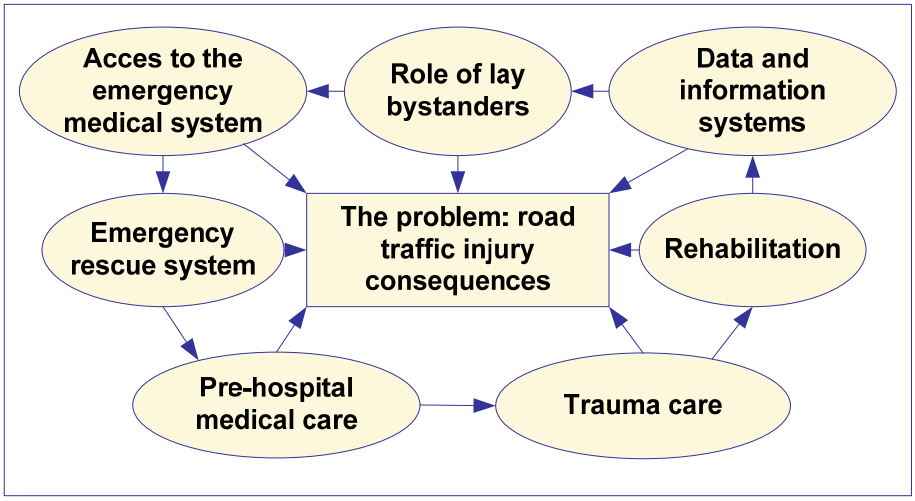
Post Impact Care

Please refer to this document as:
European Road Safety Observatory (2006) Post Impact Care, retrieved March 20, 2007 from www.erso.eu

1. Post impact care – the chain of help

Diagram & Summary



Post-impact care is a strategy which aims to reduce the severity of injury consequences once a road traffic crash has occurred. Minor injury patients will often need the help of a general practitioner and optimal medical and psychological follow up care is important to alleviate pain and distress. For major injuries, clinical experts define the post-impact care needed as the chain of help starting with action taken by the victims themselves or more commonly by lay bystanders at the scene of the crash, emergency rescue, access to the pre-hospital medical care system, and trauma care and helping road crash victims who have suffered debilitating injury re-integrate into work and family life. The effectiveness of such a chain depends upon the strength of each of its links [7].

Despite the fact that the cost of years of life lost from road trauma is larger than from cancer or cardio-vascular diseases, the attention paid by health policymakers, by the medical community and by the road safety field to trauma-related care and research has been disproportionately small so far. The European Commission has stated that several thousands of lives could be saved in the EU by improving the response times of the emergency services and other elements of post- impact care in the event of road traffic accidents [12].

Nevertheless, over the last 30-40 years improvements have been seen in post-impact care in several countries ranging from improvements in emergency medical response systems to advanced trauma care procedures to specific surgical intervention techniques [16][43]. While studies analysing the relationship between the performance of the trauma management system and road crash outcomes are not frequent, research indicates that various improvements have contributed to better injury outcomes [43][46][44]. In a review of 1970-1996 data in several OECD countries it is suggested that between 5% and 25% of the reductions in road crash fatalities may have been due to improvements in medical care and technology (including trauma and emergency response systems) [43].
The main sources of information for this outline comprise: in particular, a review of post impact care by medical experts from across the European Union [7] ; a review of studies by

Elvik and Vaa [16]; the World Health Organization's pre-hospital care guidelines [50], essential care guidelines [36] and World Report on Road Traffic Injury Prevention [48] and a recent unpublished overview of research produced within the SafetyNet project.

2. The problem: road traffic injury consequences

2.1 Road traffic deaths and injuries

During 2005 there were around 41,600 road deaths in the European Union (25) with a fourfold difference in highest and lowest death rates per 100,000 population [14]. Involvement in road accidents is one of the three leading causes of death and hospital admission for EU (12) inhabitants (together with cancer and coronary heart diseases), and it is the leading cause of death for EU citizens under 50 years old [17]. It has also been estimated that for EU (12) countries [49]:

- 1 in 3 citizens will need hospital treatment during their lifetime due to road crashes
- 1 in 20 citizens will be killed or impaired by road crashes
- 1 in 80 citizens will end their life 40 years too early due to road crashes
- Road crashes cause 6 months shorter life expectancy

2.2 Health of survivors and long term disability

While information on road traffic deaths is available in most European countries, there is no systematic information which can be compared on the health of survivors. There are a variety of definitions of 'serious injury'; many serious injuries are not reported [45]; data on the long term health consequences of road traffic injury is not collected on a systematic basis; and while rating systems have been devised and are in use, there are no international standards for describing and quantifying the disabilities arising from traffic injuries, particularly those involving neurological trauma [27].

The World Health Organization uses a severity ratio guideline of 15 serious injuries (requiring hospital admission) and 70 minor injuries for every road death. The European Federation of Road Accident Victims has estimated that a minimum of 150,000 survivors in road crashes sustain permanent disability in EU (15) countries every year. Disability is usually defined as an individual's inability to carry out a normal range of daily activities due to physical and/or psychological sequelae. Permanent disability, such as paraplegia, quadriplegia, loss of eyesight, or brain damage, can deprive an individual of the ability to achieve even minor goals and result in dependence on others for economic support and routine physical care. Less serious – but more common – injuries to ankles, knees and the cervical spine can result in chronic physical pain and limit an injured person's physical activity for long periods. Serious burns, contusions and lacerations can lead to emotional trauma associated with permanent disfigurement. Road crashes can also result in a variety of long-term psychiatric and psycho-social problems [48].

In-depth studies indicate that:

- Motor vehicle crashes are the leading cause of traumatic brain injury [48]
- The majority of whiplash injuries are sustained by car occupants in crashes, and around 50% of these are in rear impacts [28]
- 22% of a sample of patients attending hospital with fractures to the upper or lower limb, or a soft tissue injury to their cervical spine ("whiplash") had some form of disability 4 years after the crash [37]

- Pedestrians and motorcyclists suffer the most severe injuries as a result of motor vehicle collisions, report more continuing medical problems and require more assistance, compared with other types of road user [48].

2.3 Socio-economic costs and the value of prevention

The socio-economic cost of fatal, serious, minor injuries and taking into account intangible elements is estimated to be about 2% of EU countries' gross domestic product - around Euro 180 billion and twice the EU's annual budget.

Many national estimates, however, do not take account of the cost of long-term disability resulting from road traffic accidents and associated intangible costs. Injuries reported as being minor at the time of crash can often lead to costly long term disability. One British study [37], which contributed to subsequent national accident cost estimates, monitored the costs to the Health and Social Security services of treatment of patients with whiplash and fractures over a 4 year period. For fracture injuries, the largest single cost to the Health Service was in-patient treatment and for 'whiplash' patients physiotherapy was the largest single cost. Long term disability also brings, however, many intangible costs to the patient and family.

2.4 Time between road crash and road death?

A study by medical experts in European high-income countries found that about 50% of deaths from road traffic crashes occurred within minutes, either at the scene or while in transit to hospital. For those patients taken to hospital, around 15% of deaths occurred within 1-4 hours after the crash, but around 35%, occurred after four hours [7].

Three phases of deaths from severe injury
Phase 1.Deaths occur immediately or occur quickly as a result of overwhelming injury;

Phase 2 Deaths occur during the intermediate or sub-acute phase. These deaths occur within several hours of the event and are frequently the result of treatable conditions;

Phase 3 Deaths are delayed. Deaths during this phase often occur days or weeks after the initial injury and are the result of infection, multisystem failure or other late complications of trauma.

World Health Organization, 2005

In reality, as the World Report on Road Traffic Injury Prevention [48] underlined, there is not so much a "golden hour" [29] in which interventions have to take place as a chain of opportunities for intervening across a longer timescale. A comparative study of mortality among seriously injured patients across a range of countries found that for low-income and middle-income countries, the vast majority of deaths occurred in the pre-hospital phase [35].

2.5 Survivable and non-survivable road traffic injury?

A Swedish study into survivability in fatal road traffic crashes concluded that 48% of those who died sustained non-survivable injuries. Out of the group who sustained survivable injuries, 5% were not located in time to prevent death, 12% could have survived had they been transported more quickly to hospital and a further 32% could have survived if they had been transport quickly to an advanced trauma centre [23]. A UK study estimated that 12% of

road crash victims with serious skeletal trauma went on to have significant preventable disability [33]. The appropriate management of road casualties following the crash is a crucial determinant of the chance and quality of survival.

2.6 Post impact care and national road safety plans and targets

While post impact care is acknowledged as a key road safety strategy, it is often neglected in national road safety plans and programmes in European countries. This may be because it is outside the direct responsibility of the lead agency for road safety which is generally the Ministry of Transport. Good inter-governmental coordination arrangements can ensure that attention is given to this key area in target-setting and plans. New Zealand, for example, targets a specific reduction in hospitalizations, the number of people hospitalized for more than one day and the number of people hospitalized for more than three days. Improving trauma management systems is one of the priorities of the Road Safety to 2010 strategy (Land Transport Safety Authority Wellington 2003).

3. The role of lay bystanders

3.1 The first link in the chain of help

The chain of help begins, according to the World Health Organization, with those who are present or who arrive first at the scene of a crash. Lay bystanders can play an important role in various ways, including:

- Contacting the emergency services, or calling for other forms of help
- Helping to put out any fire
- Taking action to secure the scene (e.g. preventing further crashes, preventing harm to rescuers and bystanders, controlling the crowd gathered at the scene)
- First aid e.g. unblocking airway obstruction. One of the most common causes of death for road crash victims is anoxia – a lack of oxygen supply – caused by blocked airways which take, on average less than 4 minutes, to prove fatal according to the British Red Cross.

3.2 Do commercial and public transport drivers need first aid training?

While basic first-aid training for commercial and public transport drivers and trained community first responders in rural and remote locations is recommended by the World Health Organization [50], it has not been scientifically established whether such a measure would decrease pre-hospital mortality. EC Directive 2000/56 provides for the requirement of first aid training and refresher courses for professional drivers.

3.3 Would first aid training for the general public help?

The Word Health Organization holds the view that training of specially selected community volunteers and other lay professionals could be valuable. However, there is no strong evidence that basic first aid training by drivers and members of the public would decrease pre-hospital mortality. There is, also, concern that unless there is in-depth knowledge of basic life support techniques, more harm might be done than good. At the same time, the level of cost to provide the necessary in-depth training supplemented with regular refresher courses for all road users would need to be balanced by evidence of substantial benefit. There is no evidence that provision of first aid kits in cars would help [7] . For EU countries,

EC Directive 2000/56 provides for Member States to take measures to ensure that:
applicants for driving licenses know how to behave in the event of a crash;
they can assess road crash victims including emergency action such as evacuation of passengers and basic knowledge of first aid.

4. Access to the emergency medical system

4.1 Telephone notification

A national emergency number speeds up the process and guarantees that all relevant agencies are warned and involved. In high-income countries, access to the emergency medical system is almost always made by telephone, but the coverage and reliability of the telephone link varies between countries. The growth in the use of mobile telephones is having a helpful effect on crash notification [48] .

The EU 112 emergency notification number**.** For the European Union, 112 is the emergency telephone number which allows European citizens in distress to contact the emergency services in all Member States. It was established by Council Decision of 29 July 1991 and reinforced through the Directive 98/10/EC and now to be found in the Universal Service Directive. According to the European Commission it has now been implemented in all EU countries, although the number is little known by EU citizens according to European Commission monitoring. No information is available about the time taken to answer this emergency call number and no EU standard exists for call receipt.

4.2 In vehicle emergency notification systems

'Mayday' systems aim to reduce the time between when the crash occurs and when medical services are provided. By improving information transfer between the trauma care physician and emergency medical service personnel, they aim for faster and more appropriate treatment. In 2000, Autoliv and Volvo introduced one of the world's first post-crash safety systems.

Automatic Crash Notification (eCall) which is currently under development takes the safety benefits of Mayday systems further by providing emergency responders with data that indicates the severity of the crash and the nature of injuries sustained. A Finnish study has estimated that such a system might reduce between 4-8% of road deaths and 5-10% of motor vehicle occupant deaths in Finland [54].

4.3 Telephone answering by the emergency services

An efficient call receiving system is essential to avoid wasted time. A variety of models exist but have not been studied. In some Member States, calls are answered by the ambulance services or the emergency medical services, in others by other emergency services - police and fire service – and then appropriate calls are transferred to the emergency medical system. A priori direct over indirect contact is to be preferred [7]. It is not known whether all countries have standards for call receipt, although several countries have developed call receipt performance indicators.

4.4 Emergency Medical Dispatch

In Europe, calls received by the Emergency Medical System either results in:

- Automatic dispatch of an emergency ambulance requiring the call taker to give accurate identification of the location of the incident and to mobilize the emergency crew;

- Selective dispatch depending on the perceived nature and urgency of the incident and the process of doing this is known as Emergency Medical Dispatch.

The functions of the Emergency Dispatch System are:
- Prioritization by level of urgency (triage) to determine the speed of response
- Prioritization by level of need to determine type of response
- Provision of pre-ambulance arrival instructions in first aid and scene management
- Communication with those on the scene and in the receiving hospital.

Clinical experts across Europe believe that all calls to the Emergency Medical System in Europe should be transferred as soon as possible to a trained dispatcher able to make a layered response using an appropriate Emergency Dispatch System [7].

A computerized system which promotes the call taker, records responses, supports decision-making and provides information for audit and quality assurance is considered essential [42]. There are various ways of operating emergency medical dispatch systems: the essential elements which have been identified are the use of a standard protocol, the need for medical supervision, audit of operations and the training of dispatchers [7] .

5. Emergency rescue systems

5.1 Coordination between emergency services

Emergency rescue requires effective coordination between all the emergency services. The objective is to ensure speedy first aid and transport to an appropriate treatment centre. There needs to be close professional cooperation at the scene between fire-fighters, coastguards and police (who may arrive first at the scene) and the emergency medical service personnel.

5.2 Training of emergency personnel

Emergency medical technicians who staff an ambulance who carry out basic pre-hospital care techniques to save lives and limit disability. However, research shows that the level of training and the degree of professionalism involved varies [9][26]. The important status of the emergency medical technician is often not well recognized, is seen as an accessory for the fire department, or is even left to volunteers. The establishment of minimum standards at European Union level has been recommended by clinical experts in Europe [7]. Non-medical emergency services need to be trained in basic life support in order to provide immediate first aid. There also needs to be cooperation between the fire-fighting services and medical personnel when victims are not readily accessible and special training is organized in many Member States to this effect. One issue, in particular, is the need for safe extrication of victims and awareness of the rescue services of special hazards such as undeployed airbags.

5.3 The availability and response times ambulances

Land ambulances are used in the majority of road collisions in Europe. The standardization of equipment in ambulances in Europe has been recommended, together with the development of appropriate vehicle and driver safety standards, given the considerable number of crashes involving ambulances [7].

A research overview by Elvik and Vaa [16] indicates that the faster a road casualty can gain access to expert first aid, the greater the chance of survival and full recovery. Research shows that:

- In general, road traffic deaths increase with increasing ambulance response time which is strongly related to population density
- The proportion of fatal crashes is lowest where ambulance availability is best and highest where ambulance availability is poor.

5.4 Is helicopter rescue effective?

Helicopters are used widely throughout Europe as emergency ambulances in a primary responder role in post-impact care and have been used in this role in Germany since the early 1970s. They are thought to be useful in improving response times and removal times to and from the scene, giving a more appropriate level of response, and providing access to more appropriate hospitals. Research shows that using helicopters to transport patients does not influence greatly their probability of survival, they are costly (between around 0.5 million – 1.5 million euro annually to operate) and not without significant crash risk [16][7]. No cost-benefit analyses of improved provision of medical services for those injured in traffic accidents have been found. A cost-benefit analysis of the national air ambulance helicopter service [15] concluded that the current service in Norway carried out by these helicopters had a benefit-cost ratio of around 5.4. Rescue helicopters carry out both search and rescue missions and ambulance transport. For the search and rescue missions, the benefit-cost ratio of current services is around 4.9. For ambulance services, the benefit-cost ratio was calculated to be around 5.9.

If helicopters are operated, the evidence suggests that it should be on a regional basis in a secondary responder role in which they are called out at the request of emergency personnel at the scene or at a primary receiving hospital [7].

6. Pre-hospital medical care

6.1 What type of treatment?

While the old method of ‘scoop and run’ without any treatment is no longer practiced in high-income countries in Europe, to ‘stay and play’ at the scene may also be detrimental for the prognosis of the patient [7]. A recent survey of pre-hospital literature found only 24 randomized controlled trials and concluded there was insufficient data to provide a strong evidence base for the effectiveness of many common pre-hospital interventions [6]. The World Health Organization [50] distinguishes between basic and advanced systems of pre-hospital care.

Basic Life Support (BLS): Consists of emergency medical care to restore or sustain vital functions (airway, respiration, circulation) without specialized medical equipment and to limit further damage in the period preceding the arrival of specialized, advanced emergency medical care.

Advanced Life Support (ALS): Medical care given by medical doctors and nurses trained in critical care medicine with the use of specialized technical equipment, infusion of fluids and drugs aimed to stabilize or restore vital functions. Advanced life support is an integral part of a system of emergency medical services that needs adequate medical supervision.

While advanced systems are impressive and undoubtedly benefit some patients, WHO states that there is little evidence that they are inherently superior to systems that offer basic pre-hospital care. They may also hinder the overall provision of pre-hospital care if they lead system planners to divert scarce resources from basic interventions that benefit large numbers of patients to interventions that benefit fewer patients. With few exceptions (such as early defibrillation for victims of cardiac arrest), most advanced interventions have not been scientifically proven to be effective because the necessary randomized trials have not been conducted. In contrast, improved outcomes have been documented after bystanders and health-care providers have been educated to provide the fundamental elements of trauma care [50].

Scientific knowledge about the efficacy of pre-hospital medical care techniques is, thus, still evolving. The optimal approach needs to be determined for different types of trauma patients and well-controlled studies need to be carried out to address this question further. It is clear, however, that only essential treatment should be given so there is no unnecessary waste of time. Measures to protect the victim from further injury, basic life support measures such as providing a free airway and techniques used to aid breathing are considered essential. Mouth to mouth resuscitation and mask bag valve ventilation and decompression are also essential techniques. Measure to reduce circulatory failure and maneuvers started for immobilizing possible fractures to prevent further damage are also considered to be essential treatments [7].

6.2 Who should deliver the pre-hospital care?

Those who provide basic pre-hospital trauma care have had formal training in pre-hospital care, scene management, rescue, stabilization and transport (World Health Organization, 2005). Essential basic pre-hospital care techniques can be delivered by emergency medical technicians staffing ambulances. Advanced techniques can only be provided by:

- Paramedics (emergency medical technicians who have received further training) e.g. in the UK
- Nurses specialized in critical care e.g. in the Netherlands
- Physicians in mobile intensive care units which is a system widely used in Europe e.g. in Belgium, Germany, France, Italy.

In order to make the best use of resources, a two-tier system has been set up in some European countries comprising emergency medical technicians as the first tier and mobile intensive care units as a second tier.

6.3 Which hospital? The importance of field triage

Different factor needs to be taken into account in the decision about the appropriate hospital for the road traffic victim such as type of injuries, services available at the hospital, comparative distances and times to reach hospitals, and regulations concerning the transport of injured people.

Triage is the term applied to the process of classifying patients at the scene according to the severity of their injuries to determine how quickly they need care. Careful triage is needed to ensure that resources available in a community are properly matched to each victim's needs. Formal algorithms or protocols need to be developed to ensure that community resources are used properly to care for trauma patients; these algorithms must exist for both the pre-hospital and hospital setting. Failure to develop protocols may lead to over-triage or under-triage. Over-triage occurs when non-critical patients are sent to facilities offering the highest

level of care. Under-triage occurs when critically injured patients are treated at the local level or sent to facilities that are not properly equipped to meet their needs. This may result in increased morbidity and mortality among patients with otherwise treatable injuries [50].

6.4 Medical control and direction of pre-hospital care

Physician input is needed throughout the planning, implementation, evaluation and audit of the Emergency Medical System. Medical control and direction of pre-hospital care is essential and at the local level, a knowledgeable and committed health-care professional should be identified to serve as the medical director. In urban areas, an experienced hospital-based physician trained in accident and emergency medicine, anesthesiology or critical care, or trauma surgery, and ideally trained or experienced in pre-hospital care, may be best suited to this role. In rural communities where a physician may not be available, the most experienced nurse or paramedical professional should fill this role. It is important that qualified individuals be assigned responsibility for assuring the availability and quality of pre-hospital care in their community, whether it is delivered through paid health-care providers or local volunteers [50].

6.5 Planning and care in multiple casualty crashes?

Major road crashes which involve multiple casualties. Contributory factors include fog and excess speed [7]. Large numbers of injured persons may also result from collisions involving buses or lorries carrying explosive, toxic or inflammable chemical products. A disaster planning document is needed to strengthen the capacity of local and regional governments, health-care providers and public health organizations to react to such events [50]. Best practice indicates that a region-wide trauma team is the optimal means of dealing with such events utilizing such a disaster plan. Post impact care is coordinated by hospital-based medical teams who are trained in disaster management and in collaboration with the ambulance, police and the fire service. Efficient rescue involves on-site triage and immediate care, evacuation and hospital admission [7] .

6.6 Legislative framework for pre-hospital care

The following topics are commonly addressed by law or by administrative regulation [50]:

- Training, certification and licensure of providers of pre-hospital emergency medical care
- Services, including minimum skills requirements and provisions for disciplinary actions
- Scope of practice (allowable skills) of pre-hospital providers and the conditions under which they may use these skills
- Scope and authority of medical direction, including protocols determining a patient's destination, triage guidelines and protocols for interfacility transfer
- Licensure or authorization of emergency medical services, including medical
- Direction and training, and vehicles, including equipment, communications and others
- Complaint investigation procedures
- Quality improvement
- Financing
- Designation of medical facilities as specialty care centers if appropriate
- Data collection, reporting and confidentiality
- Accreditation of education programmes
- Liability protection of providers and physicians, if needed
- Communications requirements
- Access to the emergency medical care system, including a nationwide emergency telephone number

- Emergency medical service catchments areas and mutual aid requirements; disaster response.

7. Trauma care

7.1 What is trauma care?

This involves the provision of appropriate care at a medical establishment to road crash victims with major and minor injuries.

Minor injury: Injuries are treated by the patients themselves, a general practitioner or the accident and emergency department. Correct treatment of injuries such as head and neck trauma and adequate follow up care is important to limit pain and prevent adverse consequences.

Major injury: A trauma care systems needs to be put in place by every hospital receiving patients with major trauma.

7.2 Are trauma services effective?

Evidence of the effectiveness of improvements in trauma services comes from panel reviews of preventable deaths, hospital trauma registry studies and population-based studies [36]. Panel reviews indicate an average reduction of 50% in medically preventable deaths and population-based studies and trauma registry studies show around a 15%-20% or great reduction in mortality as a result of improvements in the trauma care system [51] [32] [4]. A comprehensive population based study examined the effects of planning of system for trauma management in all 50 states of the United States and found an 8% reduction in overall trauma mortality (including deaths at the scene and having adjusted for various confounding variables) due to improvements. The study found that the effect of the system of trauma managements was not usually evident until 10 years after its implementation and reached a maximum at 16 years [38][39]. More recently, a further study in the US confirmed that the risk of death is significantly lower when care is provided in a trauma centre than in a non–trauma centre [31].

7.3 Establishing a national trauma system

A prerequisite for high-quality trauma care in hospital emergency departments is the existence of a strategy for the planning, organization and provision of a national trauma system. The strategy for the organization of a national trauma care system needs to be formulated by health policymakers with input from medical professionals to provide research-based guidelines, standards and general advice about the treatment of trauma victims. Trauma centers in several European Countries have protocols for the pre-hospital and hospital phase. National guidelines need to be formulated in consultation with national, scientific medical societies on trauma centers and their organization.

Each trauma system must be defined by local needs and assessments of capacity and developed with due regard for local culture, legislation, infrastructure, health-system capacity, economic considerations and administrative resources [36]. International essential trauma care guidelines have recently been established by the World Health Organization.

There is considerable potential worldwide and in Europe to upgrade arrangements for trauma care and improve training in trauma care at the primary health care level, in district hospitals

and in tertiary care hospitals [48][7][11]. The US vision of a national trauma system is set out below [41].

The US Vision of a Trauma System for the Future

Trauma systems, when fully implemented throughout the U.S., will enhance community health through an organized system of injury prevention, acute care and rehabilitation that is fully integrated with the public health system in a community. Trauma systems will possess the distinct ability to identify risk factors and related interventions to prevent injuries in a community, and will maximize the integrated delivery of optimal resources for patients who ultimately need acute trauma care. Trauma systems will address the daily demands of trauma care and form the basis for disaster preparedness. The resources required for each component of a trauma system will be clearly identified, deployed and studied to ensure that all injured patients gain access to the appropriate level of care in a timely, coordinated and cost-effective manner.

Comprehensive Trauma Care System: Key Infrastructure Elements

The infrastructure of a trauma care system includes eight key elements:

- Leadership
- Professional resources
- Education and advocacy
- Information
- Finances
- Research
- Technology
- Disaster preparedness and response

In a model system, these elements are integrated and coordinated to provide cost-efficient and appropriate services across the continuum of care

7.4 The trauma team

The creation of a multi-disciplinary trauma team and the appointment of a trauma team leader is required by the in-hospital trauma service. The multi-specialist trauma team comprises anesthesiologists, surgeons, radiologists, emergency physicians etc. and takes care of every major trauma patient admitted to hospital. A minimum threshold of basic clinical capabilities needs to be established for each trauma centre. Best practice arrangements in Europe with regard to composition and availability of clinical care are outlined in Appendix 1. A review by the World Health Organization of studies on the effectiveness of trauma teams found that organized trauma teams have been shown to improve the process and outcome of trauma care in high-income countries [6]. For example, in one study on trauma resuscitations, resuscitation time was halved in the presence of an organized trauma team [13].

7.5 The trauma team leader

In Europe trauma team leaders tend to be either emergency physicians, surgeons (orthopedic surgeons, neurosurgeons, general surgeons) or anesthesiologists and specialists in intensive care. The leader is well trained in trauma care and is available on a 24 hour basis. The functions are to interpret, apply and decide about the priorities for the primary and

secondary survey of polytrauma as well as team training. Studies have shown that the presence of a trauma team leader improved resuscitation time [25][53] .

7.6 Education, training and audit

Team leader training: The global standard for trauma team leader training is the ATLS course of the American College of Surgeons, although this is not always applicable for Europe which tends to see more blunt than penetrating injuries. Good practice indicates that the leader's previous experience in trauma care should include a period sufficient to have been involved in the treatment of at least 50 trauma patients in a level I/II trauma centre emergency Department (in Europe such a department would be expected to admit more that 150-180 major trauma cases each year) [7].
Education and training of trauma team: Each trauma centre is responsible or the training of the trauma team and this is usually organized by a committee of trauma team leaders. In Germany, for example, team trauma training is aligned to pre-hospital and hospital phase protocols.

Audit: Together with the trauma co-ordinator, the group of trauma team leaders takes responsibility for the audit of the care and outcomes of all major trauma. This entails setting up a trauma registry and recording patient details by means of various scores, ratings and injury scales. (See 9. Data and Information systems).

Greater attention is needed worldwide to define and optimize the training of doctors and nurses in trauma care (both in basic education and post-graduate settings. A range of available courses are listed in the Guidelines for Essential Care [36].

8. Rehabilitation

8.1 Returning the patient to the community

The last link of the trauma system care chain is to return the injured individual to his or her place in the community. This involves the integration of initial 'high tech' medicine and rehabilitation services and attention to the psychological needs of the patient. Training is required for staff caring for patients as well as those supporting relatives. Long lasting psychological and social suffering of relatives may result from the way they are approached by emergency care givers [18].

Patients who have sustained traumatic brain injury (TBI) will require additional specialized attention on the part of neuropsychologists and psychologists. Research shows that even relatively 'mild TBI' is followed by prolonged disability in a high percentage of cases. In hospital trauma care a neuropsychologist should take part in the acute rehabilitation phase. Psychologists should be involved in the 'discharge planning' of all patients with TBI and be consulted whenever there is concern about the re-integration of a patient into the community. Post traumatic stress disorder is recognized as a major obstacle to full recovery after injury. It is probable that early assessment and early referral for rehabilitation will improve long term outcome and speed up the recovery process.

Other injuries e.g. of the spine and the upper and lower limbs can also be debilitating and rehabilitation of these patients should receive the necessary attention.

9. Data and information systems

9.1 Documenting information

The collection and documentation of data on road traffic injury consequences and the different phases of post impact care are essential to identify priority areas, monitor progress and check that investments are being appropriately directed. Detailed information on injury severity and health outcomes is needed in European Union countries for a better understanding of the scope for savings through post crash care. The recording of injury severity in hospitals; the measurement of road crash survivor outcomes; and post injury measures of disability (at least on discharge from hospital or at 30 days post impact), to be included in routine hospital statistics linked to national crash data [7]. It concluded that data should be collected by all Member States of the European Union for auditing the performance of the Emergency Medical Services. The review highlighted the need for regulations for performing post-mortems or radiological investigations in all road traffic deaths should be formulated.

9.2 Monitoring pre-hospital care

The following data represent the information necessary to support the ongoing evaluation of pre-hospital care systems. The patient care record should be based on the International Classification of External Causes of Injury (55) and the WHO Injury Surveillance Guidelines. These should include at minimum sufficient information to answer the following questions:

- Who was injured and who provided care?
- What caused the injury and what was done to treat it?
- When did it occur?
- Where did the injury occur?
- How did the patient respond to treatment (outcome)?

The medical director or field supervisor has several simple but effective ways of ensuring the quality of pre-hospital care by listening in on radio or other communications, direct observation, report review, critical incident review, outcome studies, continuing education and maintaining discipline.

A variety of performance indicators are used.

9.3 Monitoring hospital trauma care

Trauma Registries (based on hospital recruitment areas) are used and provide an important tool to change legislation, to promote trauma prevention, to assess the management of patient care, and to evaluate trauma system effectiveness [8]. They contain detailed information on trauma care.

EuroTARN The Trauma Audit & Research Network: The EuroTARN initiative consists of a regular participation of trauma centre professionals in 14 European countries and support from many others who have come together to develop an effective system to review the standards of trauma care across Europe and develop an effective method for future data collection.

Belgium	Norway
Croatia	Portugal
Germany	Spain
Denmark	Sweden
Greece	Switzerland
Ireland	The Netherlands
Italy	United Kingdom
Bosnia-Herzegovina	Slovakia
Macedonia	Austria

The aims and objectives of this European Collaboration are:

- To promote high standards of care for trauma victims in Europe and, thereby, reduce the associated burden of death and disability
- In the short term to establish a common international data set so that management strategies and their consequences can be compared
- In the longer term to use the database to promote the development of clinical guidelines and associated performance indicators
- To study the epidemiology of trauma and thereby promote a rational approach to injury prevention.

Hospital inspection: A review of hospital inspection requirements is provided in the World Health Organization's), essential care guidelines [36].

9.4 Impairment, disability and loss of function scales and scores

A variety of injury and health loss scores are used in post impact care. These are used for assessing injury severity, the probability of survival and long term loss of health. They are used in the field for determining the appropriate hospital for the crash victim, evaluating trauma system performance and for research purposes.

- **Anatomical scoring systems**

The Abbreviated Injury Scale (AIS), first published in 1971 (Committee on Medical Aspects of Automotive Safety 1971), is the most widely used scheme internationally for injury severity assessment. Currently in its sixth revision, the AIS (2005) is a dictionary of approximately 2,000 descriptions of individual injuries, mainly anatomically-based, written in currently acceptable medical terminology. While many of the injury descriptions are clinically-specific and require some knowledge of contemporary trauma language, the AIS is so structured that it can equally accommodate less detailed information, thus fostering compatibility across different data needs and uses. The bedrock of the AIS is its 6-point numerical severity ranking system (AIS 1=minor injury; AIS 6=injury currently untreatable) that has remained virtually unchanged for three decades. By its nature, the AIS can be used by both medical and non-medical researchers [27].The AIS does not reflect the combined effects of multiple injuries but can give some indication of an overall severity score when used as part of ISS.

The Injury Severity Score (ISS) is an anatomical scoring system that provides an overall score for patients with multiple injuries. It is used to assess penetrating injuries, falls, crush-

type injuries as well as road traffic accident injuries. AIS is the basis for the Injury Severity Score (ISS). Its limitations are its inability to account for multiple injuries to the same body region and it limits the total number of contributing injuries to only 3. However, the NISS (new injury severity score) accounts for multiple injuries in the same body region.

International Classification of Disease, Tenth edition (ICD 10) The ICD has become the international standard diagnostic classification for all general epidemiological and many health management purposes. Compared to AIS, its limitation is the absence of severity score.

- **Physiological response scales and scores**

The Glasgow Coma Scale is used as a standard assessment of levels of consciousness following or when suspecting a head injury - this is used by paramedics and throughout the hospitals and is widely accepted in UK, Europe, US, Australia etc.

The Revised Trauma Score is a physiological scoring system, with high inter-rater reliability and demonstrated accuracy in predicting death. It is scored from the first set of data obtained on the patient, and consists of the Glasgow Coma Scale, Systolic Blood Pressure and Respiratory Rate. The revised trauma score is used to rapidly assess patients at the scene of an accident and to facilitate pre-hospital triage decisions and evaluation [10] .

Both are used widely although use is limited when a patient is intubated, chemically paralysed or under the influence of alcohol and drugs.

- **Probability of survival scales and scores**

Trauma Score - Injury Severity Score: TRISS This widely used score is designed to determine the probability of survival of a patient based on patient characteristics and was designed to evaluate trauma care and outcomes from different trauma centers [3].

- **Outcome scores**

More recently, the development of an injury outcome scale has become a priority. While the topic is not new – scales date back to the 1980s [24][22][5] – there is still significant disparity on what criteria to use, although there seems to be agreement that any future impairment scale should be directly linked to the AIS.

Injury Impairment Scale (IIS) [1]. It was fashioned directly on the AIS severity code and assigned a value between 1 and 6 to each injury descriptor that was adjudged to have some residual impairment one year post injury. Several years later, the Functional Capacity Index (FCI) [30] was proposed.

The Glasgow Outcome Scale has also been used which a crude 5 point scale of functioning is made at the time of hospital discharge.

The Functional Capacity Index (FCI) was developed through a large collaborative effort in the US [30]. It assigns a score (between 0 and 1) to each injury descriptor in the AIS in all body regions. The FCI, also directly linked to the AIS, has been validated on one patient population in the US and some revisions to the Index were subsequently proposed. It is anticipated that the FCI will be integrated into the AIS dictionary thus offering substantial

opportunities to validate it as a research tool to assess the probability and severity of injury-related impairment [27]. Validation for the Functional Capacity Index in Europe may be required [20].

- **Health loss scales**

The EQ-5D scale assesses changes in health states in 5 domains; mobility, self care, usual activity, pain, and anxiety and depression. Each domain has 3 levels of assessment and the scores can be combined to derive a composite outcome measure and used to calculate Quality Years of life lost (Qalys). Population measures are available so that the distributions of an injured sample can be compared [19].

The SF-36v2 assesses health across 8 dimensions namely, general health, physical role and functioning, social functioning, bodily pain, mental health, vitality and emotional role. The assessment incorporates the previous 4 weeks and not just a one off assessment. Scores are generated for each dimension ranging between 0-100 which are then used to generate two component scores, namely the physical component and mental component scores (PCS and MCS respectively). These can be compared with standard values for specific populations to assess trends over time and absolute changes in health [55].

9.5 Performance indicators

Different indicators can be defined to measure the quality of the Emergency Medical System system. Different indices can be used to measure the quality of treatment provided by permanent medical facilities, or to characterize the whole trauma care system.

An unpublished review of evaluation parameters in use by Gitelman et al, included:

- At the EMS Level [34][40]
  Type of training that EMS teams receive: BLS (Basic Life Support) versus ALS (Advanced Life Support)
- Type of evacuation to trauma centre: self, regular ambulance, MICU, helicopter
- Time values [52]: arrival at scene, treatment in the field, arrival for definitive treatment in hospital (are they within "the golden hour" rule?)
- Type of field treatment
- Treatment implementation according to protocols, to the extent that protocols exist.

Performance Measurement of Ambulance Emergency Services - Victoria		
Timeliness	2003-04 Expected	2004-05 Outcome
Emergency response time (code 1)in 50 per cent of cases -metro minutes	9	8
Emergency response time (code 1)in 90 per cent of cases -metro minutes	14	13
Emergency response time (code 1)in 50 per cent of cases -statewide minutes	9	9
Emergency response time (code 1)in 90 per cent of cases -statewide minutes	15	15

At the Hospital Level

- Level of coverage: to what extent do critical patients arrive at trauma centers and not at hospitals of other levels?

- Outcome according to Severity of injuries (ISS) and according to part of body injured and nature of injury (Barel Matrix), with emphasis on head, chest and abdomen injuries
- Performance of specific surgical procedures and evaluation of outcome, comparisons of treatment in specific procedures
- Speed of treatment in the hospital, speed of arrival to Emergency Rooms, extent of work according to protocols.

For outcomes

- Death rate
- Hospitalization in Intensive Care Unit
- Total length of hospitalization.

Appendix

Best practice: Trauma Service Clinical Arrangements

Minimum threshold of basic clinical capabilities to be provided by trauma centre, Buylaert ed.,1999

In-house 24 hours a day:
Emergency Medicine
Anesthesiology
General Surgery and any life saving surgery (such as urgent external fixation for pelvic fractures, vascular surgery)
Radiology: a mobile X-ray apparatus should be located in the resuscitation room and the other X-ray facilities such as CT-scan should located near the emergency department

On call promptly available:
ESSENTIAL:
Anesthesiology (2nd team)
General Surgery (2nd team)
Neurosurgery (2nd team)
Orthopedic Surgery
Maxillo facial Surgery
Interventional Radiology

DESIRABLE :
Pediatric Surgery
Vascular Surgery
Urologic Surgery
Plastic Surgery
Thoracic surgery

Facilities and resources: available in-house 24 hours a day:
X-ray and Ultrasonography
CT-scan
Trauma operating room with staffed personnel
Clinical laboratory service
Blood bank with adequate storage facilities
Rehabilitation team for the acute trauma phase

The facilities and medical instruments for every clinical procedure must be recorded on dedicated checklists which are monitored every day by trained nursing staff overseen by the trauma coordinator**.**

References

1. AAAM (1994) Injury Impairment Association for the Advancement of Automotive Medicine, Des Plaines

2. Abbreviated Injury Scale (2005) Gennarelli, T.A., Wodzin, E. (eds.), Association for the Advancement of Automotive Medicine Publisher, Barrington, IL

3. Boyd, C.R., Tolson, M.A., Copes, W.S. (1987) Evaluating Trauma Care: The TRISS Method, J Trauma 27:370-378

4. Brennan, P.W. et al. (2002) Risk of death among cases attending South Australian major trauma service after severe trauma: 4 years operation of a state trauma system, The Journal of Trauma, 53:333-339

5. Bull, J.P. (1985) Disabilities Caused by Road Traffic Accidents and their Relation to Severity Scores. Accident Analysis & Prevention 17(5):387-397

6. Bunn, F., Kwan, I., Roberts, I., Wentz, R. (2001) Effectiveness of pre-hospital trauma care Report to the World Health Organization Pre-Hospital Steering Committee Geneva

7. Buylaert, W. ed. (1999) Reducing injuries from post-impact care. European Transport Safety Council, Working Party on Post Impact Care, Brussels

8. Cameron, P., Gabbe, B., McNeil, J., Finch, C. , Smith, K., Cooper, J. , Judson, R., Kossmann, T. (2005) The trauma registry as a state-wide quality improvement tool, Journal of Trauma, 59(6): 1469-1476

9. Chamberlain, D. (1998) The pre-hospital management of acute heart attacks. Eur. Heart j.19: 1140-1164

10. Champion, H.R. et al (1989) A Revision of the Trauma Score, J Trauma 29:623-629

11. Coats T.J. and Davies, G. (2002) Prehospital care for road traffic casualties, BMJ, 324 –1135-8

12. Commission of the European Communities (CEC, 2003) European road safety action programme: Halving the number of road accident victims in the European Union by 2010: A shared responsibility Communication from the Commission Com (2003) 311 final

13. Driscoll, P.A. and Vincent, C.A. (1992) Organizing an efficient trauma team, Injury 1992 23: 107-110

14. EC (2006) European road safety action programme: Mid-term review Commission of the European Communities, Brussels

15. Elvik, R. (1996). Nytte-kostnadsanalyse av redningshelikoptrene. TØI-notat 1033. Transportøkonomisk institutt, Oslo

16. Elvik, R. and Vaa, T. (2004), Handbook of road safety measures, Elsevier, Amsterdam

17. ETSC (2003), Transport safety performance in the EU - a statistical overview, European Transport Safety Council, Brussels

18. European Federation of Road Traffic Victims (1997) Impact of road death and injury - Proposals for improvements. Geneva

19. EuroQuol Group (1990) EuroQol - a new facility for the measurement of health-related quality-of-life. Health Policy 1990;16:199-208

20. EuroTARN (2005) http://eurotarn.man.ac.uk/

21. Gitelman, V., Hafen, H. (BASt), Malka Avitzur, M. Eksler, V. and Hakkert, S. (unpublished, SafetyNet)

22. Gustafsson, H., Nygren, A., Tingvall, C. (1985) Rating System for Serious Consequences (RSC) due to Traffic Accidents, Risk of Death or Permanent Disability. Proceedings, 10th International Conference on Experimental Safety Vehicles, Oxford

23. Henriksson, E. M., Öström, M. Eriksson, A. (2001) Preventability of vehicle-related fatalities. Accident Analysis and Prevention, 33, 467-475

24. Hirsch, A., Eppinger, R. (1984) Impairment Scaling from the Abbreviated Injury Scale. 28th Proceedings, American Association for Automotive Medicine, Arlington Heights, IL, pp. 209-224

25. Hoff, W.S., Reilly, P.M., Rotondo, M.F., DiGiacomom J.C. (1997) CW The importance of the command-physician in trauma resuscitation, The Journal of Trauma, 43:772-777

26. Huemer, G., Pernerstorfer, T. & Mauritz, W. (1994) Prehospital emergency medicine services in Europe: structure and equipment. EurE. J. Emerg. Med. 1, 62-68

27. IRCOBI (2006) Future Research Directions in Injury Biomechanics and Passive Safety Research, International Research Council on the Biomechanics of Impact, http://www.ircobi.org/

28. Krafft, M. (1998) Non-Fatal Injuries to Car Occupants - Injury assessment and analysis of impacts causing short- and long-term consequences with special reference to neck injuries, Doctoral thesis, Karolinska Institute, Stockholm, Sweden

29. Lerner, E.B., Moscati, R.M. (2001) The golden hour: scientific fact or medical “urban legend”. Academic Emergency Medicine 2001,8:758 –760

30. MacKenzie, E., et al. (1996) “The Development of the Functional Capacity Index,” Journal of Trauma, Vol. 41, No. 5, pp. 799-807

31. MacKenzie, E.J., Rivara, F.P., Jurkovich, G.J., Avery, B., Nathens, M.D., Frey, K.P., Brian, L.H., Egleston, M.P.P., Salkever, D.S., and Scharfstein, D.(2006) A National Evaluation of the Effect of Trauma-Centre Care on Mortality , The New England Journal of Medicine, Volume 354:366-378, January 26th, 2006

32. Mann, N. Clay, PhD, M.S.; Mullins, Richard J. MD; MacKenzie, Ellen J. PhD; Jurkovich, Gregory J. MD; Mock, Charles N. MD, MS (1999) A systematic review of trauma system effectiveness based on registry comparisons, The Journal of Trauma, 1999, 47:546-55

33. Mckibbin, B., Ackroyd, C.E., Colton, C.L., King, J.B., Smith, T.W.D., Staniforth, P., Templeton J. & R West (1992) The management of skeletal trauma in the United Kingdom. British Orthopaedic Association, November, 1992

34. Mock, C.N., Adzotor, K.E., Conklin, E., Denno, D.M., Jurkovich, G.J. (1993) Trauma outcomes in the rural developing world: comparison with an urban level I trauma centre. J Trauma, Oct; 35 (4), 518-523

35. Mock, C.N. et al. (1998) Trauma mortality patterns in three nations at different economic levels: implications for global trauma system development. Journal of Trauma ,1998,44:804 –814

36. Mock, C., Lormand, J.D., Goosen, J., Hoshipura, M., Peden, M. , (2004) Essential trauma care guidelines, Geneva, World Health Organisation

37. Murray, P.A. , Pitcher, M. and Galasko, C.S.B. (2001) Project Report 45 The cost of long term disability from road traffic accidents four year study - final report, Transport Research Laboratory, Crowthorne

38. Nathens, AB, Jurkovich, GJ; Rivara, FP. MD; Maier, RV (2000) Effectiveness of State Trauma Systems in Reducing Injury-Related Mortality: A National Evaluation. Journal of Trauma-Injury Infection & Critical Care. 48(1):25, January 2000

39. Nathens, A.B., Jurkovich, G.J., Cummings, P. and Rivaram, F.P. (2000),The Effect of Organized Systems of Trauma Care on Motor Vehicle Crash Mortality, JAMA.2000; 283: 1990-1994

40. Nathens, A.B., Brunet, F.P., Maier, R.V. (2004) Development of trauma systems and effect on outcomes after injury. Lancet. May 29;363 (9423): 1794-801

41. NHTSA (2006) http://www.nhtsa.dot.gov/people/injury/ems/emstraumasystem03/vision.htm

42. Nicholl, J. P. (1997) The role of helicopters in pre-hospital care. Prehospital and Immediate Care, 1: 82-90

43. Noland, R.B. (2004) A review of the impact of medical care and technology in reducing traffic fatalities. IATSS Research, Vol. 28, No.2: 6-12

44. Noland, R.B. and Quddus, M.A. (2004) Improvements in medical care and technology and reductions in traffic-related fatalities in Great Britain. Crash Analysis & Prevention, 36, 103-113

45. OECD-IRTAD (1994) Under-reporting of road traffic accidents recorded by the police at the international level. Special report by H. Hvoslef, Public Roads Administration of Norway, Oslo

46. Oestern, H.H., Rieger, G., Wittke, M. & AG Polytrauma (2001) Lehren und Konsequenzen aus Sammelregistern: Das Polytraumaregister der DGU. Deutsche Gesellschaft für Unfallchirurgie, Kongressband 2001

47. Offner, P. (2002) Trauma Scoring Systems, eMedicine.com

48. Peden, M., Scurfield, R., Sleet, D., Mohan, D., Hyder, A., Jarawan, E. and Mathers, C. eds. (2004): World Report on Road Traffic Injury Prevention, World Health Organisation, Geneva

49. Rumar K (1999) Transport safety visions, targets and strategies beyond 2000: European Transport Safety Council, Brussels

50. Sasser, S., Varghese, M., Kellermann, A., Lormand, J.D. (2005) Pre-hospital trauma care systems. Geneva, World Health Organization, 2005

51. Simons et al (1999) Impact on process of trauma care delivery 1 year after the introduction of a trauma programme in a provincial trauma canter, The Journal of Trauma 1999 46:811-815

52. Smith, J.S., Martin, L.F., Young, W.W., Macioce, D.P. (1990) Do trauma centres improve outcome over non-trauma centres: the evaluation of regional trauma care using discharge abstract data and patient management categories. J Trauma, Dec; 30(12),1533-1538

53. Sugrue, M., Seger, M., Kerridge, R., Sloane, D. , Deane, S. (1995) A prospective study of the performance of the trauma team leader, The Journal of Trauma, 1995, 38:79-82

54. Virtanen, N., Schirrokoff, A. Luoma, J.and Kumala, R. (2006) eCall Safety Effects in Finland, eSafety Forum

55. Ware, J.E., Gandek, B. (1998) Overview of the SF-36 Health Survey and the International Quality of Life Assessment (IQOLA) Project. J Clin Epidemiol 1998; 51(11): 903–912