Pre- and Initial Emergency Medical Care for Head Injured Patients: A European Perspective

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We have defined the goals of Emergency Medicine as follows:
1. to create a special functional structure for the care of all medical emergencies;
2. within this structure, to assure as a top priority the limitation of mortality (early and late) and morbidity (single or multiple organ failure) and disability, through **early** diagnosis and therapy of life- organ- or limb-threatening conditions caused by illness or injury (Delooz H.H.: Emergency medicine: an anesthesiologist's concept, Bailliere's Clinical Anesthesiology 1992, 6 (1): 1 -23).

The key term in this definition is **early.** The time period during which oxygen deficit accumulates determines both mortality and morbidity (Guyton A.C. & Crowell J.W.: Dynamics of the heart in shock. Federation Proceedings 1961, 10:51; Shoemaker W.C., Appel P.L. & Kram H.B.: Tissue oxygen debt as a determinant of lethal and non-lethal postoperative organ failure. Critical Care Medicine 1988, 16: 1117-1120).

Therefore, Emergency Medicine is concerned with both the pre-hospital emergency care and the immediate in-hospital care. The aim of pre-hospital care is to reduce to a minimum the therapy-free interval.

As stated in the Manifesto for Emergency Medicine in Europe, published by the Council of the European Society for Emergency Medicine (European Journal of Emergency Medicine, 1998, 5 (1): 7-8), «Emergency medical care of high quality should be available to every person in need in all situations and at all times. This requires a **dedicated system** which provides care for all acutely ill or injured people in an appropriate form.»

Because the time factor is a key issue, care of a high standard, consistent with current knowledge and provided within a system, requires **protocol** development, especially when the care is provided by a multidisciplinary team (report to the Second World Conference on Injury Control, May 1993).

The protocol defines what has to be done, in which order and by whom. Part of the protocol can be turned into «standing orders» when the pre-hospital care is delegated to ambulance technicians, paramedics or specifically trained nurses. According to Webster's Dictionary, standing orders are «a series of instructions remaining in force until countermanded or repealed by a proper authority, especially not subject to change by an officer temporarily in command».

This definition points to the fact that both standing orders and protocols are a list of a minimum of acts, to be performed on any patient fitting the condition for which the protocol has been developed. The protocol can be used as a means of quality control, by comparing the actual actions carried out with the prescribed sequence of events. However, this use of the protocol will only serve as an a-posteriori quality assurance: any error identified will hopefully benefit the

TRAUMA CARE PROTOCOL

Coordination of protocol: **emergency physician (EPh)**
Execution of protocol: **anesthetist (Ane), trauma surgeon (TrS), neurologist (Neu), radiologist (Rad) and E.D. nurse (ENu)**

PRE-HOSPITAL

FIRST PRIORITY: Airway control

- maintenance of a free airway is mandatory (EPh - ENu)
  ! if necessary, oro-tracheal intubation under direct laryngoscopy and immobilization of the head;
  check GCS - movements of the 4 limbs
- immobilize the cervical spine with a cervical collar (EPh - ENu)
- note respiratory frequency (ENu)
- controlled ventilation = normoventilation - optimal oxygenation (EPh - ENu)
  ! patients in coma, in shock and with major multiple trauma
- thoracocentesis: mid-clavicular, second intercostal space (EPh - ENu assisting)
  needle/drainage set
  ! spontaneous ventilation = clinical suspicion of tension-pneumothorax
  ! artificial ventilation = clinical suspicion of pneumothorax and/or obvious subcutaneous emphysema

SECOND PRIORITY: Circulation

- evaluation of circulatory activity (EPh - ENu):
  - carotic and femoral artery; CPR if necessary
  - peripheral circulation - capillary refill
  - ECG monitoring or pulse-oxymetry
  - BP control if possible (ENu)
- IV (EPh - ENu)
  - min. 14 Gauge - max. access-time : 2 minutes
  - Hartmann- plasma substitute (Gelofusine)

1. blunt trauma = IV
2. Penetrating trauma of chest = no IV
3. Head injury = maintenance of adequate systolic systemic BP is mandatory

THIRD PRIORITY: Neurological status and immobilization

- Glasgow Coma Scale (Revised Trauma Score) (EPh)
- further immobilization with cervical collar (if not performed in first priority) and vacuum mattress (EPh - ENu)
  vacuum mattress for
  - all unconscious victims
  - all victims with suspicion of spine injuries, pelvic or femur fractures
- sterile dressing of wounds and staunching of hemorrhages (ENu)
- reposition and immobilization of fractures with pneumatic splints and/or vacuum mattress (EPh - ENu)
- announce arrival of trauma victim(s), GCS and RTS to the E.D. (EPh)

IN-HOSPITAL(for all patients; for secondary transfers check available evidence)

1. CHECK PRE-HOSPITAL PRIORITIES

1.1. General evaluation: (EPh, TrS, ENu)
- airway control, ventilatory pattern, frequency and symmetry
- consciousness (GCS), active movement of 4 limbs
- color and temperature of extremities, pulse and bloodpressure

1.2. Re-evaluation of all pre-hospital invasive techniques
- endotracheal intubation, IV (EPh)
- thoracocentesis, immobilization and haemostasis of severe bleedings (TrS)

1.3. Blood sampling and additional IV-access (min. 14 Gauge) and blood sampling + typing and cross-match (EPh/Ane - ENu)

2. **FAST RESPONSE TO NEUROLOGICAL STATUS**

2.1. Neurological check +note (Neu)
- pupils, GCS, active moments, minimal reflexes
- determination of an urgent indication for CT scan of the skull (see 6.3)

2.2. GCS ≤ 8 or M ≤ 5:
- sedation - analgesia - muscle relaxation (EPh/Ane)
- controlled ventilation = normocapnia

3. **PATIENT IN SHOCK =** cold, clammy, pale or cyanotic extremities

3.1. extra IV-access = upper extremity and/or rapid infusion catheter (v. jug. int. - v. subcl. - v. femoralis) (EPh/Ane - ENu)
plasma substitute max 2 l Gelofusine and 2 l Hartmann

3.2. packed cells O neg and top priority typing + cross-match (EPh)

3.3. call surgical supervisor NOW. (TrS)

4. **PATIENT IN SHOCK OR NOT IN SHOCK**

4.1. gastric tube; if suspicion of skull base fracture, oral placement. (ENu - Ane)

4.2. RX in therapy room (Rad - ENu - TrS - Ane)
- RX-thorax (a - p)
  ! diaphragm and mediastinum are not ideally visualized in lying position
- cervical spine including C7 - Th1 (profile)
  ! pull on arms / swimming position
- pelvis (a - p)
- echography of abdomen, only to visualize presence of fluid (max. 2 min.)
- other RX-examinations to be done later in RX-room

4.3. Thoracocentesis for pneumo- and/or haemothorax:
mid-axillary line - 5th intercostal space (TrS - ENu assisting)
  ! careful auscultation of the thorax before insertion

4.4. Bladder catheter (ENu):
  ! if pelvic fracture and/or lesion at the level of the external genital area:
  the trauma surgeon has to perform catheterisation or decide on suprapubic puncture

5. **IF SHOCK PERSISTS** and external blood loss or blood loss through the thoracic drain are not evident as cause:

5.1. Perform NOW abdominal paracentesis (TrS)
  if echography was not conclusive and/or a long surgical procedure is expected
  if the patient has a penetrating injury of the abdomen
Leave material in place if paracentesis is negative

5.2. Decision on life-saving surgery to be made on available evidence by surgical supervisor

5.3. Announce arrival to OP: supervisor anesthesiology: 18/44605 (EPh/Ane)

5.4. Announce arrival to OP: supervisor nursing: 43030 (TrS)

6. **IF NO INDICATION FOR LIFE SAVING SURGERY EXISTS AND IF THE CIRCULATORY STATUS IS STABILIZED**

6.1. Complete examination of the patient (TrS - Neu - EPh/Ane)

6.2. Determine indication for other technical investigations (TrS - EPh):
- arteriography or TEE if enlarged mediastinum following a high energetic impact
- CT-scan of skull and/or spine, pelvis, thorax,....
- RX total spine
- other investigations

Determine indication for consults: ophthalmology, otorhinolaryngology, maxilla-facial surgery, neurosurgery ..... (TrS - EPh)

7. **ARTERIAL LINE** (EPh/Ane)
- for BP monitoring and repeated blood sampling
- radial artery, brachial artery, femoral artery

8. **URGENT SURGERY** is decided by surgical supervisor consulting anesthetist
- announce patients to OP (TrS)

9.1. ! Tetanus prophylaxis (TrS)

9.2. ! Prophylactic antibiotic therapy if indicated (EPh/Ane)

ACTIONCARD TRAUMA PROTOCOL EMS / PREHOSPITAL SETTING		
EMERGENCY PHYSICIAN		**EMERGENCY NURSE**
1. Consider own safety situation at scene nature of trauma		
Evaluate 1. consciousness 2. respiration 3. circulation	**2**	**Make visible** 1. torso 2. pelvis 3. limbs
Note 1. GCScale 2. active limb movement	**3**	**Note** respiratory rate
Maintain free airway **Oxygenate** **Intubate** and **Ventilate**	**4** *If COMA, SHOCK, SEVERE MULTIPLE TRAUMA:*	**Prepare** 1. suction airways 2. oxygen therapy 3. bag + mask **Immobilize manually** head and neck **Assist** ventilation
5. Immobilize (cervical collar) head and neck		
Order needle and drainage set **Proceed**	**6.** *Consider thoracocentesis*	**Prepare** needle and drainage set **Assist**
Note 1. peripheral circulation 2. systolic blood pressure 3. pulse rate	**7**	**Ensure monitoring** 1. pulse oxymetry 2. ECG
Place 14 G IV access	*If NO penetrating trauma:* **8**	**Assist and prepare** Hartmann/Gelofusine
Note 1. GCScale 2. RTS 3. fractures, wounds and hemorrhages	**9**	 **Dress** wounds **Staunch** hemorrhages
Consider sedation and analgesia **Reposition** limb fractures **Splint** limb fractures	**10** **Immobilize in vacuum mattress**	**Prepare** sedatives and analgesics **Assist** **Prepare** splints **Assist**

next patient. If the protocol, however, is the result of multidisciplinary discussion of the evidence available from the literature, from own data such as the results of a Major Trauma Outcome Study and from personal observation and experience, then the protocol will be carried out through the engagement of all the participants and thus serve as a means of a-priori quality improvement. Of course, any protocol will require periodical discussion and review.
Finally, commonly agreed protocols will serve as a means of ethically acceptable cost-containment, through the identification of real futility, while aiming at the most efficient and effective medical care (Delooz H.H.: Ethical issues in critical care: criteria for treatment in «Critical choices and critical care», K. Wm. Wildes (ed.), Kluwer Academic Publishers, 1995: 79-101; Morris A.H.: Paradigms in management in «Pathophysiologic foundations of critical care», R. Pinsky and J.F. Dhainaut (eds.), Williams & Wilkins, 1993, 192-206).
Individual protocols will have to be adapted to the concrete organization of the pre-hospital and immediate in-hospital care.
In our system, the pre-hospital care is provided by a two-tiered system. The first tier consists of an ambulance technician and a specifically trained nurse while the second tier is provided by a nurse with the same qualifications, plus an emergency physician. Both the emergency physician and the emergency nurse are active within the Emergency Department and leave from the department for the scene of the emergency. The second tier is either requested by the regulator of the regional emergency medical service dispatching center or by the ambulance crew on the scene. In the ED we have among others a permanency of anesthesia, trauma surgery, radiology and emergency medicine. A neurologist is on call in the hospital and sees all the neurological and neurosurgical emergencies in the ED.
This information on organization is mainly of interest when looking at the attribution of acts to individual actors within the protocol, it does not influence the identification, nor the sequence of the acts to be performed.
The protocol as presented here is the most recent version and differs from earlier versions (Delooz H.H.: Organization and implementation of emergency services in the treatment of major trauma. Journal of Neurotrauma 1991, 8 (suppl): S7-S12).
For practical purposes the protocol can be transcribed in an action card, as illustrated by the action card carried in a plastified version by the second tier of our EMS system.

It is clear from this protocol that neurotrauma in general and head injury in particular are considered parts of an over-all trauma protocol. This is mandatory, as associated injuries, which may require lifesaving surgery, can only be ruled out or diagnosed through the diagnostic steps described in the protocol. On the other hand, the maintenance of optimal vital functions and especially oxygen transport is of utmost importance for any trauma patient and even more so for the patient with a head injury.
As part of a Major Trauma Outcome Study (MTOS) carried out over a period of two years, we noted the first clinical impression of the emergency physician when seeing the patient either at the scene or in the ED. As illustrated in table 1 both cyanosis (hypoxemia) and shock (hypoperfusion) were highly significant and independent predictors of survival. Our observations of trauma patients in general thus corroborate the observations made in the Traumatic Coma Data Bank (TCDB) (Chesnut RM, Marshall LF, Klauber MR, Blunt BA, Baldwin N, Eisenberg HM, Jane JA, Marmarou A, Foulkes MA (1993) The role of secondary brain injury in determining outcome from severe head injury. J Trauma 34:216-222).

The same MTOS illustrated the efficacy of **multidisciplinary trauma care according to a commonly agreed protocol:** comparison

Table 1: MTOS Leuven - Outcome

First clinical impression (pre-hospital or ED		Mortality	
agitation	yes	23/177	13%
	no	135/2625	5%
shock	yes	69/167	**41%**
	no	89/2635	**3,4%**
cyanosis	yes	40/73	**55%**
	no	118/2729	**4,3%**
asym. respir.	yes	32/147	22%
	no	126/2655	4,7%
subcut. emphys.	yes	9/36	25%
	no	149/2766	5,4%

Independant predictors of outcome. Log-Rank test p< 0.0001

of our outcome data with those of USA trauma centers showed an extra survival of 8 patients out of 1000 victims and this difference is statistically significant (Figure 1).

Figure 1: TRISS standardized W with 95% confidence limits

Table 2 shows that both trauma populations are comparable as far as the patient fractions per prediction of survival (Ps) range are concerned.

It is important to note that we included every patient cared for by an emergency physician, even if he died on the spot or during transport to the ED, whereas the USA MTOS only includes patients arriving alive at the ED.

We conclude with some of the features of Emergency Medicine as listed in the **Manifesto for Emergency Medicine in Europe:** «Emergency medicine encourages collaboration between all members of the health care team. An efficient chain of care requires liaison with pre-hospital care providers, hospital specialists and other staff and also with community medical and nursing staff and social workers. Team work is essential and must involve close cooperation and integrated facilities for protocol development and implementation, teaching and research.

However, the speciality of emergency medicine will only realize its full potential when qualified emergency physicians possess the authority to

Figure 1: TRISS standardized W with 95% confidence limits

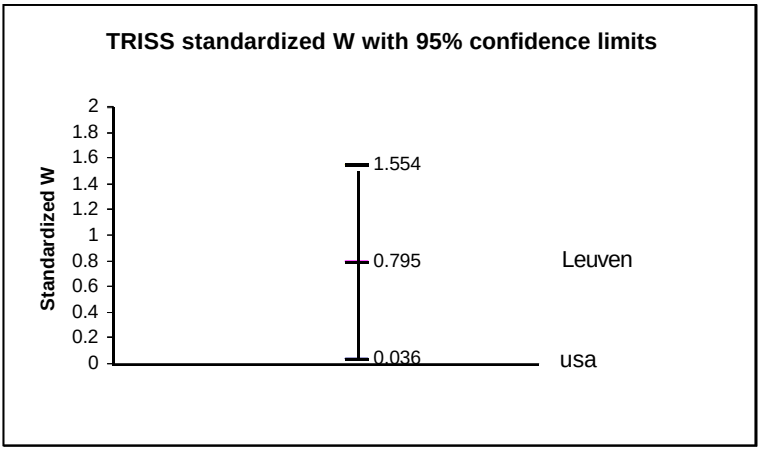

Table 2 : MTOS Leuven - M statistic for complete database with complete data (n = 2663)

Ps range	U.S. norm pt fraction	Leuven pt fraction
0.96-1.00	0.828	0.831
0.91-0.95	0.045	0.068
0.76-0.90	0.044	0.037
0.51-0.75	0.029	0.018
0.26-0.50	0.017	0.017
0.00-0.25	0.036	0.030
	1	1

M = 0.975 > 0.88

direct the emergency care that patients receive and accept responsibility for the outcome of that care. These physicians must have a similar responsibility for the management of the environment in which emergency care occurs».
These features will enable us to realize the objectives of the European Society for Emergency Medicine:

- to provide an integrated system of pre-hospital, in-hospital and inter-hospital emergency care to standardize and to improve the quality of emergency medical care;
- to reduce the mortality, morbidity, disability and suffering associated with injury and sudden illness;
- to research into the nature and treatment of medical emergencies;
- to collect epidemiological data which relate to the prevention of accidents and to health promotion;
- to study the epidemiology and the management of major incidents and disasters and to participate in the planning for such circumstances;
- to study the ethical problems involved in emergency medical care and to provide guidelines for decision making.

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