Protection of respiratory integrity and haemodynamic stabilization

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Abstract. Protection of respiratory integrity and haemodynamic stabilization. Objectives: To perform an analysis of the protection of respiratory integrity and haemodynamic stabilization based on the literature review and the experiences and perspectives of emergency and ENT specialists.

Methodology: A comprehensive literature search was undertaken through PubMed and MEDLINE, using the following keywords: [protection of the respiratory integrity], [intubation], [hypotension] and [haemodynamic stabilization]. Articles were selected if the topic was relevant to current ENT and emergency practice. Additional articles were identified through a careful review of reference lists in Uptodate. A critical review of ENT and emergency specialists was carried out. Evidence staging and recommendation levels were established using the Paul Shekelle scale.

Results: Firstly, protection of the airway is necessary before starting haemodynamic stabilization. Fibre-optic examination and laryngeal intubation form the gold standard of diagnosis and treatment in the protection of the airway. For circulation, a short catheter with a large size allows the management of intravenous fluids, with vasopressors if necessary. Aetiological and specific treatments are also very important.

Conclusions: Appropriate and collaborative management is necessary with the “ABCDE” approach: Airway and immobilization of the neck; Breathing; Circulation; Disability and Exposure. A fibre-optic examination is the gold standard of airway diagnosis. Laryngeal intubation is the most effective treatment for protection of the respiratory integrity. The management of circulation includes the implementation of a venous route to initiate administration of IVFs, preferably with isotonic saline. Vasopressors and inotropes are used as second line agents. A multidisciplinary and team approach is preferred, in order to achieve diagnosis and therapeutics simultaneously.

Introduction

Protection of respiratory integrity and haemodynamic stabilization must be integrated into a patient-centred care. Appropriate and collaborative management of emergency and ENT situations must include the “ABCDE” approach (Figure 1): A for Airway and protection of the spine; B for Breathing; C for Circulation; D for Disability and E for Exposure.

Protection of the respiratory integrity or airway is presented in Part I, and haemodynamic stabilization in Part II. Conclusions, with a take-home message for emergency and ENT specialists, are presented in Part III. In this collaborative and integrated approach, we focus on living patients. Advanced life support (ALS) recommendations from 2015 are available if the patient is dead.

Part I: Protection of respiratory integrity

1. Upper airway conditions

ENT and head and neck surgeons usually face the following major causes of obstruction of the upper airway:

- Inflammatory, infectious or allergic swelling of the pharynx or larynx
- Maxillofacial traumas
- Laryngotracheal traumas
- Benign or malignant tumours
- Fixed foreign bodies
- Bilateral vocal cord paralysis.

Their respective levels of airway obstruction are shown in Table 1.
2. ABCDE principles

The formulation of the mnemonic ABC has its roots in the 1950s. Safar described methods to safeguard the airway and to deliver rescue breaths, thereby giving rise to the first two letters of the mnemonic, A and B. The mnemonic “ABCDE” stands for Airway, Breathing, Circulation, Disability, and Exposure.

As described in the previous section of this annual report, with the ABCDE approach, the initial assessment and treatment are performed simultaneously and continuously.

Firstly, life-threatening airway problems are assessed and treated; secondly, life-threatening breathing problems are assessed and treated; and so on. Using this structured approach, the aim is to quickly identify life-threatening problems and implement treatment to correct them.

On completion of the initial ABCDE assessment, assessments should be repeated until the patient is stable. It must be remembered that it may take a few minutes before the effect of an intervention is evident. In the case of deterioration, a reassessment should be performed.
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3. Aims of “A” and “B” assessment

Airway, breathing, and circulation work in a cascade. In case of acute airway obstruction or narrowing, breathing capacity is reduced or stopped, and can result in severe hypoxia and cardiac arrest. These three issues are paramount in any treatment, in that the loss of control of any one of them can rapidly lead to the patient’s death. The three objectives form the foundation of training for many advanced medical training programs. The aim of the “A” (airway) assessment is to address the following question: is the airway patent? The purpose of the “B” (breathing) evaluation is to evaluate whether breathing is sufficient. Both examinations can provide clinical and biological indicators.

Ensuring a clear airway is therefore the first step in treating any patient; once it is established that a patient’s airway is clear, rescuers must evaluate a patient’s breathing, as many other things besides a blockage of the airway could lead to an absence of breathing.

4. Assessment instruments at pre-hospital and hospital level

4.1. Is the airway patent?

The initial clinical evaluation is essential for detecting and staging airway obstruction.

Airway obstruction can be partial or complete.

- With a completely obstructed airway, there is no respiration despite great effort (i.e., paradoxical respiration, or “see-saw” sign).
- Signs of a partially obstructed airway include a changed voice, noisy breathing (e.g., stridor), and an increased breathing effort. Another common sign of partial airway obstruction in the unconscious state is snoring. A careful neck exploration is mandatory at this stage, due to its potential impact on airway narrowing and subsequent therapeutic options.

A. Conscious casualties

If the patient responds in a normal voice, then the airway is patent.

B. Unconscious casualties

A reduced level of consciousness is a common cause of airway obstruction, partial or complete. Firstly, unconscious casualties do not have control over their muscles, including the muscles that control the tongue. The relaxed tongue will fall backwards and block the airway. If an unconscious, breathing casualty remains on their back, the risk of airway obstruction increases. Furthermore, material in the mouth (such as food, blood or vomitus) may also obstruct the airway of an unconscious casualty.

Over the years, various devices used in anaesthesiology have been introduced to pre-hospital care providers. The clinical advantages of fibre-endoscopy are paramount for both ENT and emergency specialists. It is also interesting to notice the development of new technologies in laryngoscopes, from different laryngoscope blades to oral and nasal airways and the 2-mm rigid Bonfils intubation endoscope. Most publications of video-assisted laryngoscopes such as the Glidescope® (Verathon Inc., Bothell, WA, USA), the Ambu® Pentax Airway Scope (AWS) (Ambu, Ballerup, Denmark) the C-MAC® Video Laryngoscope (Karl Storz, Tuttlingen, Germany) or the McGrath® Video Laryngoscope (LMA, the Netherlands Antilles) include case reports in trauma patients, but not randomized trials.

4.2. Is the breathing sufficient?

In all settings, a measurement of the respiratory rate and a fine inspection of the thoracic movements or use of auxiliary respiratory muscles are mandatory. Moreover, percussion of the chests is helpful in case of unilateral dullness or resonance. Cyanosis, distended neck veins, and lateralization of the trachea are usually easily identified. Finally, lung auscultation and, if available, placement of a pulse oximeter complete and consolidate the clinical examination.

5. Securing airways and facilitating breathing at pre-hospital and hospital level

Firstly, obstructions due to effects on the mucosa by an external trigger (allergen, fire, inflammation, caustic agents, post-intubation) which causes swelling and oedema are generally reversible conditions, where we might observe the patients while we administer drugs to them. At any moment, a decision can be made to intubate if clinical signs and the general condition of the patient deteriorate.

In case of obstruction due to mucosal and submucosal oedema, in the first line next to oxygen therapy corticosteroid (Pulmicort®) every
2 hours; 2cc adrenaline inhalations (a solution of 1mg adrenaline dissolved to 20 ml with physiologic serum) can be administered each hour, while awaiting of the effects of the intravenous corticosteroid. Solu-Medrol® should be the first choice, as it has a rapid effect, with Tmax 1 hour and quick elimination from the body between 2 to 5 hours after the administration.

The second case is obstruction due to a partial or total physical barrier in the upper airway. In these situations, the obstacle has to be removed. In this case the question arises as to whether it is safe and feasible to act quickly to re-establish the airway, or whether it is wiser to secure the airway first by intubation and/or tracheotomy and then safely address the cause. Whenever intubation is feasible it should be done. It is safer for the patient, and might even prevent a tracheotomy. However, tracheotomy should promptly be performed when the clinical signs and conditions indicate it, even with local anaesthetic.

We should mention the specific clinical presentation of a patient with paradoxical closing vocal cords. This condition mimics acute respiratory distress due to obstruction with stridor. It can occur in patients who are anxious, with shortness of breath, sometimes associated with mild upper-respiratory airway infections (asthmatics and certain psychiatric conditions). Every effort should be made to prevent them from being intubated or having tracheotomy performed on them. Clinical history-taking is key to diagnosing these patients. However, their clinical condition can be seriously misleading at the time of investigation.

5.1. Making the airway patent

Regardless of the difference in trauma patterns in patients, loss of airway or breathing is the most rapid cause of death, since it leads to cardiac arrest. The airways of severely injured patients need to be secured as soon as possible.

Airway management can be divided into two categories: basic and advanced. Basic techniques are easily performed by non-professionals and do not require medical equipment; advanced techniques require special training and equipment.

Because of the uncontrolled and unsupportive environment, airway management on site is often more difficult than intubations in the operating room or the emergency department. This is further affected by differences in provider training and experience, patient location, and coexisting medical or surgical problems.

In any case, a casualty requiring rescue breaths depends on an open airway.

5.1.1. Remove any visible obstruction from the casualty’s mouth

Unless you can fully assess a casualty in the position in which you find oral foreign bodies, turn the casualty onto their back. If possible, foreign bodies causing airway obstruction, including dislodged or loose dentures, should be mechanically removed. When available, and with the proper equipment, gentle suction of the airways to remove obstructions, for example, blood or vomit, is recommended.

If a pharyngeal or laryngeal foreign body is suspected in conscious patients, carry out a Heimlich manoeuvre by:

1) leaning the person forward slightly and standing behind him/her;
2) making a fist with one hand;
3) putting the arms around the person and grasping the fist with the other hand near the top of the abdomen, just below the centre of the rib cage;
4) making a quick and hard movement inward and upward.

For children, the removal of deep foreign bodies should be performed as follows:

- place the infant stomach-down across the forearm;
- give five thumps on the infant’s back with heel of the hand;
- sweep the finger through the child’s or infant’s mouth to remove debris.

If the victim becomes unconscious, start cardiopulmonary resuscitation according to guidelines.

5.1.2. Head-tilt and chin-lift manoeuvre

All health care professionals, regardless of the setting, should be able use a head-tilt and chin-lift manoeuvre to open the airway and reduce the risk of regurgitation. In most situations, the airway can be managed with the use of head tilt and chin lift. The tongue is pulled away from the back of the throat by tilting the head back and lifting the chin forward.

There are two types of head tilt used in resuscitation:

- Backward (Figure 2A): used in resuscitation of older children and adults
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Mouth-to-nose ventilation is an effective alternative to mouth-to-mouth ventilation.

If the victim’s mouth is seriously injured or cannot be opened, the rescuer is assisting a victim in the water, or a mouth-to-mouth seal is difficult to achieve.

B. Advanced airway techniques

The various advanced airway techniques will be described in a later section of this report and can be summarized as in Figure 3. Advanced airway management is categorized, in increasing order of invasiveness, into:

- supraglottic devices, such as oropharyngeal and nasopharyngeal airways;
- infraglottic techniques, such as tracheal intubation; and
- surgical methods.

Several retrospective studies compared a variety of supraglottic devices (laryngeal mask airway, laryngeal tube, Combitube, oesophageal obturator airway) to both bag-mask ventilation and endotracheal intubation. The authors found that there was no high-quality evidence demonstrating a difference in survival rate or favourable neurologic outcome from use of a supraglottic airway (SGA) compared with bag-mask ventilation or endotracheal intubation. Similarly, they did not

5.1.3. Airway and breathing: basic versus advanced airway techniques

The optimal approach for managing the airway and to assure ventilation has not been agreed, and several recent observational studies have challenged the assumption that advanced airway techniques are necessarily superior to basic ones.

A. Basic airway techniques

The safety of both the rescuer and victim are paramount during a resuscitation attempt, especially when performing mouth-to-mouth or mouth-to-nose ventilation. Rescuers should take appropriate safety precautions where feasible, especially if the victim is known to have a serious infection, such as tuberculosis.

Figure 2

Head-tilt and chin-lift manoeuvre. A. In adults. B. In children
find any high-quality evidence favouring the use of endotracheal intubation over bag-mask ventilation or an advanced airway device, in relation to overall survival or favourable neurologic outcome. In this regard, the 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care focused on recommendations for airway management, based on rate of survival and favourable neurologic outcome, and concluded that “either a bag-mask device or an advanced airway may be used for oxygenation and ventilation during CPR in both the in-hospital and out-of-hospital setting”. The strength of these recommendations was of Class IIb (weak but with benefits stronger than risks) and the level of evidence classified as C-LD with limited data. For healthcare providers trained in their use, either an SGA device or an endotracheal tube (ETT) may be used as the initial advanced airway during cardio-pulmonary resuscitation (CPR).

The European Resuscitation Council endorsed the use of SGA devices in its guidelines, which were published in 2005 and revised in 2010. Various supraglottic devices exist: for example, Laryngeal Mask Airway LMA® (LMA, the Netherlands Antilles), Combitube™ (Nellcor, Boulder, CO, USA), Rusch EasyTube® (Teleflex Medical Company, Reading, Pennsylvania, USA), and King LT™ (King Systems, Noblesville, IN, USA). In comparison with ETT, these devices are usually easier to insert by providers after minimal training but do not provide a definitive airway compared to a cuffed ETT. The supraglottic devices offer an alternative to establishing a pre-hospital rescue airway after failed intubation and can prepare for a definitive airway such as a cricothyrotomy.

This debate is directly linked to the assessment and management of difficult airways; this topic will be covered in a subsequent chapter in this annual report. It should be noticed that, besides the Mallampati classification (Figure 4), tonsil hypertrophy following Brodsky classification (Figure 5) and Cormack and class classifications (Figure 6), several studies have identified key clinical indicators predictive of difficult airways: for example, the frontal plane to chin distance (FPCD) and the FPCD/weight ratio are the most consistent predictors of laryngoscopic difficulty in paediatric patients while, in adults, a thyroid-to-hyoid distance of less than 2 fingers is the only independent variable in predicting difficult intubation.
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Figure 4
Classification for tongue hypertrophy: Mallampati

Figure 5
Classification for tonsil hypertrophy: Brodsky

Figure 6
Classification for tongue base hypertrophy: Cormack
5.1.4. Facilitating breathing
If breathing is insufficient, assisted ventilation must be performed by giving rescue breaths, with or without a barrier device. Tension pneumothorax must be relieved immediately by inserting a cannula where the second intercostal space crosses the midclavicular line (needle thoracocentesis). Bronchospasm should be treated with inhalations. Importantly, high-flow oxygen should be provided to all critically ill persons as soon as possible. The 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations suggests the use of the highest possible inspired oxygen concentration during CPR (weak recommendation, very-low-quality evidence).

The same consensus paper promotes continuous waveform capnography, in addition to clinical assessment, as the most reliable method of confirming and monitoring the correct placement of an ETT. The corresponding strength of recommendation was of Class I (strong, with benefits clearly higher than risks) and the level of evidence was C, with limited data. Finally, after placement of an advanced airway, the experts consider it reasonable for the provider to deliver one breath every 6 seconds (10 breaths/min) while continuous chest compressions are being performed. As for ventilation systems, the strength of recommendations was of Class IIb (weak, but with benefits stronger than risks) and a level of evidence classified as C-LD with limited data.

Part II: Haemodynamic stabilization

1. Introduction
For circulation (C), we must determine if the haemodynamic situation is stable or unstable. Haemodynamic means literally “blood flow”, and concerns only the mean arterial pressure. In this section, we discuss blood pressure and adequate cardiac output. Haemodynamic stabilization means the stabilizing of blood pressure and the cardiac output. The mean arterial pressure (MAP) is calculated as follows: MAP = 2/3 (DBP) + 1/3 (SBP). The cardiac output (CO) is the volume of blood being pumped by the heart, calculated as follows: CO = Stroke Volume × Heart rate. Cardiac index (CI) is the haemodynamic parameter that relates CO from the left ventricle within one minute to the body surface area (BSA), relating heart performance to the size of the individual.

Haemodynamic circulatory instability is defined as absolute hypotension (SBP < 90 mmHg or MAP < 65 mmHg) or relative hypotension (with a decrease in SBP that exceeds 30 mmHg from baseline). Cardiogenic shock is defined as CI < 2.8 L/min/m² with Svo2 < 65%. This value must be correlated to clinical symptoms of shock (tissue hypoperfusion), such as hypotension, tachycardia, oliguria, abnormal mental status, cool, cyanotic skin and metabolic acidosis.

2. Pre-hospital management (outside the hospital)
Management of the circulation (haemodynamic and cardiac stabilization) outside the hospital includes, first of all, the implementation of a venous route, preferably with a short catheter with a large size (14- to 16-gauge). Two large-bore peripheral IV lines are recommended. If peripheral venous access is unavailable or fails, an intra-bone route is indicated. This is the first choice for children in haemodynamic instability.

Intravenous fluids (IVFs) are first-line agents in the treatment of patients with undifferentiated hypotension and shock. Administration of IVFs in well-defined boluses (500 mL to 1000 mL or 20ml/kg; Grade 1C) is the first-line attitude. This is “fluid challenge” and can be repeated until blood pressure (MAP > 65mmHg) and tissue perfusion are acceptable. Clinical signs, including blood pressure, urine output, mental status, and peripheral perfusion are often adequate to guide fluid resuscitation.

Replacement therapy is done with always crystalloid solutions like Hartmann’s, Ringer’s acetate and 0.9% saline. Colloids, as suspensions of high molecular weight particles derived from gelatine, are no longer recommended, despite the many discussions and articles on this topic. Large volume resuscitation using isotonic saline may be associated with the development of hyperchloaemic metabolic acidosis. This has led to suggestions that physiologically-buffered fluids (e.g., lactated-Ringers solution) be used for large volume resuscitation. Rarely, vasopressors are used outside the hospital. Haemorrhage control with direct pressure, garrotte or tourniquets should remain a primary focus of equipment and training.
At this stage it is necessary to begin considering etiological causes and specific treatment of haemodynamic and cardiac instability using limited resources and integrated into the “ABCDE” management.

3. Assessment and management within the hospital

Assessment and management within the hospital is easier than outside it, since we can use the all hospital resources, such as infrastructure, more staff, more specialty and more options. The first-line, emergency physicians must warn and mobilize the upstream resources at the hospital to plan and prepare for receiving the patient.

At the hospital, a multidisciplinary and team approach is preferred, using the model of a trauma team leader and team members. Like outside the hospital, general and specific management are necessary. General management within the ABCDE approach is necessary, with specific management such as total body CT scanning, echocardiography and specific echography to identify the causes of shock. Symptomatic and aetiological treatments are necessary. It is necessary to identify the aetiology of shock to determine a specific treatment. Four classes of shock are recognized: distributive (e.g., septic or non-septic shock), cardiogenic (e.g., myocardial infarction), hypovolaemic (e.g., haemorrhagic or non-haemorrhagic shock) and obstructive (e.g., pulmonary embolism).

Vascular access and fluids for resuscitation are the same as pre-hospital management, although more options are available, such as a central venous catheter or large-bore, single lumen central cordis in patients who fail to respond promptly to initial fluid resuscitation, with the help of another specialist if necessary. Central venous pressure (CVP) can be used as management for replacement therapy.

3.1. Aim

The aim of replacement therapy is to correct existing abnormalities in volume status and/or serum electrolytes. The rate of correction of volume depletion depends upon its severity. Fluid repletion is continued at a rapid rate until the clinical signs of hypovolaemia improve. The aim can be more easily achieved with CVP > = 8mmHG (or 12 mmHg for mechanic ventilation) (recommendation level: Grade B following Shekelle).

3.2. Choice of fluid

The choice of replacement fluid is dependent upon the type of fluid that has been lost and on any concurrent electrolyte disorders. Most patients are initially treated with isotonic saline. For patients with severe non-haemorrhagic shock, we recommend initial fluid replacement with an isotonic crystalloid solution, rather than a hyperoncotic starch solution (e.g., hydroxyethyl starch (level of evidence: Grade 1A) or albumin-containing solution (GRADE Evidence scale: Grade 2B)) is recommended. For patients with severe haemorrhagic shock, red blood cell transfusions are an appropriate choice for initial volume resuscitation, with the specific ratio 1/1/1: one pack of red blood cells/one pack of platelets/one fresh frozen plasma (GRADE Evidence scale: Grade 2B). Major haemorrhage protocol (MHP) must be activated in this case. Tranexamic acid should be given within 3 hours of injury to any patients who have, or are thought to be at risk for, major haemorrhage. A chapter dedicated to the control of coagulation disorders will discuss this issue in more detail. The total volume infused is determined by the aetiology of shock. Hypovolaemia should be corrected prior to the institution of vasopressor therapy for maximum efficacy.

3.3. Vasopressors

Vasopressors (norepinephrine, epinephrine, phenylephrine, and dopamine) and inotropes (dobutamine and milrinone) are second-line agents, but are powerful classes of drugs. Vasopressors are indicated when either condition results in end-organ dysfunction due to hypoperfusion. Expert recommendation is for a more rapid use of these agents, and they should be titrated according to the response. Repletion of adequate intravascular volume, if time permits, is crucial prior to the initiation of vasopressors. For patients with hypodynamic septic shock, norepinephrine is the first-line agent (GRADE Evidence scale: Grade 1B). Alternative agents include epinephrine or, for patients with tachyarrhythmia, phenylephrine. Addition of vasopressin may be of benefit if the adrenergic agent is inadequate. Epinephrine is the preferred agent for most patients with anaphylactic shock. For patients with cardiogenic shock, norepinephrine is the preferred initial agent. Once an adequate perfusion pressure has been obtained,
dobutamine may be added, as tolerated. Patients should be closely monitored for lack of response and the need for the addition of an inotropic agent.

**Part III: Conclusions and take-home message (emergency and ent)**

The aim of this paper was to discuss the protection of respiratory integrity and haemodynamic stabilization. The take-home messages can be summarized as follows:

- Multidisciplinary approaches with teams are preferred, in order to achieve simultaneous diagnosis and application of therapeutics for the protection of respiratory integrity and haemodynamic stabilization.

- Strategic management of emergency and ENT situations should include the “ABCDE” management approach. A stands for airway and protection of the spine; B for breathing; C for circulation, including haemodynamic (MAP) and cardiac evaluation (CO); D for disability; and E for exposure.

- General management with the “ABCDE” approach is necessary with specific management (such as fibre-optic examination and echography) to identify the causes of destabilization of the airway and circulation. Symptomatic and aetiological treatments are necessary.

- Airway (A) evaluation can be diagnosed by fibre-optic examination. Laryngeal intubation is the most effective treatment for protection of respiratory integrity.

- Circulation (C) stands for haemodynamic (with MAP) and cardiac evaluation (with CI). Management of cardio-vascular instability includes the implementation of a venous route to initiate administration of IVFs. If no response, vasopressors and inotropes can be used as second-line agents until MAP, CO and tissue perfusion are acceptable.

**Abbreviations**

A: Airway  
ALS: Advanced Life Support  
BP: Blood pressure  
BSA: Body Surface Area  
B: Breathing  
CO: Cardiac Output  
CI: Cardiac Index  
CVP: Central Venous Pressure  
C: Circulation  
CT: Computerized Tomography  
DBP: Diastolic Blood Pressure  
D: Disability  
E: Exposure  
ENT: Ear, Nose and Throat  
IV: Intravenous  
IVFs: Intravenous fluids  
MAP: Mean Arterial Pressure  
MmHg: Millimetres of mercury  
MHP: Major Haemorrhage Protocol  
SBP: Systolic Blood Pressure  
Svo2: Venous saturation of oxygen

**References**

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