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Difficult Pre-hospital Airway Management

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In management of patients with an emergency, airway management and ventilatory care are the highest priorities (1, 2). Everybody who is confronted with a patient in distress has to start with the ABC's: Airway, Breathing, and Circulation. Establishment of an airway is the first step in the ABC's. If the airway is blocked, death will occur within a few minutes. When an airway is only partially blocked, death will not occur immediately, but it can still be a life-threatening situation, depending on the gravity of the blockage. For this reason, the airway should be opened totally and not only partially.

When the airway has been opened, the next step in the ABC's is "B", Breathing: Oxygenation and Ventilation. When the airway has been opened, but not maintained, breathing or ventilation will not be effective. In a spontaneous breathing patient with a partially obstructed airway, the airway resistance will be increased. This means that the patient has to work harder to maintain the minimal level of oxygenation and ventilation. Not only is oxygenation important, but also the elimination of CO_2 is important. It is essential to maintain at least a normal level of CO_2 in the arterial blood, especially in patients with a brain injury or stroke. In such patients, a rise in arterial CO_2 can increase intracranial pressure (ICP), thereby decreasing the cerebral perfusion pressure (CPP).

Even a little increase in airway resistance can inhibit ventilation in comatose patients, resulting in elevation of the CO_2 level and rising ICP. If a patient in this situation is given oxygen by a facemask, oxygen saturation will not be reduced initially. Therefore, pulse oximetry is not a reliable instrument for measuring ventilation. It only indicates the level of oxygenation in the arterial blood, not the CO_2 level. Capnography is a more reliable method in measuring ventilation. When airway resistance is reduced, ventilation can become sufficient again and the CO_2 level will be normalized if the injuries didn't affect the respiratory center of the brain.

When ventilation is insufficient in a completely open airway, artificial ventilation is needed. The goal of respiratory care is to oxygenate and to ventilate for maintaining a normal O2 and CO_2 level. In the case of an airway obstruction, airway resistance will be increased and airway pressure will rise during artificial ventilation. When the airway pressure exceeds a pressure of 20-25 cm H_2O, gastric insufflation will occur (3, 4, 5, 6). Gastric insufflation can result in regurgitation and aspiration of gastric contents. Aspiration is a very serious complication, which substantially increases the risk of a lethal outcome. Gastric insufflation will also lift the diaphragm and decrease the thoracic volume. This will reduce tidal ventilatory volume significantly, especially in pediatric cases. As a consequence, trying to maintain tidal volumes with a bag-valve-mask device or volume controlled ventilator will result in high airway pressures, which, in turn, will result in more gastric insufflation, and so on. One possible way to avoid this complication is to use automatic resuscitators that are pressure controlled and are driven by a constant flow of oxygen.
Gastric insufflation also can cause circulatory insufficiency, most likely caused by triggering of the vagal nerve. Hypovolaemic patients or patients with a pump failure of the heart are especially at risk to become hypotensive by gastric distension.
For these reasons, gastric insufflation should be avoided at anytime. In an unprotected airway, airway pressures should be limited to pressures not exceeding 20-25 cm H_2O and low constant flow should be maintained.
In other words: First of all: open the airway and keep it open!

In emergency medicine the problem of maintaining a fully open airway is of utmost importance but often more complicated than in anesthesia. In regular anesthesia, the risk of aspiration of gastric contents can be limited by accepting patients for general anesthesia only if they are sober for at least 6 hours. In an emergency this is not possible, of course, where patients are presented unexpectedly, and should be recognized as not sober.
Also prediction of a difficult airway or difficult intubation often can be anticipated when there is time for proper preparation. In emergency medicine, this preparation time often is lacking because of the need for immediate treatment of an airway obstruction.
Another problem in airway management in emergency situations is that a comatose patient is not always totally relaxed. Of course, in cardio-pulmonary resuscitation (CPR), patients do not move or resist treatment. Airway maneuvers can easily be performed and adjuncts like an oropharyngeal airway (OPA) will be fully tolerated by the patient. Many emergency patients,

however, are not totally relaxed and are posturing or have convulsions. These patients do not require CPR (yet) and have a good chance for a favorable outcome, if the airway can be opened and maintained to enable sufficient oxygenation and ventilation. The technique for maintaining an open airway by manual maneuvers is not easy, but is essential to be learned by everybody involved in emergency medical care.

In comatose trauma patients another problem exists: controlling a possibly injured cervical spine. In these patients, simple airway maneuvers like head tilt are not possible because of the risk of damaging the cervical cord in c-spine injury. The only way left to open the airway is by lifting the mandible, i.e. by the jaw-thrust maneuver. But when the patient is not relaxed, this technique requires, above all, correct technique and some manual strength.

Pre-hospital emergency medicine is full of difficulties compared to hospital- based emergency medicine. But foremost in the pre-hospital situation, the environment can be a considerable factor that can hinder airway and ventilatory management.

When a patient is trapped, for example, there can be limited space around the patient. Assessment of the airway and breathing can be difficult in situations where there is noise, wind, darkness etc.

For this reason, pre-hospital airway management can be extremely difficult, especially in trauma cases (7).

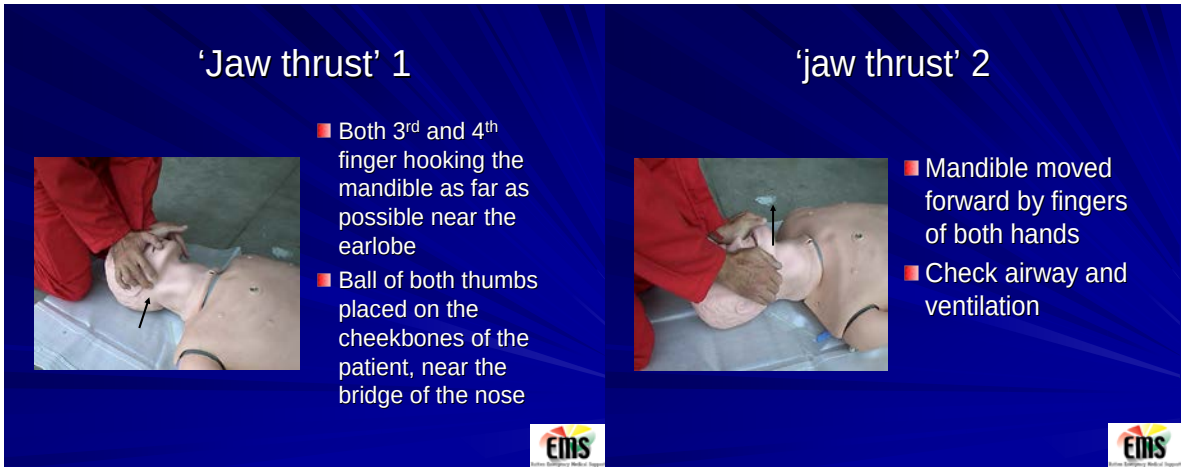
For fire fighters or first responders, it is only possible to maintain an open airway and ventilation by manual techniques and with the help of some simple adjuncts. These manual techniques, however, can be highly effective if performed in the right way.

One of the most important techniques is the “jaw-thrust” technique. Originally this technique was discovered by Dr. Esmarch, a 19th century German military surgeon (8). In those days, it was the responsibility of the surgeon to give general anesthesia. One of the most popular

anesthetics was ether. When inducing a patient in ether anesthesia, the patient initially will relax a little bit, but after this first phase of ether anesthesia, the second phase will commence.

In this second stage of anesthesia- the "excitation" phase, the patient is not relaxed at all anymore and is even "fighting", although unconscious. This means that an open airway is more difficult to obtain, but if not performed properly, the patient will become cyanotic and induction to the 3rd phase of anesthesia will not be reached because the anesthetic gas will not be able to reach the lungs. For this reason, it is essential to maintain an open airway, especially in the 2nd phase, although sometimes difficult because of the resistance of the patient.

Esmarch's maneuver opens the airway by tilting the head backward, retracting the patient's lower lip (with the rescuer's thumbs) and by forceful forward displacement of the mandible (triple airway maneuver).
In a trauma situation where head tilt is not possible for reason of possible c-spine injury, only the jaw thrust maneuver and retraction of the lower lip is possible.
With the Esmarch's maneuver it is possible to open the airway, even when the patient is posturing or has convulsions, if performed properly.



By this means, it is possible to maintain an open airway, even in difficult conditions, awaiting further, higher-level support.

In the unconscious patient, the jaw becomes slack and the tongue as a consequence tends to fall back against the posterior wall of the pharynx. This however is not the only cause of airway obstruction in the comatose patient. Together with the mandible and the jaw, the epiglottis also falls back and is another important cause of airway obstruction. For this reason, an oropharyngeal airway is not always successful in opening the airway in the unconscious patient, because the OPA doesn't retract the epiglottis from the larynx (9).
An OPA however can be helpful in making the jaw thrust easier. Because most patients have an "over-bite" of the incisors, it can be difficult to push the mandible forward. This can be overcome by insertion of an OPA, where the incisors can move freely from each other. The force needed to bring the mandible forward is somewhat reduced when the mouth is opened a little bit.

Another important adjunct in managing the comatose patient with an unprotected airway is a suction unit. Not only because aspiration of vomit causes a life threatening situation, but also because even a small amount of secretions or blood can increase the airway resistance tremendously. Therefore, a suction device should always be at hand, and even a small amount of secretions or blood should be removed.

For Esmarch's maneuver both hands are needed. That means that, in such cases, ventilation by bag-valve-mask (BVM) is only possible when another rescuer squeezes the bag. One rescuer pushes the mandible forward and keeps the mask fixed on the face without an air leak, while the other rescuer squeezes the bag gently, with an inspiration time of 1,5 – 2 seconds and a just visible thorax expansion. BVM is, especially in trauma patients, a two-person maneuver.

But, in many trauma cases, there is no second rescuer available or there is not enough space around the victim. Especially in these cases, airway management is extremely difficult. That means that airway management and BVM ventilation should be done by one rescuer, which is impossible in most cases. A solution for this kind of situation is the use of a constant flow / pressure regulated automatic resuscitator. Such an automatic resuscitator can be seen as an "automatic bag squeezer", however with a much better regulation of inspiratory flow and pressure, which probably will reduce the risk of complications. It also is important that such

an automatic resuscitator can work also in an automatic mode, because otherwise it will be very difficult to maintain the airway in combination with pushing the inspiratory button.

An example of such an automatic resuscitator is the Oxylator® (CPR Medical Inc., Toronto, Canada). It has a constant inspiratory flow and the pressure is limited. There are three models: FR-300, EM-100 and EMX. The EMX and the EM-100 are designed for professionals and have an adjustable maximum inspiratory pressure. In the FR-300 version, especially designed for first responders or fire fighters, the pressure is limited and fixed to 20 cm H_2O. It can be used in a manual or automatic mode, where inspiration continues until reaching the pressure of 20 cm H_2O. Then inspiration stops and passive expiration starts. When expiration has fully stopped, inspiration starts again until the pressure of 20 cm H_2O is reached, and so on. With such a device, the rescuer can ventilate by mask safely and effectively, with minimal risk of inflation of the stomach and, even in the most difficult situations in trauma care, concentrate on an optimal open airway. Control of ventilation is easy, visually as well as audibly.

In conclusion, pre-hospital airway management should be anticipated as difficult. Especially in the trauma patient, manual airway maneuvers are an essential skill for every first responder or fire fighter. Esmarch's maneuver or jaw thrust is the best way to open the airway in an unconscious trauma patient, where immobilization of the cervical spine is needed. Combination of artificial ventilation and manual airway management can be extremely difficult when performed by BVM and should be considered as impossible in a one-rescuer situation. Therefore, the use of a constant flow, pressure controlled manual or automatic resuscitator in such situations is strongly recommended.

References

1. Butler KH, Clyne B. Management of the difficult airway: alternative airway techniques and adjuncts. Emerg Med Clin N Am 2003;21(2):259-289
2. O'Malley RJ, Rhee KJ. Contribution of air medical personnel to the airway management of injured patients. Air Med J 1993;12(11-12):425-428
3. Lawes EG, Campbell I, Mercer D. Inflation pressure, gastric insufflation and rapid sequence induction. Br J Anaesth 1987;59:315-318
4. Ruben H, Knudsen EJ, Carugati G. Gastric insufflation in relation to airway pressure. Acta Anaesth Scand 1961;5:107-114
5. Weiler N, Heinrichs W, Dick W. Assessment of pulmonary mechanics and gastric inflation pressure during mask ventilation. Prehosp Disaster Med 1995;10:101-105
6. Wenzel V, Keller C, Idris AH et al. Effects of smaller tidal volumes during basic life support ventilation in patients with respiratory arrest: good ventilation, less risk? Resuscitation 1999;43:25-29
7. Mahoney PF, Carney CJ. Entrapment, extrication and immobilization. Eur J Emerg Med 1996;3(4):244-246
8. Beyer CW, Dick WF. Johann Friedrich August von Esmarch: a pioneer in the field of emergency and disaster medicine. Resuscitation 2001;50(2):131-133
9. Boidin MP. Airway patency in the unconscious patient. Br J Anaesth 1985;57(3):306-310