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Prehospital management of trauma patients

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OBJECTIVES

To describe the most relevant aspects of the management of trauma victims in the prehospital setting.

MATERIALS AND METHODS

A review was carried out of all relevant secondary sources such as UpToDate database (Prehospital management of the adult trauma patient) and publications of the American College of Surgeons (Advanced Trauma Life Support program for doctors 7th Ed) and the European resuscitation Council (Avanced Life Support, 5th Ed).

RESULTS

A description of the adequate approach to evaluate trauma patients is made with an emphasis on the primary survey, whose objective is to rule out and treat life threatening injuries. The secondary survey, immobilisation and transfer is also discussed.

CONCLUSIONS

The management steps taken during the critical period condition the survival and posterior morbidity of trauma patients. Life should take priority over function and this over aesthetics. The primary survey is the key to detect and treat life threatening injuries. Definitive treatment is nearly always hospital based and therefore transfer should not be delayed. The absence of a definitive diagnosis should not impede the application of therapeutic measures. Psychological suffering and pain should not be left unattended and the principle of primum non nocere should always be taken into account.

One Sunday morning a young couple decide to take a secondary route to avoid a police check for alcohol, after a night at a discoteque in a rural setting. While on duty at a rural emergency service, you receive a call at 6.30 am from the emergency call center indicating that you should first attend to an accident scene in your area. At the scene of the accident you find a car crashed into a tree. There are two passengers. The driver does not move or respond to verbal commands and seems to be dead. The copilot looks severely injured, is conscious, confused, and you see her with some breathing difficulty. She is actively bleeding from the scalp. A few minutes later she becomes even more confused, and her breathing difficulty increases….

What are the first measures to take at the scene of an accident? What evaluation must you carry out on the patient? What would make you think she is critical? What vital injuries could place her life in danger? How should you initially manage and treat your patient? How should you manage a patient in shock? Is the patient critical? Should you transfer immediately? What interventions can you carry out at the scene? If she is not critical what steps should you take next? How would you immobilise her and prepare for transport? What transfer options do you have?

Introduction

Epidemiology of trauma

The World Health Organization defined trauma in 1958 as any fortuitous event caused by an external force that acts quickly and results in physical or mental injury. Each day nearly 16,000 people die from all types of trauma[1].

In Spain, accidents are the fourth cause of overall mortality in all ages and the first in those under 45 years. With regard to morbidity accidents are the first cause of loss of potential life years. Eight percent of discapacity in the general population is caused by accidents, 50% of which occur in people under 30 years of age[2].

Mortality in trauma victims

The distribution of mortality caused by trauma follows a tri-modal distribution[3]. In the early phase, in a 50 % of the trauma patients, death occurs in the first seconds to minutes after the event, and generally is due to brain lacerations, brain stem damage, high spinal trauma, cardiac injury, aortic rupture and other great vessel injury. Very few of these patients survive. These deaths are hardly salvageable and here lies the importance of preventive measures and health education.

The second phase corresponds to the first hours after the incident and death occurs due to subdural or/and epidural haemorrhage, haemo-pneumothorax, spleen or liver injury, pelvic fractures or multiple injuries associated with severe haemorrhage. This group comprises 30% of trauma victims and death can be prevented by an adequate prehospital and hospital emergency system. For this reason, the first professional who assists a victim has the possibility to influence either positively or negatively in the final outcome.

In the third phase, death occurs days to weeks after the incident and is greatly caused by sepsis or multiorgan failure.

Critical period

The “Golden Hour” is defined as the period of one hour between the moment of the traumatic event and definitive surgical care. Dr. Adams Cowley de-

veloped the concept of "Golden hour" in trauma and noted that if tissue oxygenation was not reestablished within an hour of injury the possibility of survival would be scarce. The Golden hour is now referred to as the "critical period" because some patients have less than one hour to receive medical assistance while others may have a more prolonged critical period. Within the critical period prehospital assistance at the site of the event should not take longer than 10 minutes if the patient is critical, what some authors refer to as the platinum 10 minutes[4].

The objective of the present review is to offer, through a series of principles, a guideline for prehospital management of trauma victims. All critical patients are managed following the same systematic approach. This approach, regardless of the injury is based on a wider concept of maintaining life, securing correct oxygenation, breathing and perfusion: the ABCDE of the primary evaluation within a limited period. We hope the paper will be a useful tool for health care providers in pre-hospital care as a guide to approach these patients in an orderly fashion.

Physiopathology of injury. Mechanism of injury

Knowledge of the physiopathology of trauma could be the key to discovering or suspecting any inadvertent injury. Trauma can be classified as contuse or penetrating. A single contuse or penetrating injury could affect multiple systems. The exchange of energy involved in both types of trauma is similar, but differ in the penetration across the skin.

Contuse trauma occuring after traffic accidents can involve various injury mechanisms (head on collision, lateral and rear impact, with rotation or rollover collisions). Other accidents include falls, runovers, and sports related injuries. Penetrating trauma includes injuries due to blunt trauma or firearms with entrance and exit orifices.

The injury mechanism can orient the health provider to suspect injuries in organs or systems. This orientation could lead us to suspect internal and hidden injuries when possibly no external signs are evident. For example, in the case of a fall, integrating injury physiopathology in our thinking implies that we ask ourselves about the factors involved: the height of the fall, the relation between the height of the patient and the distance of the fall, the type of landing surface, etc. This could help us suspect internal organ injury or spinal injury and establish priorities in our management.

The aim of the primary survey is to detect and treat life-threatening injuries.

Evaluation of the severe trauma patient

WHAT ARE THE FIRST STEPS TO TAKE AT THE SCENE OF AN ACCIDENT?

Evaluation of the scene. Safety and situation

As soon as an emergency call has been made, health care providers should analyse the initial information obtained, and integrate new data once arriving at the scene (what happened? how many victims are there? what are their ages?, what injury mechanism was involved?, etc.). The sum of this information should help to determine whether the scene is safe.

Safety at the scene is a requirement for all health care providers. An orderly approach to the victims at the scene should include the following:

Universal precautions

The use of gloves is fundamental to protect oneself from the transmission of some infections (HIV, hepatitis). Besides nitrile gloves, kevlar gloves (made of resistant material to fire and cuts) are useful to avoid cuts and abrasions while getting access to the patient and can be removed once used[5]. Eye protection and masks are also universal precautions to take into account. The helmet, resistant footwear and intervention gear are elements not to be obviated.

Safety at the scene

Prudence and prevision of possible threats before arriving at the scene contributes to a safe intervention. In the context of a possible crime scene the presence of the police may be warranted.

Elements of passive safety on vehicles such as the airbag that did not open after a collision, could do

so at any time during the intervention in the vehicle and produce serious injuries to the victim or heath care providers. The medical team should first put themselves in the hands of the rescue team (firemen, etc.).

Safety of the patient

Protection screens are available and if not a blanket could be enough. In critical situations, such as fire or a dangerous position of a vehicle, rapid extrication should be employed. If the victim is trapped priorities with the rescue team should be made for a quick and safe liberation of the patient.

HOW SHOULD THE PATIENT BE EVALUATED? WHAT INJURIES COULD PLACE THE LIVES OF THE VICTIMS IN DANGER? HOW DOES ONE DECIDE WHETHER A PATIENT IS CRITICAL OR NOT?

Primary survey

The objective is to detect and treat life-threatening injuries. The primary survey follows the ABCDE approach of the ATLS (Advanced Trauma Life Support program) under the American College of Sugeons[6,7]. This brief exploration allows us to systematically examine the airway (A), breathing (B), circulation (C), disability, mental status and neurological status (D) and exposure (E) of the patient to detect any other obvious injuries. Treatment of injuries detected in the primary survey should not be delayed but rather treated as they are found (treat as you go).

That is, if during the primary survey we detect an obstruction of the airway, then this should be treated immediately before moving on to the next step. An airway problem can cause death in seconds, a breathing problem in minutes and a circulation problem in hours. Thus we should not be easily "distracted" with the reduction of a fractured limb, if we have not acted upon the airway, breathing and circulation. Life prevails over function and function over aesthetics. The ABCDE scheme helps to identify whether patients are critical or not. In case of a critical patient, an on-scene time of less than 10 minutes is recommended.

A

Airway and cervical spine

A patent airway is a priority in the management of all trauma victims[8]. All actions taken or the use of any method to manage the airway should be done under the assumption that a cervical spine fracture exists. Thus airway patency will be explored under strict control of the cervical spine (manual in-line stabilisation –MILS– in neutral position).

To evaluate the airway (A) the first thing to do is to ask the patient a question to evaluate response. If the patient is able to speak then patency is ascertained. If the patient is unconscious or does not respond, the airway should be assessed and patency should be secured. Noisy breath sounds or diminished air entry could indicate a parcial obstruction of the airway. The main maneuvres to open, assess and maintain a patent airway include:

MANUAL CLEARING OF THE AIRWAY

If any foreign object is observed (teeth, food, prostheses, etc.) this should be removed with forceps (such as Magill forceps) or with a finger sweep.

MANUAL MANEUVRES TO OPEN THE AIRWAY

In unconscious patients (supine position), the tongue loses its muscle tone and may be displaced towards the posterior pharyngeal wall causing airway obstruction. Recent studies in anesthesized patients have shown that the site of airway obstruction more frequently occurs at the soft palate and epiglotis and not the tongue[9]. To avoid this, two techniques can be applied: mandible displacement (head-chin tilt lift or modified triple maneuver without cervical spine extension) along with a manual in-line stabilisation of the head and neck by an assistant, and the jawthrust maneuver.

Both techniques displace the jaw bone forward, lifting the tongue and separating it from the posterior pharyngeal wall, thus opening the airway.

SUCTION

In occasions, the presence of blood or vomit, may be the cause of airway obstruction. Vigorous and prolonged suctioning can cause or worsen hypoxemia. Wide bore rigid suckers are preferable (Yankauer) to fine bore flexible soft suction cathe-

ters. The sucker is introduced in the mouth up to the desired area to suck and suction is carried out *as the catheter is pulled out* from the mouth and for not more than 15 seconds.

USE OF OROPHARYNGEAL AND NASOPHARYNGEAL AIRWAYS

Both are employed to maintain an open airway but they do not prevent bronchoaspiration as they do not seal the airway. The nasopharyngeal airway is contraindicated in patients with suspected skull base fractures.

TRACHEAL INTUBATION

This is perceived as the optimal method to manage and secure the airway. It is indicated in patients unable to maintain an open airway on their own, including those with Glasgow coma scale (GCS) scores of <9 points, patients with airway burns, etc.

It is important to check and prepare the material beforehand (ensure functioning of the laryngoscope´s light source and battery, tube cuff, etc). In the prehospital environment, drug-assisted intubation (DAI)[10] can prove useful, which may include the use of opioids, and a rapid sequence induction (RSI) to avoid bronchoaspiration (table 1). After a period of pre-oxygenation with 100% oxygen, sedative (etomidate can be useful as it does not produce hypotension as with midazolam) and paralytic agents (succinylcholine) are introduced in tandem to improve laryngoscopy and facilitate intubation. In cases where intubation is decided it is important to know the GCS score before administering sedative agents (see section D, neurological evaluation). The main characteristics of the most common sedative agents employed are shown in table 2. The use of DAI requires training and it is highly recommended that guidelines be established in accordance with the characteristics of the prehospital care system[10].

From the moment the patient loses the ability to maintain and protect the airway, the Sellick manoeuvre should be applied (pressure over the cricoid cartilage) to avoid gastric reflux. Correct insertion of the endotracheal tube (ETT) should be carried out, by auscultating both sides of the thorax (apical, axilar regions, bases and epigastrium), monitoring the end tidal CO_2 and having directly visualised the tube go pass the vocal cords[11]. In cases of selective right bronchus intubation, the ETT should be removed between 1-2 cm and ventilation verified in both sides of the chest. When a failed intubation occurs or an intubation is not performed due to inexperience or difficulty, there are other alternatives to maintain the airway secured (though not completely) and the patient ventilated and oxygenated.

In the management of the airway and breathing, the main aim is not intubation but rather oxygenation (and ventilation if required)

Table 1. Drug assisted intubation (DAI) including rapid sequence intubation (RSI).

PREPARATION
Evaluation of the airway and plan for the procedure. Indications, risks and alternatives (in case of failed intubation). Preparation and verify functioning of material.
PREOXYGENATION
100% Oxygen for 3-5 minutes. 4-8 inspirations maximum (FiO_2: 1). Ventilate only if pulsioximetry ≤ 90%.
PREMEDICATION
Sedatión-Analgesia-Amnesia. Opioids: fentanyl (1-2 mcg/kg). Defasciculatión: succinilcholine (1-1.5 mg/kg). Optional: lidocaine (1 mg/kg). Useful in head injury or increase in intracraneal pressure. Optional: atropine (children).
PARALYSIS WITH SEDATION
Inductor in bolus (table 2). Paralytic agent (succinilcholine: 1-2 mg/kg; rocuronium 0.6-0.9 mg/kg).
PROTECTION
Sellick maneuver (cricoid pressure). Correct positioning of the patient. Ventilation only if pulsioximetry $SatO_2$ ≤ 90%.
PASS THE TUBE-INTUBATION
Laryngoscope and intubation. Verify position of endotracheal tube. Inflate cuff.
POSTINTUBATION MANAGEMENT
Release cricoid pressure. Fix tube. Sedation and adequate relaxation.

Intubation adjuncts

Guides

The Eschmann and Frova tracheal tube introducers are widely used. The latter is provided with a lumen that permits a brief period of ventilation. Under direct vision with a laryngoscope, these devices are first introduced passed the glottis (the Eschmann has a 45º angulated tip to facilitate its introduction) after which a standard ETT is passed over the introducer.

Optic larygoscope (Airtrach™)

A single use device that allows direct visualisation of the glottis. The device contains two conduits, one with an optic apparatus and the other through which the ETT is placed. Mobilisation of the cervical spine is not needed, and given the ease of placing the tube, this device is an attractive alternative in cases of failed intubations (figure 1).

Supraglottic devices

When intubation is indicated but is not possible for some cause (inexperience, failed technique, etc.) there are other alternative devices to ventilate the patient such as the laryngeal mask airway (ProSeal™, Fastrach™), combitube (dual lumen dual cuff airway) and the laryngeal tube (figure 2).

All these devices offer air/oxygen flow above the glottis not reaching past the vocal cords. They do not completely eliminate the possibility of inflating the oesophagus and the passage of gastric content into the airway. As for the laryngeal mask airway it is important to verify its functioning before use (inflation-deflation). There are several variations including:

ProSeal laryngeal mask

It permits the use of a nasogastric catheter to drain gastric content. The double cuff design provides better seal pressure than the classical laryngeal mask.

FasTrach laryngeal mask airway

This carries a metallic handle to facilitate manipulation. Once placed and the cuff inflated, bag ventilation can be carried out. In addition, an ETT can be advanced through the lumen (figure 3).

The I-GEL airway mask

It is a novel device made of a non-inflammable thermoplastic polymer that adapts to the laryngeal anatomy of the patient providing a nearly complete seal of the airway. Moreover, it allows for an ETT and gastric drain to be advanced through it[12,13].

In cases when intubation is not possible due to inexperience or difficult airway or there are no other alternatives, then bag-mask ventilation should be carried out until more expertise is available for intubation.

B
Breathing

Hypoxia is caused by insufficient supply of oxygen due to tissue hypoperfusion or because arterial blood is not sufficiently oxygenated.

The administration of 100% oxygen is absolutely primordial in the trauma patient. The first observa-

Table 2. Principle sedatives used in intubation.

MIDAZOLAM (Dormicum™)	ETOMIDATE (Hypnomidate™)	KETAMINE (Ketolar™)	PROPOFOL (Diprivan™)
Variability among different patients in effects. Maximum effect in 3 minutes. Rapid and predictable intramuscular absortion (>80%). Moderate hemodynamic repercussion. Not an anesthetic induction agent. Dose: 0.1-0.4 mg/kg (variability)	Hypnosis en 30-60 seg. Duration of effect: 5-10 minutes. Cardiovascular stability Neuroprotection. Spontaneous movements, mioclony. Dose: 0.3 mg/kg	Dissociative state Potent analgesia Broncodilator Useful in asthma, burns Increase in intracraneal pressure (ICP). Dose: 1-2 mg/kg iv., 3 mg/kg i.m.	Rapid action (60 seconds). Short duration (5-10 min. after bolus) Pharmokinetics unaffected by renal or liver impairment. Decreases ICP Cardiovascular depression. Dose: 2-2.5 mg/kg

Figure 1. Optical laryngoscope Airtrach™
Figure 2. Supraglottic devices:
(Left to right): Combitube, laryngeal mask, laryngeal tube, I-GEL.
Figure 3. Fastrach mask™

tion to make is whether the patient is breathing or not. If not, then cardiorespiratory resuscitation should be initiated. If the patient is breathing then we should evaluate the work of breathing, chest motion movements, use of accessory muscles, etc. In a first inspection we should look for open or sucking wounds, abrasions or signs of contusion in the neck and thorax. Some very important signs should not be overlooked in the neck such as subcutaneous crepitation (possible underlying pneumothorax), open wounds, laryngeal crepitation (laryngeal rupture), tracheal deviation (tension pneumothorax), and jugular ingurgitation (tension pneumothorax, cardiac tamponade).

In the thorax, observe for asymmetry in the chest wall and paradoxical chest motion. Palpation of the chest should be carried out to find painful areas, subcutaneous crepitation, as well as auscultation of all lung fields and heart (diminished heart sounds, displacement of heart sounds, etc.).

If the patient is breathing, oxygen should be applied via Venturi mask or a nonrebreather mask with an oxygen reservoir. If ventilatory support is needed, then bag mask ventilation (Ambu™) connected to a 100% oxygen supply should be given until a definitive airway is secured.

Effective bag mask ventilation (BMV) is not as easy as it may seem. It is important to obtain a proper seal with the mask on the face of the patient to avoid air leaks. Two handed mask ventilation is preferable to single handed ventilation, as the former generates superior tidal volumes and peak pressure. One person is in charge of applying the mask to the patients face while the other ventilates (approximately 10-12 ventilations per minute).

In the evaluation of breathing, the potential injuries that can be ruled out are as follows:

FLAIL CHEST

This consists of a fracture of two or more ribs in two different sites, resulting in a segment that remains free from the rest of the chest wall. The segment moves freely in inspiration and expiration in the opposite direction to the rest of the chest wall (paradoxical movement). There is a reduction in vital capacity, increase in work of breathing, pain and this implies underlying pulmonary contusion which could require ventilatory support with bag mask, or early intubation.

OPEN PNEUMOTHORAX

Here both atmospheric and intrathoracic pressures are equalised. It is estimated that if the defect in the chest wall is 2/3 the size of the trachea, then air will enter the pleural space (negative intrathoracic pressure) with each inspiratory effort, resulting in pneumothorax. Management involves, besides 100% oxygen supplementation, the application of an occlusive dressing over the wound. One side of the dressing should be left untaped to act as a flap-valve to allow air to escape from the pneumothorax during expiration, but not to enter during inspiration. Commercial dressings such as the Asherman seal are available.

TENSION PNEUMOTHORAX

One hemithorax is not ventilated, as the pleural space fills up with air, and collapses the lung. When the pressure in the pleural space exceeds the atmospheric pressure, the mediastinum (heart and great vessels) are displaced to the opposite side. Ventilation becomes more difficult as intrathoracic pressure increases, followed by a reduction in venous return, cardiac filling and cardiac output, resulting in shock. Symptoms and signs of tension pneumothorax include important work of breathing and extreme anxiety (if conscious), cyanosis, taquipnoea, tachycardia, jugular ingurgitation (due to increase in intrathoracic pressure), hypotension, subcutaneous emphysema, and absence of ventilation sounds on auscultation. Tracheal deviation can appear in occasions, but at later stages. If suspected, then tension pneumothorax should be immediately decompressed with needle thoracostomy. An intravenous cannula (12 or 14G) is inserted into the second rib space (mid-clavicular line), over the superior edge of the third rib to avoid damaging the neurovascular bundle[14].

MASSIVE HEMOTHORAX

This is the accumulation of blood in the pleural space (up to 2.5-3 litres). Symptoms develop from the resulting hypovolemia and to a lesser extent due to the associated lung collapse.

CARDIAC TAMPONADE

It occurs mainly in penetrating trauma. If the pericardial sac is filled with blood (200-300 ml is sufficient), myocardial distension is limited producing reduced cardiac filling leading to a situation of low cardiac output and shock arises. Classical signs include the presence of a paradoxical pulse (fall of blood pressure by >10-15 mmHg during inspiration), jugular ingurgitation, and diminished heart sounds. Rapid transfer to an emergency room with supportive measures is fundamental, where pericardiocentesis can be perfomed before definitive surgical repair.

In summary, the objective of the management of the airway and breathing is not intubation, but rather provide adequate oxygenation (and ventilation if required). Though intubation is the most effective method to maintain and secure the airway, it should not be made an obsession. The trauma patient needs oxygenation/ventilation and this can be achieved by alternative methods. Even though these alternatives do not completely secure the airway, they allow for a more than acceptable supply of oxygen and ventilation of the patient.

C
Circulation and hemorrhage control

The objectives of the "C" step of the primary survey are to evaluate the circulatory status and to detect and control hemorrhage (external and evident or internal and occult), determine whether the patient is in shock and if so, determine the type (hypovolemic, cardiogenic, etc.) and severity, and initiate treatment as soon as possible.

What defines shock? Inadequate oxygen delivery to tissues produced mainly by hypoperfusion (reduced blood flow) results in shock. If not treated, this process progresses to an anaerobic state with the production of lactate and pyruvate, resulting in acidosis and finally cell death.

Identification of shock. In the prehospital context the identification of patients in shock is a clinical diagnosis. An overall judgement should be made after exploring pulse (quality and rate, regularity) capillary refill, skin (aspect, color and temperature), rate and work of breathing, and mental status. Table 3 shows the ATLS classification of hemorrhagic shock[7].

If taken individually, the outlined clinical signs are hardly sensitive and specific. However, if evaluated as a whole then the sensitivity and specificity increases considerably. For example, a patient under treatment with betablockers in a state of shock, could possibly not show tachycardia, but could be cold, pale, and breathe rapidly and superficially. Thus as a general norm, *any patient that*

is cold, pale, sweaty and with a fast heart rate is in shock.

All these changes are a consequence of compensating mechanisms that eventually are exhausted if the patient is not treated promptly and adequately, resulting in sharp fall in blood pressure (Grade III). This state is known as uncompensated shock and can be recognised in the prehospital scene as the loss of radial pulse.

All trauma victims that are cold, pallid, sweaty and with tachycardia are in shock

CONFOUNDING FACTORS

Age

Elderly patients have poorer compensation mechanisms due to physiological changes related to aging, or to medication (for example betablockers). This means that they could present a fall in blood pressure and a loss of radial pulse with a 15% blood loss. On the contrary, children compensate well by increasing their heart rate and maintain their blood pressure at normal levels until blood loss reaches 45%.

Athletes

They usually present a greater capacity for compensation and tachycardia may not appear in the initial stages of shock.

Pregnancy

The increase in cardiac output, blood volume and heart rate related to this state contributes to the fact that signs of shock do not appear until blood loss reaches 30%, despite the presence of fetal distress. Moreover in the third trimester compression of the uterus by the great vessels in supine position could result in hypotension. Therefore pregnant women should be placed in the left lateral tilt position.

Previous disease

A reduction in cardiopulmonary reserve may occur in COPD or cardiac disease.

Medication

Certain drugs can contribute to a decrease in blood pressure (antihypertensive drugs) or facilitate bleeding (antiplatelet and anticoagulation agents). The use of pacemakers could interfere with the heart rate.

Time between injury and treatment

During the period between the accident and the first medical attention the injuries continue their evolution, such that a patient with a ruptured spleen seen in the first minutes after the incident occurred could still be hemodynamically stable at this point.

Table 3. Classification of shock (adapted from the *American College of Surgeons* ATLS, 1997).

	CLASS I	CLASS II	**CLASS III**	CLASS IV
Volumen of blood loss (% total)	< 750 ml (< 15%)	750-1,500 ml (15-30%)	**1,500-2,000 ml (30-40%)**	> 2,000 ml (> 40%)
Heart rate (beats per minute)	Normal	> 100	**> 120**	> 140
Respiratory rate (rpm)	Normal	20-30	**30-40**	> 35
Systolic Blood pressure (mm Hg) Palpable pulse	Normal Radial palpable	Normal Radial palpable	**Reduced** **Radial pulse not palpable**	Reduced Carotid palpable +/-
Neurological status	Alert	Anxious	**Confused**	Lethargic
Urine output (ml/h)	Normal	20-30	**5-15**	Minimum

The most frequent cause of shock is hemorrhage (cause of early and preventable mortality) though other types of shock also should be considered and could appear concurrently in the same patient:

Hypovolemic shock

Mainly reflects blood loss which can be estimated by the ATLS classification (table 3). It is important to identify the site of the bleeding: extenal hemorrhage (visual diagnosis) and/or internal in one or more of the four cavities:

· **Pleural-thoracic.** It may cause a massive hemothorax (look, listen and feel)

· **Peritoneal.** One should suspect organ damage. Initially there may be scarce symptoms until a blood loss of 2,000-3,000 mL. The abdominal examination is of little value. If the patient is in shock then we should first suspect an abdominal injury until ruled out by imaging such as focussed assessment with sonography for trauma (FAST) or computed tomography.

· **Retroperitoneal–pelvic.** This is associated with unstable fractures of the pelvis, with arterial or more frequently venous blood loss, soft tissue and bone damage (in the latter 80% damage can be reduced with closing of the pelvis). A high index of suspicion could be obtained from the injury mechanism and the physical examination (pain, equimosis in the perineal region and scrotum, rotation and deformity in the lower extremity). Currently, all maneuvers to establish stability of the pelvis are not recommended as they are hardly specific and increase the probability of further bleeding. If an open pelvic fracture is suspected then the pelvis should be "closed" (immobilised) until ruled out by diagnostic radiological imaging[15,16].

· **Long bones-soft tissue.** Femur fractures can cause blood loss of up to 1,500 mL[17].

Cardiogenic shock

This can be due to intrinsic or extrinsic causes resulting in cardiac pump failure.

· **Intrinsec.** This may be due to contuse cardiac injury after chest trauma with an alteration in contractility, arrhythms (which guides the diagnostic suspicion) and mechanical complications (ventricular or valve rupture).

· **Extrinsic.** Here increased intrathoracic or intrapercardial pressure causes diminished cardiac filling of the left ventricle. Exemplary injuries that follow this mechanism include tension pneumothorax and cardiac tamponade.

Neurogenic shock

This type of shock is associated with spinal trauma affecting the cervical spine or high thoracic vertebral column. The clinical condition involves the suppression of sympathetic innervation of blood vessels and the heart leading to peripheral vasodilation (relative hypovolemia, dry flushed skin) and bradycardia (a confounding factor). A high index of suspicion is important in this type of shock because initially it is not outrightly manifest, and often causes difficulty to evaluate hypovolemic shock (due to bradycardia) and evaluate pain when exploring the abdomen, pelvis or long bones. In case of spinal injury with neurological compromise, it is primordial to rule out bleeding, immobilise the patient and arrange early transfer.

MANAGEMENT OF PATIENTS IN SHOCK

The aim of management of shock is to provide oxygen supply to tissues reversing metabolism from anaerobic to aerobic. The following indications are useful in treating these patients:

· **Guarantee a secured airway** and correct ventilation.
· **Control bleeding.** Control of hemorrhage is the most effective way to adequately manage shock. In case of external hemorrhage, this should be carried out in tandem according to the site of bleeding:

- *Direct pressure* over the wound with sterile padding or bandage.
- *Elevation* of the limb, if the wound is located in a non fractured extremity.
- Pressure at a proximal site to the wound to compress the responsable artery pressure points (axilary, femoral)
- Torniquet. It should be the final resort when all else fails and is used in amputations.

In case of internal hemorrhage, the majority of bleeds require surgical control and/or angiography. Supportive treatment with blood products to reestablish delivery of oxygen may also be needed.

- Pleura-thorax: aggressive management of the airway and ventilation, and consideration of chest decompression by tube thoracostomy in cases of massive hemothorax or needle thoracostomy in tension pneumothorax.
- Abdomen: early transfer to a trauma center.

- Retroperitoneum-pelvis: by simply "closing" the pelvis, venous bleeding, soft tissue and bone injury can be reduced. This can be done applying a sheet, or an inverted FernoKed, or the vacuum Mattress, or commercial devices available which should be maintained until a pelvic radiograph is obtained to confirm or rule out injury[15].
- Long bones: like the femur, which requires adequate immobilisation (preferably splints with traction).

· **Hypothermia.** The most important aspect in the management of hypothermia is prevention. Hypothermia can produce myocardial dysfunction, vasoconstriction, electrolyte disturbances and coagulopathy, contributing to the trauma triad of death (acidosis, hypothermia and coagulopathy) that augments considerably mortality in these patients. All wet and humid clothes should be removed and the patient well covered, while the interior of the ambulance or room should be conditioned to a temperature of 29ºC. Fluid and blood derived products should also be warm.

· **Fluid resuscitation.** Currently no solution is capable of transporting oxygen (except blood) and thus in the prehospital environment the term replacement of volume is more adequate, ie: without the possibility of transporting oxygen to tissues. Transfer to a hospital should not be delayed by initiating fluid resuscitation at the scene of an accident[18,19]. The normalisation of vital parameters should not be the aim of an aggressive approach to fluid replacement (what are the really "normal" vital signs of a patient?) Aggressive and excessive fluid replacement has its risks which include a dilutional coagulopathy, "concealing" the state of shock (with normalised vital signs but with precarious oxygen transport) and the pop the clot phenomenon causing new internal bleeding by dislodging a clot. Permissive hypotension however has been gaining weight in recommendations on fluid management of the trauma patient. A maximum limit for systolic blood pressure of 90 mmHg (palpable radial pulse) is a guide to fluid resuscitation[16,20].

Fluid therapy should be administered via wide bore intravenous access (ideally 12-14G). Two reasonable attempts to obtain an intravenous access should be performed before opting for an alternative access (for example intraosseous). Currently there is a debate on the automatic initiation of fluid replacement. Previously, the tendency was to administer 2,000 mL of crystalloids in 10-15 minutes (ATLS, 1997)[7]. However, it was seen that aggressive resuscitation produced dislodging of clots (pop a clot phenomenon), hypothermia and the activation of an inflammatory systemic response. Moreover, the correction of blood pressure levels did not necessarily guarantee adequate perfusion of tissues, especially if bleeding was still uncontrolled. Currently, the tendency in prehospital scenes is to titrate fluid therapy indistinctly in blunt trauma and mostly in penetrating trauma.

Different fluids can be used, although none possesses the capability of transporting oxygen. These fluids differ in expansion of volemia, permanence in the intravascular compartment and in adverse effects.

· Crystalloids / Ringer lactate solution. These are safe and not expensive. However, only 33% of the solution remains in the intravascular compartment thus large volumes are required.
· Colloids. These remain longer periods in the intravascular compartment and less quantities are needed. The most recommended today is HES 6% (Hydroxyethyl Starch, Voluven™). Maximum daily dose: 50 mL/kg.
· Hypertonic saline 7.5%. This is particularly beneficial in patients with head injury. Perfusion improves with a reduction in cerebral oedema, and intracraneal pressure but, in cases of vascular lesions, bleeding may be increased due to an osmotic effect.
· Oxygen Carriers. Purified artificial hemoglobin of bovine origin HBOC-201[21].
· Solutions with anti-inflammatory properties and Ringer ethyl pyruvate solution (experimental).

Estimated blood loss can be evaluated with the response to the volume of fluid administered. Three situations can occur:

· **The patient improves.** This suggests that there has been a loss of up to 30% of volemia and the rate of resuscitation is greater than the loss. These patients may need blood posteriorly.
· **The patient initially improves but later deteriorates.** In this case there may be an increase in the rate of blood loss or a new site of bleeding appears or there is a loss in hemostasis at the inicial site of bleeding (pop a clot phenomenon). The latter may be due to aggressive approach in fluid resuscitation. The majority of these patients require surgery and blood.
· **The patient does not improve at all.** This means that the patient loses more blood than what is administered or that the patient may not also be suffering from hemorrhagic shock. The former may have lost >40% of their volemia (Grade IV) and require urgent surgery or embolisation with blood derived products.

Considerations from a consensus on fluid management:

· Transfer of patients should not be delayed by cannulation of intravenous lines.
· Crystalloids should be considered as first choice.
· According to the severity of shock, boluses of 500 mL-1,000 mL of warmed cristalloids should be administered until a radial pulse is palpated.

D
Discapacity

The level of conscious (LOC) of the patient, pupils and signs of lateralisation should be evaluated at this point. The Glasgow Coma scale (GCS), provides information on cerebral function and prognosis (table 4). A score between 14-15 correlates with a mild head injury; 9-13, moderate and <8 with a severe head injury.

It is convenient to carry out this neurological evaluation every 5 minutes to detect changes in the level of consciousness. It is important to remember that a GCS <9 is an indication for endotracheal intubation and that a low level of consciuosness could be due to cerebral hypoxia, injuries in the central nervous system, drugs or alcohol, or metabolic disturbances (hypoglycemia, seizures).

The size and reactivity of pupils to light and accomodation should be examined. A dilated pupil or bilateral dilation or fixed pupils could indicate cerebral herniation and require prompt surgical intervention to reduce intracraneal pressure (ICP). Aniscoric pupils in a conscious patient do not indicate increased ICP.

E
Exposure

In the last step of the primary survey, all clothing should be removed to examine the patient entirely. This should be carried out respecting the dignity of the patient and in a way that prevents hypothermia. Once performed, the patient is covered to conserve body warmth and prevent hypothermia.

IS THE PATIENT IN A CRITICAL CONDITION? IS RAPID TRANSFER REQUIRED? WHAT INTERVENTIONS SHOULD BE APPLIED AT THE SCENE?

The primary survey is usually carried out at the scene (except in cases of imminent danger). However interventions at the scene should be limited. During and after the primary survey, *primary resuscitation* measures are carried out such as opening of the airway, administration of high concentrated oxygen, (FiO_2>0.85), bag mask ventilatory support, compression of external bleeding, and fluid replacement may be initiated. In circumstances where there is a risk of death as in tension pneumothorax, needle thoracostomy may be requiered urgently to avoid early death. In a non-critical patient, splinting of isolated fractures, dressing of wounds and pain management, etc., may be performed.

However, the majority of injuries will need hospital care and it is therefore important to reduce prehospital delay within the critical period to increase the posibilities of survival of the trauma patient. Once the health care provider determines that the patient is critical, then prompt transfer to an appropriate center becomes a foremost priority. Cannulation of intravenous access should not delay transfer and can be carried out en route.

Table 4. Glasgow Coma scale (GCS).

RESPONSE	SCORE
Eye opening	
No eye opening	1
To pain	2
To speech	3
Spontaneously	4
Best verbal response	
None	1
Incomprehensible sounds	2
Inappropriate words	3
Patient confused	4
Patient oriented	5
Best motor response	
None	1
Extensor response to painful stimulus	2
Flexion to painful stimulus	3
Withdraws from pain	4
Localizes to pain stimulus	5
Obeys commands	6

Ideally, interventions at the scene should not take more than 10 minutes. In rural or distant areas, health care providers who arrive at an accident scene should carry out an initial triage of patients and solicit more resources depending on the type of accident, the number and severity of those victims involved. Once it is determined that a patient is critical and more resources are solicited for early transfer, then primary resuscitation measures can be performed and a secondary survey completed, while awaiting an ambulance or helicopter. Reevaluation of the patient involves detection of changes in LOC, clinical condition, vital signs, management of fluid therapy and analgesia, splinting of fractures. All these measures may facilitate smooth handing over of the patient once transfer commences.

Transfer may occur from the scene of the accident, local primary care centre, or secondary transfer from one hospital when more specialised care is needed. Transfer is a delicate link in the management of these patients and close vigilance of the patients condition may be jeopardised. Thus during transfer of the patient the patient should be reevaluated frequently especially after any changes in the clinical condition. A secondary survey can also be performed if time allows and other therapeutic measures should be carried out depending on the duration of transfer.

IF THE PATIENT IS NOT CRITICAL, HOW SHOULD WE PROCEED?

Secondary survey

Anamnesis and directed physical examination

The prehospital health care professional should complete the primary survey, identify potentially mortal injuries and initiate treatment and evalute the efectiveness of these interventions. Once the primary survey is completed then a secondary survey which consists of a brief head-to-toe examination of the patient is performed.

The objective of the secondary survey is to identify problems that are not potentially vital, using the *look, listen and feel* technique in all regions of the body. A summary of the secondary survey is shown in table 5.

The majority of vital injuries require hospital care and thus prehospital management should not delay transfer

WHERE SHOULD THE PATIENT BE TRANSFERRED TO? HOW SHOULD THE PATIENT BE IMMOBILISED?

Immobilisation of the spinal column

Once access is made to the trauma victim, stabilisation of he cervical spine should be performed. The reason for this is to prevent, if not already occurred, any spinal injury. In-line immobilisation of the cervical column is carried out and maintained with no traction until a cervical collar is placed. The cervical collar however does not completely relieve us of stabilising the neck. It should be recalled that the cervical collar limits flexo-extension and lateral movements but does not provide 100% immobilisation. The collar should not interfere with the ability of the patient to open the mouth or breathe[13].

Maneuvers to extricate the patient from the vehicle should be carried out with the cervical collar in place and manual in-line stabilisation maintained. Once the patient is placed on a long spinal board, then complementary head blocks should be added with strapping. Cervical spine immobilisation should also be accompanied by full spinal column immobilisation on a long spinal board.

The responsibility of cervical spine immobilisation should be assumed by one of the members of the rescue team. Preferably, neither the physician nor the nurse should be given this responsibilty, but rather ideally could be handed over to the ambulance technician who, by doing so, frees the rest of the team to focus on other aspects of management.

In victims of penetrating trauma, cervical immobilisation should be performed in cases of neurological abnormalities during the physical examination. In blunt trauma, spinal immobilisation is

Table 5. Secondary evaluation.

Anatomical area	Signs	Notes
Head	Evaluate scalp. open wounds, bleeding, bone displacement. Careful palpation of bone margins.	Skull base fractures: early signs: (hemotypanum, oto-rhino cerebro spinal fluid, conjuntival hemorrhage) and late signs: (racoon eyes, Battle sign).
Neck	Pain, crepitus, deformity and echimosis, emphysema at neck. Jugular vein distension. Ausculate carotid arteries for murmurs (possible dissection). Open or penetrating wounds.	Mantain in-line neutral stabilisation. Suspect pneumothorax if subcutaneous emphysema. If jugular vein distension, and tracheal deviation (suspect tension pneumothorax or cardiac tamponade).
Spine	Echimosis, pain, crepitus. Paralysis, paresthesia, rectal tone.	Auscultate posterior chest. To evaluate the spine, turn the patient on the side with coordination with the team.
Thorax	Pain, open rounds, abrasions, deformities and abnormal movements or assymetry in the chest wall. Bone crepitation, and subcutaneous emphysema. Seat Belt injuries. Auscultate anterior y lateral sides of chest.	Open pneumothorax. Tension pneumothorax. Cardiac tamponade. Hemothorax.
Abdomen	Hematoma. Distension, abrasions and echimosis. Abdominal guarding on palpation: low sensitivity and specificity.	Seat belt sign: suspect injury to duodenum and lumbar spine fractures (Chance fracture) Abdominal auscultation has little value.
Pelvis	Suggestive signs of pelvic fracture: pain, abdomino-pelvic distension, and unstability. Hemorrhage in urethral meatus, hemorrage in scrotum, defomities in lower extremities with shortening and external rotation, palpation of bone fragments in vagina and rectum. Ascended prostate gland.	Hematoma in expansion. If suspected pelvic fracture, do not palpate: immobilise, and wait to cofirm or rule out fracture from radiology.
Extremities	Pallor, pulses, weakness or paralysis, sensitivity.	Repeat examination and check pulse, etc., alter any maneuver or immobilisation of a limb.
Neurological examniation	Glasgow coma scale. Pupils (size, symmetry, and response to light). Sensory-motor examination (dermatomes-myotomes).	In case of neurological deficit, suspect spinal injury, immobilise and transfer.
History (AMPLE) **Vital signs**	**A**llergies. **M**edications. **P**ast medical history: COPD, heart failure (reduced cardiorespiraory reserve). **L**ast meal **E**vent.	Vital signs: Blood pressure, heart and respiratory rate, temperature, pulsioximetry, colour, GCS with re-evaluations every 5-10 minutes and at lesser intervals if changes are observed.

carried out in patients with abnormal level of consciousness (GCS<15), anatomical abnormality, motor or sensitive deficit, and pain on spinal percussion[22,23]. Immobilisation is also indicated when the injury mechanism is preoccupying, if there are signs of alcohol or drug intoxication, or in the presence of any distracting injuries (due to pain or profuse bleeding) or in case of inability for communication (due to age, disease or lack of fluency in the spoken tongue). In any case, the prehospital health provider should use careful judgement and in case of doubt apply spinal immobilisation where deemed necessary.

Transfer of the patient should be made to an appropriate centre, that is one which will resolve the majority if not all major injuries of the patient

Transfer

In patients in critical condition, early transfer is the foremost priority at the scene. Delay in initiating the transfer of critical patients should not be caused by any technique which can be performed en route.

Transfer of critical patients should be made to "appropriate centres", that is where both specialist and technical resources are available to manage the majority, if not all the injuries adequately. The availability of specialists in neurosurgery, thoracic and vascular surgery, etc., are often vital to resolve the problems of the trauma patient and thus the latter should be transferred to a center where these resources are available. Timing is also an important factor the prehospital provider should consider in relation with the condition of the patient. It may occur that a patient may require transfer to a district hospital where initially life saving surgical intervention and control of internal bleeding can be performed. Once resolved secondary transfer may be needed to a tertiary hospital to cover all the needs of the patient.

During transfer, after a primary survey and initial resuscitation measures, the patient should be continually monitored and vital signs recorded. The primary survey should be repeated during the journey and after any change in the condition of the patient. The re-evaluation of the ABCDE can help discover any other injury not detected earlier, or any change in the clinical condition of the patient.

Two fundamental aspects in the management and transfer of patients are pain management and psychological support. Infrequent use of opiod derivatives and fear that they may worsen respiration or cause hemodynamic instability limits the use of the agents. Drugs such as tramadol[24], fentanyl or morphine chloride administered intravenously and in progressive doses (for example, successive 2 mg doses up to a total of 10-15 mg of morphine chloride) will provide safe pain relief, making the transfer more bearable for the patient[25]. A professional approach and constant communication with the patient throughout management can transmit confidence and contribute to collaboration on the part of the patient and family members.

Lastly, it is important *communicate* with the receiving centre. The prehospital professional should alert and inform the receiving centre as soon as possible of the patient and an approximate time of arrival. It is crucial that the receiving centre is prepared beforehand. Once the patient is brought in, handing over should be accompanied by both verbal and written information. In the prehospital medical report, the injury mechanism and a complete account of events, time intervals, treatments and response to treatments should be detailed. In addition this medical report should serve as an indicator of the quality of prehospital management as well as a legal document relating all measures carried out during management. It is useful to remember that "whatever is not recorded in the medical report was not done at all".

Final note

The introduction of the Advanced Trauma Life Support (ATLS) courses is a landmark in the management of trauma victims[7]. The principles applied include first treating injuries that most threaten survival of the patient, and applying therapeutic measures to injuries without a definitive diagnosis. The ATLS has been directed principally by colleges of surgeons and the courses have extended worldwide. A great part of the contents of the present article has been based on ATLS principles and methodology.

Table 6. Summary of the management of prehospital trauma patients.

Priority actions	Evaluation	Indicators of severity
Safety at the scene	Need for more resources	**Some indications for airway intervention:** Glasgow<8, Severe head injury Extreme agitation Airway compromised Hemodynamically unstable Hipoxia depsite high flow oxygen Respiratory fatigue Inhaled burns
Primary survey **A** Airway **B** Breathing **C** Circulation and control of bleeding **D** Discapacity **E** Exposure	C-spine control, oxygen Detect signs of shock Glasgow, pupils, neurological deficit Control temperature Critical: Primary resuscitation, immobilisation, and early transfer Non critical: secondary survey, transfer	**Possible interventions in situ:** Tension pneumothorax: needle decompression Open pneumothorax: occlusive dressing (3 sides) Cardiac tamponade: early transfer Hemothorax: volume replacement, early transfer
Decision	Head-to-toe, not forgetting spine	**Findigs that indicate probability of severe trauma which may require early transfer:**
Evaluación secundaria AMPLE	**A**lergies, **M**edicacion, **P**ersonal history, **L**ast meal, **E**vent	**Age and previous co-morbidity**
Immobilisation **Transfer**	Transfer to an appropriate centre and early communication Pain management Re-evaluation	**Anatomical:** Facial injury (threatens airway) Flail chest Amputation Suspected pelvic fracture Neurological deficit Other associated injuries: burns Moderate-severe head injury **Physiological:** Respiratory rate <10 or >30 Glasgow<14 Systolic BP<90 mmHg Loss of radial pulse **Injury mechanism:** High energy and velocity Ejection from vehicle Death of accompanying passenger Fall > x2 patients' height Complicated extrication Penetrating trauma

However, in the last few years the adaptability of the ATLS to health systems in European countries and the rest of the world has been questioned, with the exception of the USA[26,27]. The critics consider that management of severe trauma patients in Europe is much more multidisciplinary involving professionals ranging from primary care, medicalised ambulances, emergency physicians, anaesthesiology, thoracic surgery, general surgery, intensive care, to traumatology and orthopedics. Thus they propose collaboration from all the implicated parts in the elaboration of a multidisciplinary approach. Since 2006, the European Resuscitation Council (ERC) in collaboration with other European scientific societies have initiated the European Trauma course that intends to cover the exposed deficiencies[28]. The impact of this course in the European context is yet to be seen.

In any case there is no doubt that an early responding, fast and systematic approach in prehospital management is necessary in whatever system as this greatly determines survival.

Conclusions

Management of trauma patients should be guided by some principles among which include:

The sum of actions carried out during the critical period is a determining factor in the short and long term survival of patients and posterior morbidity. Lost time consumes lives.

Priorities in management should be clear. Life prevails over function and this over aesthetics.

The aim of the primary survey is to detect (and treat) life-threatening injuries.

Treatment of the critical patient is nearly always hospital based and transfer to an appropriate center should not be delayed.

The absence of a definitive diagnosis should not impede the application of therapeutic measures.

Psychological suffering and pain should not be left unattended.

In all aspects of management take in to account the basic principle: primum non nocere.

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