

Prehospital Trauma Care: a Clinical Review

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*"Time stays long enough for anyone who will use it."
Leonardo da Vinci*

Rezumat

Evaluarea și managementul inițial în cadrul pacientului traumatizat – etapa prespital

Introducere: În zilele noastre există multiple controverse legate de îngrijirea pacientului traumatizat pe parcursul perioadei prespital. Dată fiind heterogenitatea personalului care acordă primul ajutor și variabilitatea protocoalelor folosite între diferite țări, nu a fost stabilit efectul benefic al suportului vital avansat, aplicat în perioada prespital, asupra morbidității și mortalității.

Metodă: Review sistematic al literaturii folosind cautarea computerizată în baza de date National Library of Medicine and the International Institutes of Health MEDLINE, folosind interfața Entrez PubMed. Am selectat articolele ce abordează suportul vital de bază sau avansat, acordat pacientului traumatizat, pe parcursul perioadei prespital.

Rezultate: Deși organizarea sistemului medical de urgență este diferită în diferite state, gradul de îngrijire acordat pacientului poate fi încadrat în două mari categorii: Suport Vital de Bază (Basic Life Support - BLS) și Suport Vital Avansat (Advanced

Life Support - ALS). Există numeroase studii care evaluează amploarea gesturilor ce trebuie efectuate la locul accidentului. Cele două extreme ale îngrijirii prespital sunt: "stay and play/treat then transfer" sau "scoop and run/load and go".

Concluzii: Cel mai probabil un echilibru între "scoop and run" și "stay and play" reprezintă cea mai bună abordare a pacientului traumatizat. Modul de abordare trebuie decis în funcție de mecanismul lezional (contuzie versus traumatism penetrant), distanța față de centrul de traumă (mediu urban versus rural) și gradul resurselor disponibile.

Cuvinte cheie: traumatism, prespital, evaluare inițială

Abstract

Introduction: There are many controversies related to the trauma patient care during the pre-hospital period nowadays. Due to the heterogeneity of the rescue personnel and variability of protocols used in various countries, the benefit of the pre-hospital advanced life support on morbidity and mortality has been not established.

Method: Systematic review of the literature using computer search of the Library of Medicine and the National Institutes of Health International PubMed Medline database using Entrez interface. We reviewed the literature in what concerns the basic and advanced life support given to the trauma patients during the prehospital period.

Results: Although the organization of the medical emergency

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system varies from a country to another, the level of patient's care can be classified into two main categories: Basic Life Support (BLS) and Advanced Life Support (ALS). There are many studies addressing what to be done at the scene. The pre-hospital care can be divided into two extremes: stay and play/treat then transfer or scoop and run/load and go.

Conclusions: A balance between "scoop and run" and "stay and play" is probably the best approach for trauma patients. The chosen approach should be made according to the mechanism of injury (blunt versus penetrating trauma), distance to the trauma center (urban versus rural) and the available resources.

Key words: trauma, prehospital care

Introduction

Since their inception, the human being suffered injuries through falls, fire, drowning and interpersonal conflict. While the mechanism and frequency of different specific injuries has changed passing of millennia, trauma remains an important cause of mortality and morbidity in modern society (1). Trauma meets the conditions of a pandemic, 5.8 million people dying every year and 8.4 million being expected in 2020. Trauma is one of the main five causes of mortality and morbidity for all age groups below 60 years (2). In order to increase the chance of survival for severely injured patients, the emergency medical system must provide high quality medical care and rapid transportation to a corresponding trauma center. According to the current medical literature, the trauma patient resuscitation was divided into two time periods: "the 10 platinum minutes" and "the golden hour" (3,4). The "10 platinum minutes" represents the time period during which the emergency medical personnel should address the airways, should hinder the exsanguination and during which the critical patient should be transported from the trauma scene. The "golden hour" represents the time interval during which the trauma team should identify all the trauma lesions and address all the life threatening injuries. Nevertheless, in many emergency medical systems, the patients spend this extremely important interval of time during prehospital setting (3,4). It has been suggested that the role of emergency medical system is to ensure the proper pulmonary ventilation, thereby ensuring a proper tissue perfusion (4). Although the organization of emergency medical system varies between different countries, the level of care for trauma patients can be divided into two main categories: Basic Life Support (BLS) and Advanced Life Support (ALS). Basic life support assumes the management of injured patients by noninvasive methods. The principles of Basic Life Support assume release of the airway, oxygen supplementation, cardiopulmonary resuscitation, stopping of the external bleeding, immobilization of the fractures and of the spine. The main goal of the BLS is to maintain cardiac and respiratory function during patient's

transportation to the trauma center, without causing further damage (5). Advanced Life Support involves the use of invasive procedures for initial management of trauma patients: more sophisticated procedures for airway management, cardiac monitoring and defibrillation, intravenous catheterization and drugs administration (5). Many current studies have shown improved survival for injured patients, cared by prehospital teams which include emergency medicine physicians in their composition (6,7). On the other hand, in the severely injured patients, the rescue team should restrict to a minimum the number and type of therapeutic procedures performed at the scene, because they are time consuming from the "golden hour" of the patient (8). For the prehospital setting, it is generally accepted that the patients from the rural areas, where transportation time from scene to definitive treatment is longer, benefit most from the rescue teams that include trained physician. In urban areas, the survival of trauma patients is improved by rapid transportation to a trauma center and to a lesser extent by the rescue team composition (physicians on scene versus paramedics) (9,10). There are numerous studies in the current medical literature, assessing the extent of maneuvers to be made at the scene (11). The two extremes of prehospital care are "stay and play/treat then transfer"- the patient is stabilized at the scene, then transported to the hospital or "scoop and run/load and go"- patient transportation to a trauma center as soon as possible without trying to stabilize him at the scene. The strategy "stay and play" includes to bring the technology to the patient and its stabilization at the scene: (1) securing the airway by endotracheal intubation, (2) tube thoracostomy, (3) ensuring the intravenous lines and starting the fluid resuscitation therapy (9). The strategy "scoop and run" entails as shortest as possible transportation to the trauma center, managing the immediately life-threatening injuries in the ambulance during transportation (12). The strategy "stay and play" is generally used in European countries while the strategy "scoop and run" is used mostly in the United States. There are also emergency medical systems that combine these two ideas: conducting limited therapeutic maneuvers at the scene then transportation, performing the critical maneuvers in the ambulance, on the way to the hospital. This model is colloquially called "scoop and play" (3). Therefore, according to this approach, the emergency physicians may need to introduce a tube thoracostomy during transport by ambulance (9). The proponents of "stay and play" protocol argue that airway obstruction is a common cause of death secondary to trauma and this can be prevented by a careful on scene approach (9). The patients with traumatic brain injuries seem to benefit most from the prehospital stabilization, because in this group of patients the hypoxia aggravates the neurological injury. In a group of patients with traumatic brain injury and Glasgow Coma Scale < 8, the mortality was 23% in patients stabilized on the scene (including endotracheal intubation) and 50% of those approached according to "scoop and run" protocol (endotracheal intubation in the hospital) (9,13). The supporters of "scoop and run" management argue that the only thing that is proven to increase survival is a decrease in time until definitive

treatment in a corresponding trauma center (9,14,15). Starting from this ideas, many specialists think that a balance between "scoop and run" and "stay and play" protocol is the best approach for a trauma patient. The approach for prehospital care should be decided according to the mechanism of injury (blunt versus penetrating trauma), the distance to a trauma center (urban versus rural areas) and the level of available resources (16, 9). Most studies highlighting the benefits of "scoop and run" approach come from the United States. The patients included in these studies are generally from urban areas, with a high rate of penetrating injuries. As these patients often require surgical control of the hemorrhage, shortening the time to the operating room by "scoop and run" approach seems to be very appropriate (9, 17-19). However, as increasingly more evidence is collected and the trauma systems become more mature, it is suggested that Advanced Life Support increases the length of time spent at the scene and the interval to definitive treatment. This is significantly important for patients requiring surgical hemostasis. Therefore, spending time inserting intravenous catheters, fluid replacement therapy, anti-shock trousers, increases morbidity and mortality through failure to actually stop the bleeding. Therefore the prehospital care should focus on a fast and safe transport to a trauma center. The time spent at the trauma scene should be as short as possible, ensuring airway patency and immobilization of the cervical spine only. The intravenous catheters should be inserted during transport (20). (Fig. 1)

Primary survey

Assessment of the trauma scene

Careful assessment of the trauma scene is very important to determine the mechanism of injury, the number of trauma patients and to find the potential hazards for rescuers.

Initial assessment

The initial assessment of the victims is started immediately after it was established that there is no danger for rescuers. The goal of this initial evaluation is to find the immediately life-threatening injuries (Table 1). Although during the initial assessment the lesions should be treated as they are discovered, the experience has shown that most errors occur because the leader of the rescue team discontinues the initial assessment to

perform therapeutic maneuvers (5). Hence the recommendation that the rescue team leader should carry out the initial assessment to the end and if necessary, therapeutic maneuvers are made by another member of the rescue team. The initial assessment has to be stopped to perform therapeutic maneuvers in three situations only: (a) the trauma scene becomes dangerous, (b) airway obstruction, (c) cardiac arrest. The respiratory arrest may be addressed by another rescuer, while the team leader continues the initial assessment (14). For critical patients, the rescue team should focus for a period of time of less than 5 minutes at the scene (14).

Assessing the level of consciousness and cervical spine protection

The trauma team leader should approach the patient from the front, in order not to force him to turn his head and thus exacerbating a possible cervical spine injury. If the mechanism of trauma suggests a spinal injury, a second member of the rescue team should stabilize the head and neck. A third member of the team will protect the spine with a cervical collar. If the neck is in a vicious position and patient experiences pain on very gentle straightening movement, then it should be fixed in this position. In unconscious patients with the neck in abnormal position, if gentle maneuvers will not strength the head, then it should be fixed in this position (14). The trauma team leader should start the conversation with the victim with: "My name is We are here to help you. Can you tell me what happened?". Depending on how the patient answers the rescuers may assess the status of consciousness and the airway patency (14). Spinal immobilization should be done for the entire column and not just for the cervical spine, by setting the victim on a rigid stretcher for transport. The scenarios with an increased risk for spinal cord injury are: the plunge into the water, the falls from the horse and traffic related accidents with posterior impact. Spinal immobilization may not be required in conscious patients, without vertebral column pain, without intense pain in another body region, distracting from neck pain, and with no neurological deficits (tingling, numbness, etc.) (20).

Airway assessment

During the prehospital care of trauma victims, as much as 66%-85% of preventable death occur by airway obstruction

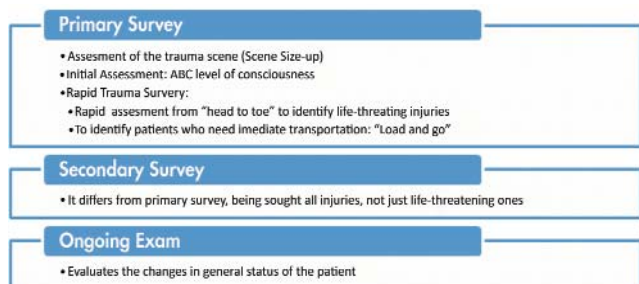


Figure 1. Pre-hospital care according to International Trauma Life Support (ITLS) (12)

A - Airway	Basic and advanced maneuvers for proper protection of airway patency
B - Breathing	Thoracostomy tube
C - Circulation	Vascular access lines, fluid replacement therapy, inotropic and vasopressor support
D - Disability (neurological status)	Cervical spine protection
E - Extra info and environmental protection	Drugs, allergies. Protect the patient from the cold / warm

Table 1. Initial assessment during the prehospital phase (7)

(4,9). The airway management is of paramount importance in patients with traumatic brain injury, cervical spine lesions and chest trauma. Any member of the rescue team should be able to manage an obstructed airway in a trauma patient: the manual cleaning of the upper airway by foreign materials, to open the airway by lifting the chin and jaw thrust maneuvers, to aspirate the oropharynx and to introduce the nasopharyngeal or oropharyngeal tubes (5). The first maneuver to be performed are chin-lift and jaw-thrust maneuvers, in order to prevent the tongue and soft palate to obstruct the hypopharynx. If a cervical spine injury is suspected, one can use the chin-lift maneuver and bag-mask ventilation, with great care to prevent neck extension (Fig. 2).

The profuse bleeding secondary to facial trauma, the vomiting and the dental fragments can obstruct the airways and require suction or extraction. The oropharyngeal and nasopharyngeal airways can ensure the airway patency by elevating the tongue, but should be used with caution because they can induce vomiting and pulmonary aspiration. In patients with skull base fractures, the nasopharyngeal tube can contaminate the cerebrospinal fluid with bacteria from the airway. When the airway is obstructed by a foreign body, it should be removed, under direct visualization, using a Magill forceps (Fig. 3).

In this setting, if the extraction fails, endotracheal intubation should be attempted. In rare cases, if the patency of the airway is not obtained, a cricothyroidotomy may be necessary. Endotracheal intubation is still the gold standard for airways protection in a pre-hospital condition. This maneuver is indicated for: (a) airways obstruction not solved by direct laryngoscopy, (b) respiratory distress, (c) neurological status alteration (GCS < 8), (d) cardio respiratory arrest. If the rescuers are not trained to perform endotracheal intubation or the maneuver is unsuccessful, Combitube double lumen endotracheal tube or laryngeal ventilation mask can be used. These devices can be "blindly" introduced into the pharynx or larynx. Percutaneous cricothyroidectomy should be performed in hospital – a large gauge needle should prick the skin and is introduced through cricothyroid membrane. Classic cricothyroidectomy should be finally performed only when other methods failed and the patient cannot be ventilated – the medical personnel need special training for this technique. Few studies showed that hypoxemia has a negative impact over the traumatic brain lesions; these patients need rapid endotracheal intubation for airways protection (22). A San Diego retrospective study revealed an improvement of the survival in brain damage patients with precocious endotracheal intubation (57% versus 36%) (22). Then, this scientific work led to a prospective study where the patients with GCS < 8 have been intubated by rapid technique – the study has been stopped because of the excessive mortality among the intubated patients (33% versus 24%) (15,22). Later tests revealed that this high mortality could be explained by hyperventilation not by the technique of endotracheal intubation (22). A recent study of the aerospace medical system in San Diego showed an improvement of the results for brain damage patients with endotracheal intubation because of the end-expiratory continuous CO₂ monitoring (hyperventilation has



Figure 2. Bag-mask ventilation system

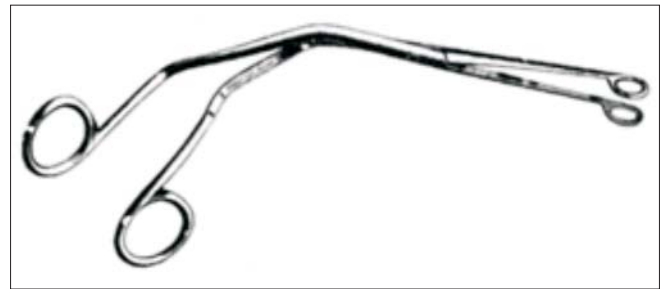


Figure 3. Magill forceps - used for extraction of foreign bodies from the upper airways

been stumbled upon to appear) (22). Stiell et al. presents 598 patients with cerebral trauma and GCS < 9: the survival rate was lower in patients with Advanced Life Support (including endotracheal intubation) as compared to patients with Basic Life Support (51.2% versus 60.1%) (23). The high level of mortality and lack of benefits for trauma patients due to pre-hospital endotracheal intubation can be explained by temporary hypoxia and bradycardia during the time of rapid intubation (24). Dunford et al. presents 54 pre-hospital rapid intubated patients, 57% of these having a 22% average decrease of the oxygen saturation, between 48 and 271 seconds. 19% of the patients also had a decrease in the heart rate under 50/minute (25).

Respiratory evaluation

Ventilation must be assisted when a patient has a hypoventilation due to superficial breathing or to decreased respiratory rhythm under 10/minute (20). Brain damage patients must be ventilated with a normal frequency and current volume, avoiding hyperventilation and decrease of the peripheral arterial CO₂ saturation and, consequently, the decrease of the cerebral blood flow. Ventilation should be performed so the peripheral arterial CO₂ saturation will be between 30-35 mmHg (3,26). For an adult, normal respiratory rate is 16/minute and the current volume is 500-800 ml (5,20). Positive pressure ventilation may enlarge a tension pneumothorax. This condition requires a quick pleurotomy with chest drain tube or, at least, needle decompression in the second intercostal space – these maneuvers have to be performed by trained personnel. Tension pneu-

mothorax appears rarely after concussion trauma but more frequent after a penetrating thoracic trauma.

Circulation evaluation

When a trauma patient is hemodynamically unstable, this patient must be quickly transported to a trauma centre (20). Hemodynamic instability is a very often used term, but quite little understood. Systolic blood pressure of 100 mm Hg may be a normal value for a 20 years old patient but very low for a 75 years old trauma victim (27). Most of the bleedings can be stopped by direct pressure over the hemorrhagic area. If this maneuver is not solving the problem, than a tourniquet should be immediately applied on the proximal segment (5,28). For a shocked patient, intravenous catheters must be inserted during the transportation in order not to waist time at the crash scene. For incarcerated victims, venous pathways can be realized during the release. Anti-shock pneumatic clothes or anti-shock military pants can be useful for medical management of the shocked status occurring after pelvic bones fractures or continuous bleedings on pelvic limbs. These devices have 3 compartments, inflated to 60-80 mmHg pressure, which are compressing the lower limbs, pelvis and abdomen (20). Femoral fracture immobilization can decrease the blood loss on the site of the fracture (20). Pre-hospital Trauma Life Support (PHTLS) recommends no resuscitation or mild resuscitation but no massive intake of isotonic intravenous fluids, as before 90s (29). This algorithm is also recommended by The Battlefield Advanced Trauma Life Support (BATLS) which is indicating a hypotensive resuscitation, enough for conscious status maintenance or for radial artery pulse presence (systolic blood pressure around 80 mmHg) (29). The eighth edition of the Advanced Trauma Life Support (ATLS) Protocol for Hospital Critical Care Units, recommends the insertion of two large intravenous cannulas, with isotones electrolytes solutions administration to rapidly reestablish a normal blood pressure (starting with 2 liters of crystalloid solutions) (29). If the bleeding cannot be surgically stopped, the increasing blood pressure along with coagulation factors dilution (due to crystalloid solutions administration), will increase the bleeding. This will lead to an increased need for crystalloid solutions, risk of coagulopathy by dilution and hypothermia – as a consequence, a vicious circle will occur (9). In 1994, Bickell et al. reports 598 patients with penetrating trunk wounds and blood pressure less than 90 mmHg – 309 (62%) of them received standard volemic resuscitation therapy (both in pre-hospital stage – average crystalloid solutions volume 870 ml, as well as in hospital – average volume 1608 ml). 289 patients received intravenous fluids only after they reached the Operating Room – delayed volemic resuscitation. These last patients registered a higher survival rate (70% versus 62%, $p=0.04$), a lower complications rate (23% versus 30%, $p=0.08$) and a shorter hospitalization time (30). Demetriades et al. showed that the mortality of the patients with severe trauma (ISS > 15) is higher when these patients are transported by emergency medicine mobile units than they are transported by non-specialized personnel (relatives, witnesses, police) (28.2% versus 17.9%, $p<0.001$) (31). While PHTLS

Table 2. Fluid resuscitation therapy based on clinical data (3,23)

Suspected injuries based on clinical examination and the mechanism of trauma	The targeted systolic blood pressure (SBP - mm Hg)
Uncontrolled bleeding in the thorax, abdomen, retroperitoneum	80 to 90
Injury to the central nervous system	90
Controlled external bleeding with secondary hemorrhagic shock	Rapid infusion of 1-2 L of crystalloids, to normalize SBP and heart rate If the patient becomes hypotensive again - TAS=80 to 90 mm Hg

and BATLS are recommending hypotensive resuscitation and ATLS recommends normotensive resuscitation, there are no data regarding long term results of these two different approaches. In urban areas, due to a short time transport to a trauma center, the adverse effects of the hypotensive resuscitation are probably minimal. On the other hand, late effects of the hypotensive resuscitation must be taken into account in rural areas or battlefield trauma, where the time for transport is much longer. Definitely, it is better to be alive due to long time hypotensive resuscitation than to die due to an excessive resuscitation (29). Clinical data can be useful for fluid resuscitation protocol (Table 2) (5,26). Lewis imagined a computerized model and established the conditions when the intravenous fluids administration is beneficial: (1) bleeding rate between 25-100 ml/minute, (2) pre-hospital time more than 30 minutes, (3) the fluid intake rate should be equal to the bleeding rate (32). For severe trauma patients, the concept of damage control resuscitation is arriving, same like damage control surgery (29,33). This damage control resuscitation concept includes the acceptance of blood hypotension, prevention and aggressive treatment of the hypothermia, acidosis control, fresh frozen plasma / red blood cell transfusion 1:1 administration, precocious administration of platelets, precocious using of the recombinant VII a factor (29,33).

Rapid examination

Rapid examination is performed to detect any life-threatening conditions. A complete evaluation will be performed later, when possible, during the Second Survey.

The first rapid evaluation should be performed as it follows: (a) Head and Neck: Inspection and palpation are looking for lesions, dilated jugular veins, if the trachea is on the midline of the neck, (b) Thorax: asymmetric movements are noticed; pulmonary murmur is auscultated – if this is asymmetric, percussion should be performed in order to establish the presence of the pneumothorax or hemothorax; heart sounds are auscultated, (c) Abdomen: trauma marks, abdominal distension, peritonism (d) Pelvis: pain and instability of the pelvic bones, (e) Limbs: deformities, abnormal mobility; check if the patient can move toes before they are placed on the stretcher, (f) When the patient is placed on the stretcher back

lesions are checked, (g) Vital signs are evaluated: blood pressure, pulse and respiratory frequency; if the patient is in a critical state, rapid transportation is the right decision and vital signs will be evaluated on the way to the closest trauma center, (h) A short anamnesis will be taken: symptoms, allergies, drugs, medical history, last meal, pre-trauma events, (i) If the patient has an altered neurological status, a short neurological examination should be performed: pupils, Glasgow Coma Score (GCS), signs for cerebral hernia (34).

Decision for transport and critical care treatment

After Initial Evaluation and Rapid Examination, the trauma team leader has enough data to detect a critical condition which needs immediate transportation. Critical care treatment must be performed during the transportation (Fig. 4).

Secondary survey

The Secondary Survey consists in a detailed examination, which is looking for all the lesions in a trauma patient, not only for the life-threatening ones. It should be performed: (a) during the transport, after managing the life-threatening lesions of the critical patient who is now stable, (b) on trauma scene if the Initial Evaluation is not revealing any critical lesions and the patient is stable, (c) in the hospital if the patient could not be stabilized and needed further urgent intervention.

The stages of the Secondary Evaluation are:

1. Repeat the Initial Evaluation.
2. Vital Signs evaluation: respiratory rate, pulse, blood pressure and; monitoring devices are necessary.
3. Neurological examination:
 - Glasgow Coma Scale;
 - Pupils of the eyes;
 - Motor reflexes;
 - Sensitive reflexes.
4. "Head to toe" examination:
 - Head: search for trauma marks, burns, wounds, mouth inspection, airways evaluation.
 - Neck: search for trauma marks, jugular veins dilations, tracheal deviation.

- Thorax: paradoxical movements, costal crepitations, pulmonary murmur, cardiac noises.
- Abdomen: search for abdominal distension, pain on palpation, peritonitis signs.
- Pelvis and limbs: check for pulse, movements and sensibility distal to the fracture site; fractures immobilization.

If critical lesions are noticed during the Secondary Evaluation, the transport is decided immediately.

Continuous surveillance and re-evaluation

Re-evaluation is performed during the transport, every 5 minutes for the critical patient and every 15 minutes for the non-critical patient, in order to early detect any change in patients status.

1. Mental status re-evaluation.
2. ABC re-evaluation:
 - a) airways;
 - b) respiration;
 - c) circulation.
3. Re-evaluation of the abdomen.
4. Re-evaluation of the initial diagnosis of the lesions.
5. Re-evaluation of the inserted catheters, endotracheal tube, splints, monitoring devices.

Conclusions

The prehospital care of the severely injured patients represents a component of utmost importance in all trauma systems, due to its major impact on early and late morbidity and mortality secondary to trauma. The organization of this system varies widely, being very few prospective randomized studies on which to base patient's management outside the hospital setting. The rescue team leader ranges from minimally trained first responders to physicians specialized in acute care surgery or trauma anesthesia. Errors in the prehospital arena, as in others, include those of omission and those of commission. Both types of errors are avoidable with careful attention to defined principles of the approach to the patient. Only the combination between a mature prehospital system and a trauma center will provide a good professional care and will offer the best possible outcomes. The design of the prehospital care should be distinctive for the trauma epidemiology in a specific area, geographical characteristics of hospital facilities and travel times within each trauma network.

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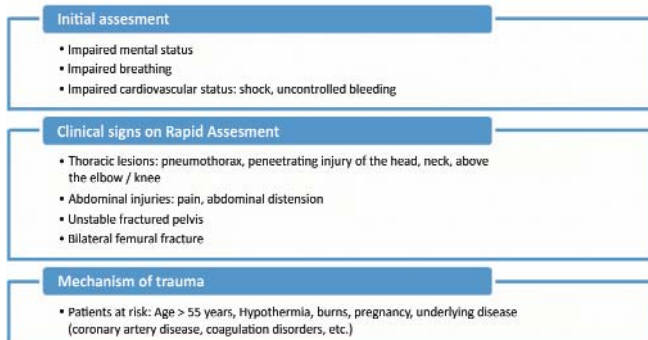


Figure 4. Indications for immediate transport of the patient (time spent at the scene <10 minutes) (3,12)

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