynes, Phil Yao

Introduction:

Editor's Note: This chapter builds on Airway Management and Endotracheal Intubation, which discusses the basics of airway management, specific equipment, medications, and management of difficult situations. The reader will be well served by starting with that chapter before reading this one.

Airway management for trauma victims can be challenging for a variety of reasons. These include distortion of airway anatomy, obscured visualization from blood, emesis or other material, and the need to maintain the head in a neutral position when a cervical spine injury is suspected. It is important to understand the particularities of each situation and how to evaluate and to safely manage the airway in such patients.

Before the airway can be managed, it must be assessed. The steps in the evaluation of airway patency and adequacy of breathing will not be discussed in this chapter. The reader instead is referred to Basic Life Support (BLS) and Advanced Cardiac Life Support (ACLS) for further explanation of these steps. But it is important to understand that hypoxia and hypoventilation need to be recognized and acted upon quickly, as these can be signs of life-threatening injuries and can worsen the level of consciousness and brain injury in head-injured patients. Some of the particularities of airway management in trauma victims are discussed below.

Cervical spine injury

Most trauma patients are assumed to have a cervical spine injury until it is ruled out either by physical exam or imaging. Until such an injury has been ruled out the patient's neck must remain in a neutral position at all times using a properly placed cervical collar or manual in-line stabilization. This can make intubation difficult or sometimes impossible. Therefore, it is important to be prepared with back-up airway equipment (e.g., bougie, videolaryngoscope, cricothyroidotomy kit) before attempting intubation. If intubation fails the operator should also be prepared to insert a rescue airway device such as a laryngeal mask airway. The esophageal-tracheal Combitube or King supralaryngeal device may be available at some hospitals and can be lifesaving in these situations. While these devices are not a permanent solution, they can provide oxygenation and ventilation until a more permanent airway can be established.

Proper technique for cervical spine stabilization during intubation when cervical spine injury has not been ruled out. The assistant (left side of the picture) uses the "earmuff" technique, which allows the mandible to move downwards. During insertion of the tube, the assistant and the intubator will be working "against" each other, as one tries to see the vocal cords as well as possible and the other tries to limit movement of the neck. Source: Kovacs G et al. https://doi.org/10.1016/j.emc.2017.08.006

Risk of pulmonary aspiration

All trauma patients are considered "full stomach" and therefore at increased risk of aspiration of gastric contents. This is one reason why securing the airway is so critical whenever the patient's level of consciousness is depressed (Glasgow Coma Scale [GCS] less than 8). Intubation should be performed with rapid sequence induction in order to secure the airway as quickly as possible and protect the lungs from aspiration of gastric contents. This technique is outlined in the chapter on endotracheal intubation.

In our institution, we use cricoid pressure in all rapid sequence inductions. In theory, this maneuver serves to occlude the esophagus and prevent aspiration of gastric contents. However, studies have questioned whether cricoid pressure actually achieves this effect. If used, this technique

should be applied as soon as the patient loses consciousness and released once endotracheal intubation is confirmed. The recommended pressure to be used is 3 to 4 kg at most. Excessive cricoid pressure can cause further trauma to the airways. Cricoid pressure can also obscure the view of the vocal cords, so ask the assistant to apply less pressure if you are having difficulty.

Inhalational burns

Exposure to fire and smoke in an enclosed space can cause inhalational injury to the airway resulting in progressive edema and airway closure. In patients with suspected inhalational injury, endotracheal intubation should be performed early before significant airway edema occurs. Inhalational injury should be suspected in any patient who was exposed to a fire in an enclosed space, those with singed or soot-covered nostrils or mouth, and those displaying signs such as hoarseness, dyspnea, tachypnea or altered level of consciousness not explained by head injury. While succinylcholine can be used safely in patients within 48 hours of burn injury, those outside of this time window are at increased risk of hyperkalemia when given this medication. In these situations, it is better to use a non-depolarizing muscle relaxant.

Patients with severe burn injuries or those which occurred in enclosed spaces should also be considered at risk for carbon monoxide poisoning. Carbon monoxide binds to hemoglobin with an affinity approximately 250 times that of oxygen. This results in a left-ward shift of the oxy-hemoglobin dissociation curve and impaired availability of oxygen at the level of the tissues. Because standard pulse oximetry cannot distinguish between oxyhemoglobin and carboxyhemoglobin, this tool will display a falsely elevated oxygen saturation in a patient with carbon monoxide poisoning. In patients with carboxyhemoglobin levels of 20% or greater (measured by arterial or venous blood gas analysis) intubation and mechanical ventilation will be necessary to improve oxygenation and enhance carbon dioxide clearance by the body.

Head and neck trauma

Any patient with severe head and neck trauma can have significant airway distortion which can make direct laryngoscopy and endotracheal intubation difficult or impossible. Blood in the mouth and oropharynx is often encountered. Adequate suction should be immediately available before attempts at laryngoscopy are made. Hematoma formation in the mouth or neck can also distort anatomy making visualization more challenging. In some cases, patients may have direct injury to the glottic opening and/or the trachea. For such patients, a head and neck surgeon should be consulted as soon as possible. It may be necessary to proceed directly with cricothyroidotomy or awake tracheostomy depending on the urgency of the situation.

Left neck hematoma after stab wound to the neck. A hematoma like this has the potential to deviate the airway significantly and make safe orotracheal intubation difficult or impossible. Photo courtesy of Dr. Demetrios Demetriades.

Traumatic Brain Injury

As mentioned above, most patients with a GCS less than 8 from traumatic brain injury (TBI) are unable to effectively protect their airways or maintain ventilation. Hypoventilation will lead to hypoxia and hypercarbia, both of which can further depress consciousness and lead to secondary brain injury. Most TBI patients should be administered 100% oxygen by non-rebreather mask if GCS is greater than 8 and ventilation appears adequate. If not, the decision should be made earlier rather than

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later to secure the airway with intubation and place the patient on controlled ventilation. TBI can take different forms, including diffuse axonal injury, subdural hematoma, epidural hematoma, and others. The major concern for TBI is maintaining adequate cerebral perfusion in the setting of elevated intracranial pressure (ICP). Airway manipulation can cause tachycardia and acute hypertension which may worsen ICP and reduce cerebral perfusion. Induction medications should maintain stable hemodynamics. Intubation should be performed only when adequate anesthetic depth is obtained. After intubation, mild hyperventilation may be initiated to reduce ICP until definitive therapy can be provided.

Succinylcholine can raise intracranial pressure so it should be used with caution in a patient with a head injury. However, it has the most rapid onset of all the paralytics, so the decision to avoid it must be balanced with the need for rapid and safe airway control in a trauma patient with multiple injuries.

Endotracheal Intubation of a Trauma Patient:

Both the patient's cervical spine and airway are at risk during this maneuver- it is crucial to have adequate, experienced help available. All people involved must be committed to avoiding hyperextension of the neck. Providers with advanced video-endoscopic airway equipment may make a first attempt at intubation without removing the cervical collar- this depends on your experience and comfort with this technique.

Preparation:

1. Airway equipment:
- Endotracheal tube of appropriate size with stylet and syringe: check balloon cuff
- Laryngoscope blade: choose whichever is most familiar; most common is Miller 2, Macintosh 3, or Macintosh 4
- Video laryngoscopy: if available
- Bougie
- Laryngeal Mask Airway
- Capnometry or End Tidal CO2 detector

2. Medications:
- Does the patient need a hypnotic agent like propofol, etomidate, ketamine, and/or midazolam? What is their volume status and will they tolerate vasodilation?
- Rapid-acting neuromuscular blockade: succinylcholine at 1 mg/kg or rocuronium at 1.2 mg/kg

Agent	Dose	Induction Time	BP Effect	ICP Effect
Thiopental	3-5mg/kg	15-20 Seconds	Lowers	Lowers
Propofol	1-2mg/kg	15-20 Seconds	Lowers	Lowers
Ketamine	1-2mg/kg	30-45 Seconds	Raises	Variable/Raises
Midazolam	0.1-0.3mg/kg	120-180 Seconds	Neutral/Lowers	Neutral

Commonly used sedation agents for intubation and some of their side effects

Agent	Dose	Onset
Succinylcholine	1.5mg/kg	30-60 Seconds
Rocuronium	1-1.2mg/kg	60-90 Seconds
Vecuronium	0.15-0.25mg/kg	2-3 Minutes
Pancuronium	0.1mg/kg	3 Minutes

Commonly used paralytics and their duration of onset. Recall that during the time of onset, the patient may not be able to breathe but may not be paralyzed enough to intubate, so a shorter onset is almost always preferable.

3. Other considerations:
- Equipment for suction
- Personal protective equipment (especially eyewear)
- Stethoscope
- Appropriate vascular access
- Breathing circuit with oxygen cylinder
- Available provider with skills and equipment for surgical airway

Procedure:

1. Assign roles for intubating, injecting medications, holding cricoid pressure, and providing manual in-line stabilization. All blunt trauma patients are assumed to have cervical spine injury until proven otherwise.
2. Discuss any concerns with airway management (blood, vomit, abnormal anatomy from trauma and/or masses)
3. Preoxygenate (if able)

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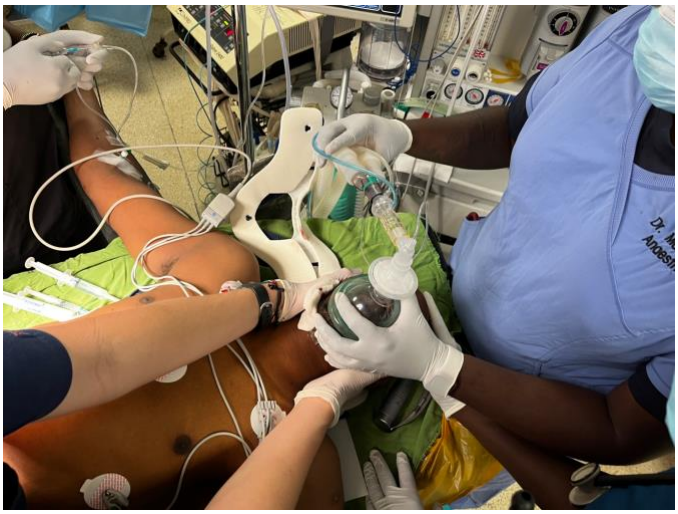
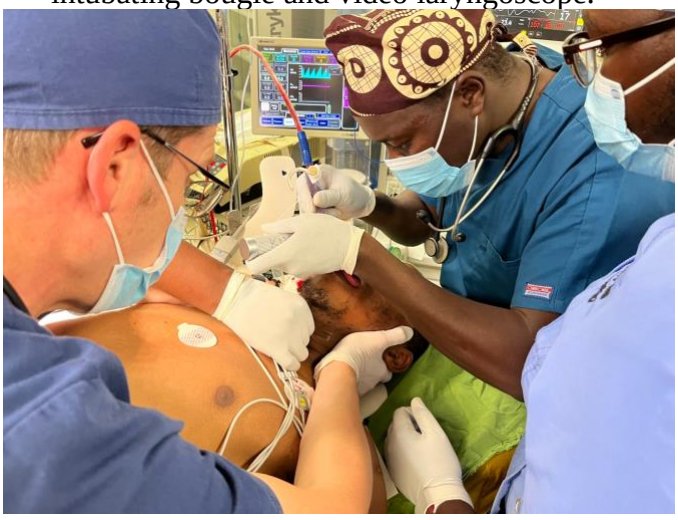


The cervical collar has been opened but not removed from the patient. The assistant provides cervical stabilization using the "earmuff" technique. The laryngeal mask airway is held in place using the one handed "EC" hold.

4. After all teams have expressed readiness, give neuromuscular blocking agent +/- hypnotic
5. Open the cervical collar and move the anterior part to the side, without fully removing the collar. Another assistant applies cricoid pressure (see "Risk of Pulmonary Aspiration" above.)
6. Perform laryngoscopy and intubation without hyperextending the neck. Adjuncts include intubating bougie and video laryngoscope.



As the assistant maintains cervical stabilization, another assistant provides cricoid pressure. Note that the intubator, whose main concern is seeing the vocal cords, is working "against" the one stabilizing the airway.

7. Attach breathing circuit and auscultate for bilateral breath sounds. Have the assistant maintain cricoid pressure, if applied, until intubation is confirmed.

After intubation has been confirmed, release cricoid pressure and replace the cervical collar. Secure the airway.

8. If initial attempt unsuccessful and patient has not desaturated <90%, reattempt with different laryngoscopy technique or have a different person intubate
9. If attempts have been unsuccessful and the patient is desaturating, provide gentle mask ventilation while holding cricoid pressure. See "Pitfalls" below for further management.

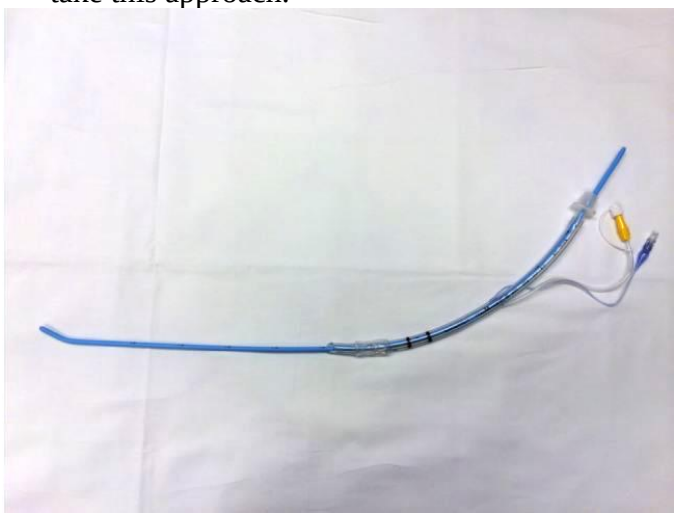
Pitfalls:

The dreaded "Can not intubate, can not ventilate" situation must be foreseen and avoided if possible. An experienced operator will recognize situations, described above, that make this situation more likely. Proceed with great care!

- Avoid airway trauma by reducing the number of intubation attempts. In a teaching situation, you must balance the needs of the learner with the needs of the patient.
- If you are unable to intubate and the patient is chemically paralyzed, consider placing a laryngeal mask airway (LMA) rather than attempting intubation again and traumatizing the airway further. Wait for the paralytic to wear off and for the patient to breathe spontaneously again (without fully awakening.) This buys you more

time as you plan the next approach, rather than trapping you in futile repeated attempts as the patient becomes progressively hypoxic.

- Your next attempt may involve different equipment (including fiber optic or video equipment,) a smaller endotracheal tube, or a more experienced operator. It is important to make the best arrangements in a calm and unhurried manner, rather than frantically as the patient is desaturating. Using the LMA until the patient can breathe spontaneously allows you to take this approach.



An intubating bougie with endotracheal tube loaded. The end on the left is passed through the vocal cords. As the tip passes over the tracheal rings, the operator feels this feedback and tracheal position is confirmed. The endotracheal tube is then advanced over the bougie into the trachea. Source: Baker JB et al, DOI: 10.5811/WESTJEM.2015.4.22857

Intubation using a fiberoptic glidescope. Note that the anesthetist is holding the blade with her left hand and an endotracheal tube with a stylet in the right hand, watching the screen preparing to insert the tip of the tube between the vocal cords as seen on the screen (Red arrow.)

- If you are unable to ventilate through LMA after paralysis in the above situation, your only option is a surgical airway. Again, this situation should be foreseen in the high-risk situations described above. Have an experienced operator with the necessary equipment standing by.

Conclusion

Airway management in trauma victims is often required to ensure a positive outcome but can be challenging. Therefore, it is important to understand the particularities of different types of trauma as discussed above and to have a plan in place for managing the airway in each situation. As with any critical situation that occurs in the hospital, communication and teamwork will be the most important tools at your disposal. Calling for help early, using closed-loop communication, and preparing beforehand for such situations may make the difference between a secure and safe airway and a post-traumatic mortality.

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