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# Prehospital Emergency Care in Acute Trauma Conditions

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## Abstract

It is well known at this moment that a systems and systematic approach to trauma care cases is ideal. The prehospital controversies of in-the-field care in trauma cases, resuscitation, and transport, ground or air, are still debated. The most controversial is rapid transport to definitive care (“scoop and run”) versus field stabilization in trauma, which remains a topic of debate and resulted in great variability of prehospital policy. Emergency medical services, including ground and air transportation, significantly extend the reach of tertiary care facilities, leading to rapid transport of critically ill patients. Emergency medical services (EMS) providers are the first link to a trauma care system, and trauma triage made by EMS personnel is also a very important factor in a good outcome of trauma patients. The assessment of patient and the treatment delivered by the first medical crew could have a large impact over the clinical evolution and output of trauma patient; that way, it is necessary to apply a systematic approach in this pathology, guided by clear and simple-to-follow recommendations applied on the scene. Recent review of the literature on helicopter emergency medical services (HEMS) showed an overall benefit of 2.7 additional lives saved per 100 HEMS activations.

**Keywords:** trauma, primary assessment, trauma algorithm, prehospital care, HEMS, ground ambulance transfer

## 1. Introduction

Emergency management of a patient with multiple trauma is complex and takes place on several stages and successive levels, requiring a great deal of specialized forces and expertise, experience, and competence and carrying out a number of risks that crews have to know, consciously assume, and learn to control and avoid them.

Trauma is a consequence of an unexpected event, which appears sometime in plain health; that is why, one of the main goals is to return the patient to a level of function as close to preinjury as possible. The other goals of trauma patient management are to identify and treat first life-threatening injuries and to prevent exacerbation of existing injuries or the appearance of additional injuries [1–3].

We will present in this chapter the recommendation during primary assessment for trauma patients, treatment required in this point, and recommendation before and during transport.

There is a large consensus that the outcome for trauma patients is improved with a systematic, multispecialty, and interdisciplinary approach from prehospital and hospital care teams. The first approach in trauma patient will be different compared with the well-known approach applied to a nontraumatic patient, which includes anamnesis, medical history, clinical and paraclinical exams, a definitive diagnosis confirmed also by imagistic diagnosis, and follow-up after treatment.

The general principles for trauma patient management are as follows:

- Treat the greatest life-threatening injuries first.
- Definitive and complete paraclinical and imagistic diagnosis is not immediately important; there is enough to diagnose the presence of clinical signs.
- Time is very important (“trauma patients’ golden hour,” which emphasizes the importance of rapid sequences of diagnosis and treatment).
- Assess, intervene, and reassess [1, 2].

In prehospital, after the primary assessment and the beginning of therapeutic approach, the patient will be transported to the hospital to receive definitive treatment. The modes of transportation are represented by road or air transfer. The decision to use HEMS transfer depends on several important geographical, physiological, and pathological factors needed to be considered.

The transfer of a seriously injured patient by helicopter may be sometimes hazardous and transportation by road could be in some circumstances a better and safer option. Other factors, including the clinical skills and experience of the helicopter crews, also need to be considered. A good knowledge of the area, resources at and flight time duration to trauma center hospitals, and the location of the landing zones (if helipads exist or nearest landing sites) also need consideration. A detailed estimation of transport time from the scene to the hospital is required to assess if ground or air ambulance transfer will offer the fastest way of transport to hospital. [1–3].

When a helicopter is requested by a ground crew already on scene, helicopter crew preparation and flight times may delay transfer times further. So, considering all these factors, a ground ambulance transfer could be a faster mode of transport than secondary air ambulance transfer.

## **2. Primary assessment and management**

The management of the patient with multiple trauma should be carried out more than for other types of urgency, under the concept of the “golden hour,” referring to the first hour after the accident, during which the patient is advised to end up in a trauma center and receive definitive treatment. In this “golden hour,” the first 10 min from the time of the accident is called “platinum minutes”, precisely to highlight the importance in the traumatized patients’ economy and implicitly in deciding their chance of survival.

This is the densest time interval at the scene of the accident, the interval that decides the percentage of “avoidable deaths” in the trauma [1–3].

Because in these cases time is crucial, a systematic approach that can be rapidly applied is essential. This approach, named primary or initial assessment, includes the following steps:

- Triage in case of multiple victims
- Primary assessment—ABCDE—with immediate therapeutic measures for patients with life-threatening injuries
- Consideration of the need for patient transfer to a more specialized medical center
- Secondary survey, which includes a complete physical exam, “head-to-toe,” and patient medical history
- Continuous monitoring and reevaluation
- Definitive care

In this particularly complex gear, the chance of survival of a traumatized patient is also conditioned by the implementation of a specific “chain of survival,” which is represented by the following links described in **Figure 1**.

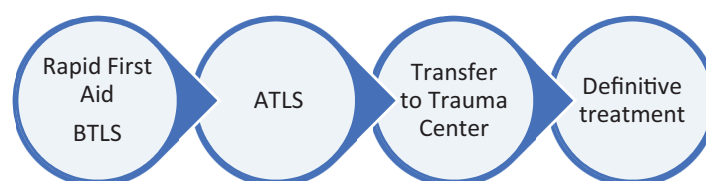
Posttraumatic cardiac arrest produces a very high mortality, but in patients with the return to spontaneous circulation, the neurological status of the survivors seems to be much better than in other causes of cardiac arrest.

The response to posttraumatic cardiac arrest must be rapid and success depends on a well-established chain of survival, which includes advanced care in prehospital and transport to specialized trauma centers. Immediate resuscitation efforts in posttraumatic cardiac arrest are concentrated on the simultaneous treatment of reversible causes, which have priority over sternal compressions [1–3].

The periarrest condition is characterized by cardiovascular instability, hypotension, absence of peripheral pulse in nontraumatized areas, and a level of consciousness deteriorating without being due to the central nervous system. Untreated, this condition will progress to cardiac arrest.

Focused assessment with sonography in trauma (FAST ultrasound examination) can be helpful in diagnosis and management, but it should not delay resuscitation efforts [4].

It is vital that a medical cardiac arrest should not be attributed to a posttraumatic cardiac arrest and this must be treated under the universal ALS algorithm. Cardiac arrest or other causes of sudden loss of consciousness (e.g., hypoglycemia, stroke, and seizures) may be the cause of secondary traumatic effects [1–3].



**Figure 1.**

*Trauma chain of survival; BTLS, basic trauma life support; ATLS, advanced trauma life support.*

## **2.1 Diagnosis**

Diagnosis of the posttraumatic cardiac arrest is only clinical. The patient has agonistic respiration, the absence of spontaneous breathing, and the absence of central pulse.

## **2.2 Mobilization and transport of traumatized patients**

The means of transport of patients play an important role in the specific care of these patients, transport being an integral part of the therapeutic attitude toward them.

It is also very important to know that choosing and using an inadequate means of extraction or transportation can compromise the rest of the therapeutic benefits of therapy and hence the chances of patient survival or functional recovery.

The criteria for choosing the means of transportation for these patients are as follows:

- Type of clinical situation (medical or traumatic)
- Profile and complexity of lesions
- The workspace, the ability to improvise certain types of grooves
- The quality of the access road to the destination hospital
- The need to adopt particular transport items
- The need to decide in the case of accidents with multiple victims

Particular transport positions:

- Trendelenburg—lying on an oblique plane with lower limbs higher than the head—patient in shock
- Dorsal decubitus, with perfect spine immobilization—patient with multiple trauma

All means of transport used by prehospital rescuers must have several features such as the following [1–3]:

- Easy to handle
- Light
- Not breakable
- Easy to clean
- Strong
- Having adequate dimensions at the waist of the patient

The means that can be used to transport patients are as follows:

- Stretcher
- Rigid stretcher
- Brancards
- Vacuum mattress

In HEMS transport, particular care should be provided to the hemodynamic status of patients, and a periarrest situation should be avoided because of the big difficulty of performing high-quality CPR during flight (the space for medical crew and patients is very limited in most helicopters used for medical missions).

Because of this, a systematic approach is recommended, and the crew should assess the patient carefully and deliver medical treatment for all the situations that can induce cardiorespiratory arrest during flight. To achieve this goal, we recommend using the following algorithm, utilized for primary assessment of trauma patients, which will help the medical crew to have a systematic and standardized approach [1, 2]:

- Airway
- Breathing
- Circulation
- Disabilities
- Environmental

### **2.3 Airway assessment and management**

Ensure an open airway and protect the cervical spine.

The release and maintenance of a free airway are priorities in the treatment of any patient.

If the patient is conscious and speaks effortlessly and without overdrive sounds, the airway is probably not obstructed. If the sound is distorted or the patient makes an important effort to talk, it means a compromised airway: snoring suggests mechanical obstruction, while gurgling indicates the presence of fluid in the air (blood, secretions, and vomiting). In case of laryngeal lesions, hoarseness and/or dysphonia may occur [1–3].

The unconscious patient, with an unassured airway, may suddenly present obstruction when the base of the tongue falls into the hypopharynx. In addition, the absence of the gag reflex is an important risk for aspiration to the unconscious patient and should be a signal for the need of orotracheal intubation.

Oxygen will be administered as soon as the airway has been opened and secured by means, methods, flows, pressures, and flow adapted to the situation. In some cases, complex ventilation management is required: mechanically assisted or controlled ventilation, intratracheal aspiration, pneumothorax, adequate positioning, and stabilization of flail chest, without which simple ventilation assistance or control fails to achieve or even worsen mood [1–3].

Even in traumatized patients who spontaneously breathe, the oxygen will be administered rapidly on the face mask with a reservoir at a rate of 10–15 l/min, to obtain an  $\text{FiO}_2$  of over 85%.

Before transporting the patient, be sure that the following conditions are fulfilled [1, 2, 5]:

- Insert an airway or endotracheal tube, if needed. Proceed to orotracheal intubation in patients with altered GCS, less than 9, but also even equal or above, when there are conditions for potential deterioration during transport, especially in case of air transport.
- Use or be prepared for suction at airway level.
- Place a gastric tube in all intubated patients and in nonintubated patients with evidence of gastric distention. Decrease by all means the risk of vomiting and aspiration.

## **2.4 Breathing evaluation and control**

Breathing assessment addresses the following major issues: the presence of spontaneous breathing, its efficacy, the respiratory rate, the pathological types of respiration requiring correction or the immediate ventilator support, and the existence of signs suggesting the existence of these highly potential lethal lesions [1, 2, 5]:

- Obstruction of upper airways
- Tension pneumothorax
- Open pneumothorax
- Flail chest
- Massive hemothorax

Detecting these lethal lesions urgently requires appropriate management, as described below:

### *2.4.1 Tension pneumothorax*

For tension pneumothorax, treatment can be started with needle decompression, is fast, and can be performed by most personnel on ambulance but has a limited value. The thickness of the chest wall makes decompression ineffective in a significant proportion of patients. The cannula is also prone to twisting and jamming. Any attempt to decompress with a needle should be followed by the introduction of a chest drainage tube [1, 2, 5].

Next in line is the simple thoracostomy, which is easy to perform, and it consists of the first stage of insertion of the chest drainage—a simple incision and rapid dissection in the pleural space. The insertion of the chest drain is then performed. This requires additional equipment; it takes longer to carry it out and creates a closed system that has the potential to re-tension. Also, the risk of chest drainage tubes becoming clogged by blood clots exists.

We want to emphasize that a simple pneumothorax can be transformed into a tension pneumothorax when a patient is intubated and positive pressure is ventilated before decompressing the pneumothorax with a chest drainage tube! [1, 2, 5].

#### 2.4.2 Open pneumothorax

For initial management of an open pneumothorax, promptly close the defect with a sterile dressing large enough to overlap the wound's edges. Any improvised occlusive dressing may be used as temporary measure to enable rapid assessment to continue. Fix it with tape on only three sides to provide a flutter-valve effect. As the patient inhales, the dressing occludes the wound, preventing air from entering. During exhalation, the open end of the dressing allows air to evacuate from the pleural space, and the patient will remain with a small pneumothorax. Taping all four edges of the dressing can cause air to accumulate in the thoracic cavity, resulting in a tension pneumothorax unless a chest tube is in place. Place a chest drainage tube (not on the wound!) as soon as possible [1, 2, 5, 6].

#### 2.4.3 Massive hemothorax

Management of massive hemothorax require the insertion of a chest drain tube, the blood from pleural space, (if pleural space is not contaminated) can be collected in a collector bag and utilize for auto-transfusion on site if necessary [1, 3].

#### 2.4.4 Flail chest

The outcome of flail chest injury is in function of associated injuries. Isolated flail chest may be successfully managed with external stabilization, but in severe flail chest, it is recommended to use also internal stabilization measure (positive end-expiratory pressure—PEEP ventilation), until thoracic surgical intervention [1, 2, 5, 7].

If there is a suspicion that airways cannot be maintained opened or there is a lesion that causes or has potential to cause inflammation at the pharyngeal level, orotracheal intubation is indicated before the development of ventilator dysfunction.

The general indications of advanced airway management in traumatized emergency patients are as follows:

- Apnea
- GCS below 9 or above, but decreasing by more than 2 points/hour
- Severe or moderate cranial trauma, to prevent secondary brain injury
- Severe facial trauma—Le Fort II/III
- Airway burn with the development of glottis edema
- The need for hyperventilation, including neurological trauma/hyperoxygenation in severe intoxication with CO
- Grade III-IV hemorrhagic shock
- Respiratory rate greater than 35/min
- Arterial gases: PaO<sub>2</sub> below 70 mmHg, PaCO<sub>2</sub> above 55 mmHg
- The need for general anesthesia (including stabilization of the cervical spine, access to the surgery room, and transfer or transport to long-term investigations)
- Pulmonary aspiration risk due to gastric reflux



Before transporting patients, be sure that the following conditions are fulfilled [1, 2, 5]:

- Assess the quality of breathing and administer supplementary oxygen.
- Use mechanical ventilation when needed.
- Insert a chest tube if needed. It is mandatory for patients with pneumothorax (diagnosed or suspected) to have a chest drainage tube placed when they are being moved by air transport.

## **2.5 Circulation evaluation and fluid resuscitation**

Blood volume, cardiac output, and active bleeding are major circulatory issues to consider. Active hemorrhage is one of the most important causes of preventable deaths after a trauma event, immediately after tension pneumothorax.

Cardiac output can be severely decreased because of cardiac tamponade, and this is the other important finding in circulation assessment, after trauma events [1–5].

### *2.5.1 Bleeding*

Identifying, quickly controlling hemorrhage, and initiating fluid resuscitation are crucial steps in assessing and managing circulation.

The following are the elements that provide information over the quality of the circulation during the primary assessment:

- The level of consciousness
- The color of the skin
- Pulse (quality, frequency, and regularity)

Tachycardia and hypotension are usually signs of hypovolemia. Any clinical shock signs in a traumatized patient will be assumed and treated at first as a hypovolemic shock and may be accompanied by other forms of shock encountered in the trauma: neurogenic and obstructive shock due to suffocating pneumothorax and/or cardiac tamponade.

For the early treatment of hypovolemic shock, place 2 i.v. cannulas (at least 14 g), stable and safe, at the peripherals, and start crystalline and colloid administration if necessary.

The hemostasis of the visible and approachable bleeding sources should be performed: first by applying direct pressure on the wound followed by compressive bandage, hemostatic substances, or in extremis a tourniquet. The use of tranexamic acid in the prehospital setting improved survival when this drug is administered within 3 h of injury. The first dose is usually given over 10 min and is administered in the field; the follow-up dose of 1 g is given over 8 h [1, 2, 5, 8].

For internal hemorrhages, especially intra-abdominal, hemodynamic compensation cannot be obtained even if large volumes of solutions are administered, so the patient should be transported as quickly as possible to the trauma center for emergency surgery, assisting vital functions.

Administration of type O negative blood outside the hospital, although controversial, may be a savior measure for internal hemorrhages with the loss of over 40% of the circulating volume or where hemodynamic stabilization cannot be achieved by massive administration of crystals and colloids in 10–15 min [1–5].

### 2.5.2 Cardiac tamponade

Cardiac tamponade can develop slowly, allowing for a less urgent evaluation, or rapidly, requiring rapid diagnosis and treatment. The classic clinical triad of Beck, muffled heart sounds, hypotension, and distended jugulars veins, is not uniformly present with cardiac tamponade. Muffled heart sounds are difficult to assess in the noisy environment, and distended neck veins may be absent due to associated hypovolemia. When cardiac tamponade is diagnosed, emergency thoracotomy or sternotomy should be performed by a qualified surgeon as soon as possible. Administration of intravenous fluid will improve cardiac output transiently. If surgical intervention is not possible, pericardiocentesis (guided by ultrasound if possible) can be therapeutic, but it does not constitute definitive treatment for cardiac tamponade [1, 3, 5, 9].

Before transporting a patient, be sure that following conditions are fulfilled:

- Control external bleeding and when a tourniquet is used note on a label the time of placement.
- Establish two large-caliber intravenous lines and begin crystalloid solution infusion.
- Restore blood volume losses using crystalloid fluid and blood and continue replacement during transfer.
- Insert a urinary catheter to monitor urine output.
- Monitor the patient's cardiac rhythm and rate.

### 2.6 Disability (neurologic evaluation)

A rapid neurologic evaluation will establish the patient's level of consciousness by using Glasgow Coma Score (GCS), will assess pupillary size and reaction to light, identifies the presence of lateralizing signs, and should assess the presence of spinal cord injury and the level of the injury, if it is present.

The control of the spine and especially of the cervical spine is initiated with the primary evaluation of the vital functions, respectively with the opening of the airways, from the first contact with the patient [1, 3, 5].

This element is extremely important, as it is known that amielic lesions of the cervical spine can easily transform into mielic lesions by inappropriate maneuvers or mielic lesions may worsen (including hypoxia, edema, or hypovolemia) leading to medullary sections. Patients who will benefit from cervical column immobilization are those [1, 3, 5]:

- who are involved in road traffic accidents;
- who are involved in a fall from height;
- who require extrication measure (usually in car accidents);
- who are traumatized with obvious injuries to the throat from striking, shooting, or stabbing;
- whose symptomatology indicates a cervical spine injury (localized pain in the spine, functional impotence, limb paresthesia or anesthesia, priapism, bulbo-cavernosus reflex, anal reflex, upper abdominal skin reflexes, etc.);

- who are in a mentally altered status, when the mechanism of production of the traumatic event cannot be specified.

In all these patients, the methods of protection and then immobilization of the cervical spine, as well as the special methods of extraction, mobilization, and transportation of traumatized patients, will be applied as follows [1, 3, 5]:

- Manually protecting the cervical spine by keeping the head, neck, and trunk in the axle. Manual control of the cervical spine will be maintained throughout the orotracheal intubation, which, in case of suspected cervical lesion, is a difficult maneuver, requiring Sellick maneuver.
- The stiff neck will be placed immediately after the manual fitting of the head. The stiff neck is used to protect the column against flexion-extension movements, less than the lateral and almost none of the rotation, which is why the manual protection should be maintained even after the stiff neck is placed.
- The rigid column strap with head side stabilizers and the front and lumbar fastening bands is used to achieve complete immobilization of the spine after patient evaluation and airways management have been performed and the patient is ready for extraction and transport.
- The vacuum mattress is an alternative to the rigid stretcher, especially for the patient with multiple trauma who also presents the instability of the pelvic area.

Before transporting a patient, be sure that the following conditions are fulfilled [1, 3, 5]:

- Secure airway and assist breathing in unconscious patients.
- Administer mannitol or hypertonic saline, if needed.
- Restrict spinal motion in patients who have or are suspected of having spine injuries.

## **2.7 Exposure and environmental control**

During the primary assessment, undress the patient and it is advisable to cut off clothes to facilitate a thorough examination and assessment without producing or aggravating injuries. Watch out for hypothermia; this situation can appear very fast in a trauma patient [1, 3].

After completing the assessment, cover the patient with warm blankets or an external warming device to prevent developing hypothermia. Because hypothermia is a potentially lethal complication in case of trauma patients, take all the measures necessary to prevent the loss of body heat and restore body temperature to normal.

Also, during this final step of primary assessment, if it is possible, it is recommended to find the circumstances that produce the traumatic event (trauma cinematics). According to this finding, it is possible to presume that the most probable injury occurred after the traumatic event.

## 2.8 Final general aspects

The number of patients who developed cardiac arrest caused by trauma or accidental injury is increasing, and the number of potentially preventable prehospital deaths produced in traumatic circumstances seems to remain statistically high, despite major advances achieved in trauma care.

Bystanders witness the event in most of the cases, but while making the call for medical assistance, first aid intervention of any kind is infrequent. It is clear that there exists a time following injury when the bystander has an opportunity to provide first aid before the arrival of the EMS, which could potentially improve outcomes. The window of instructions provided by the dispatch to the witness could improve the surviving rate and output of the trauma patient (e.g., recommendation to move a trauma patient, if permitted, and how to move him correctly, and recommendation of how to correctly open and maintain a clear airway). Lay personnel first aid measure including simple airway management and ventilation support during this window of time without any therapeutic measures could significantly improve survival.

The prehospital care community needs to agree to a consensus on how to define and determine the preventability of death in the prehospital phase and to enable detailed study of each of the prehospital phases in order to improve current practice [9, 10].

It is described in literature that implementation of a physician-staffed helicopter was associated with significantly reduced delay for arrival at the level I trauma center of severely injured trauma patients. The proportion of secondary transfer and 30-day mortality were also significantly reduced [11, 12].

The preponderance of recent and previous scientific evidence supports an argument that the HEMS transport is associated with significant benefit for some injured patients. The primary challenges at this moment include the determination of which patients benefit and to find of which aspects of the HEMS are responsible for any salutary effects of its utilization [13]. A top-level type of prehospital care had significantly more chances to resuscitate blunt trauma victims found in CA as compared with a simpler level [14].

Also, there are evidence of an association between helicopter transport mode and increased survival in blunt trauma patients [15].

Anyway, the role and structure of HEMS in the modern trauma service are a debate that is likely to continue. Prehospital care design should be specific to critical incident frequency, geographical particularity of hospital facilities, and travel times within each trauma network. It is also important to consider the benefits, expertise, and capabilities of the emergency medical team separately from the transport method.

An effective HEMS intervention will ultimately depend on effective operating procedures and tasking protocols, clinical governance, and auditing of the HEMS activity. Future work in this area should also examine the costs and safety of HEMS, since multiple contextual determinants must be considered when evaluating the effects of HEMS for adults with major trauma [16–18].

## 3. Conclusions

A systematic approach following a standardized protocol is recommended to be applied in case of trauma patients.

The actual recommendation is to assess quickly, at the first contact, the patient (primary assessment), delivering at the same time the necessary treatment for life-threatening situations. The approach algorithm for this primary assessment is described as ABCDE approach (Airway, Breathing, Circulation, Disabilities, and Exposure).

All the life-threatening injuries should be recognized during primary assessment and the required treatment should be applied as soon as possible, without any delay.

This step will be followed by a secondary assessment, this time a complete clinical examination, concomitant with continuously monitoring vital function, and frequent reassessment.

Obtaining intravenous access, beginning fluid resuscitation, and applying oxygen from the first moments could be lifesaving measures, and this simple procedure creates time for more complex and definitive procedures.

Providing advanced airway management is one of the top priorities of trauma care. Management of difficult airway requires technical expertise, but also, the decision of when and how to approach airway is equally important, which are the determinants of outcome. Again, we want to emphasize that a pneumothorax will be transformed into a tension pneumothorax, which can be followed by cardiac arrest, if a patient is orotracheally intubated and mechanically ventilated before decompressing the pneumothorax with a chest drainage tube.

Another essential thing to do during patient transfer is prehospital information delivery by radio or phone to the receiving hospital. This report should include the cause and the circumstances of the accident, the patient's condition upon arrival of the emergency physician on scene, medical measures provided at the site of the accident and during transport, prior diseases and any history of patient if available, and complications.

The role and structure of HEMS in the modern trauma service are still in a debate that probably will continue. Prehospital care needs to be specific to critical incident frequency, geographical situation of hospital facilities, and travel times necessary to reach the nearest trauma center. Also, it is very important to consider the benefits and capabilities of the emergency medical team separately from the transport method.

An effective transport care (using ground transport or helicopter) will ultimately depend on effective operating procedures and trauma protocols, clinical local guides, and auditing of the crew's (ambulance or helicopter) EMS activity.

## **Conflict of interest**

The authors declare no conflict of interest.

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