European Commission

Post-impact care 2018

European Road Safety Observatory
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Transport

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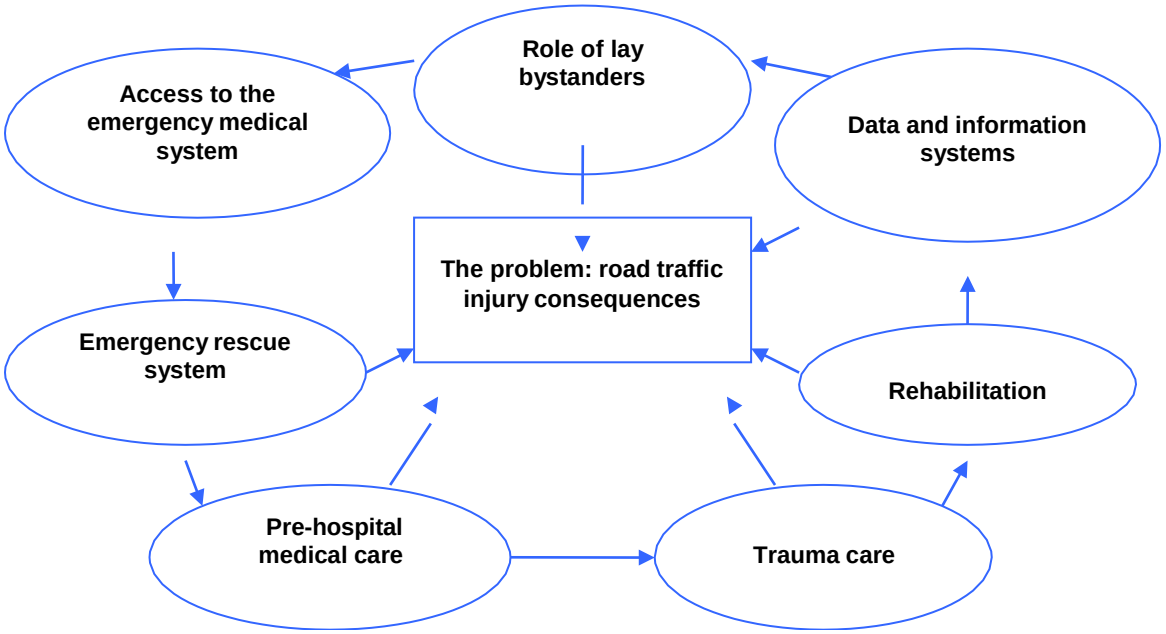
1 Overview

Figure 1: The chain of help



Post impact care is a key Safe System strategy aimed at reducing the severity of injury consequences once a road traffic accident has occurred. 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 accident, access to the pre-hospital medical care system, emergency rescue, pre-hospital medical care, trauma care and helping road accident victims who have suffered debilitating injury to re-integrate into work and family life. The effectiveness of this chain (shown above), depends upon the strength of each of its links (Buylaert, 1990). 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.

Improvements have been seen in many OECD countries over the last 40 years ranging from improvements in emergency medical response systems to advanced trauma care procedures to specific surgical intervention techniques. Post-impact care presents special challenges for low and middle-income countries as motorisation gradually increases. Provision of swift access to the emergency medical assistance in rural settings continues to present challenges for many countries, irrespective of socio-economic status.

While studies analysing the relationship between the performance of the trauma management system and road accident outcomes are infrequent, research indicates that various improvements have contributed to better injury outcomes (Elvik et al, 2009; Noland, 2004; Oestern et al, 2001; Noland and Quddus, 2004). In a review of 1970-1996 data in several OECD countries it was concluded that between 5% and 25% of the reductions in road accident fatalities may have been due to improvements in medical care and technology (including trauma and emergency response systems) (Noland, 2004).

The Decade of Action announced by the United Nations and the related Global Plan 2011-2020 and its Pillar of Action on post-accident response is leading to further attention in this area. New Sustainable Development goals relating to road safety underpin this activity (UN, 2010; UN, 2011; UN, 2015).

At EU level, post-impact care is a key element in *Policy Orientations on Road Safety 2011-2020* – the current road safety strategy (European Commission, 2010). The European Commission has taken first steps in the development of an injuries strategy in which Improving emergency medical response emergency following a road traffic accident is a key element (European Commission, 2013).

While attention to this area seems to be increasing, the designation of post-impact care as a key element of national road safety strategy and a Safe System approach is not widely evident as yet.

Acknowledgement
While several aspects have been updated, the main sources of information for this outline continue to comprise: in particular, a review of post-impact care by medical experts from across the European Union (Buylaert, 1999); the World Health Organisation's pre-hospital care guidelines (Sasser et al, 2005), essential trauma care guidelines (Mock et al, 2004), World Report on Road Traffic Injury Prevention (Peden et al, 2004) and other WHO publications; an EU SafetyNet project report (Gitelman et al, 2008) and a meta-analysis of studies by Elvik et al (2009).

2 The problem: road traffic injury consequences

2.1 Road traffic deaths and injuries

During 2015 there were around 26.100 road deaths in the European Union. The Commission estimates that 135.000 people were seriously injured (based on the new common definition of serious injury (MAIS >=3)). Serious injuries are not only more common, but also often more costly to society because of long-time rehabilitation and healthcare needs. Vulnerable road users, such us pedestrians, cyclists, motorcyclists or elderly road users are especially affected (European Commission, 2016).

The gap in road safety performance across EU countries is wide. The better performers have rates around 3 times lower than the worse performers. EU Member States with the lowest fatality rate per 100 thousand inhabitants in 2015 were Sweden (2,7), the Netherlands (2,8), the UK (2,9), Denmark (3,0) and Malta (2,6). The highest rates were reported by Romania (9,5), Bulgaria (9,5), Latvia (9,4), Lithuania (8,2) and Croatia (8,2) (European Commission, 2016).

Global Burden of Disease data for 2010 in 26 EU countries indicate that road traffic injury was either the leading or second leading cause of death for school aged children and young people (5-24 age group). In 21 EU countries (75%), road traffic injury was amongst the three leading causes of death for those aged 5-49 years (IHME, 2013). An increasingly ageing society and the physical vulnerability of older road users present new challenges.

2.2 Health of survivors and long-term disability

While common information on serious injuries according to the new EU definition is now being collated, data on the long-term health consequences of road traffic injury is not collected on a systematic basis. Rating systems have been devised and are in use, there are no, however, international standards for describing and quantifying the disabilities arising from traffic injuries, particularly those involving neurological trauma (IRCOBI, 2006).

In Europe it is estimated that for every death, there are 4 permanently disabling injuries such as to the brain or spinal cord, 10 serious injuries and 40 minor injuries (Mackay, 2005). Disability is usually defined as an individual's inability to carry out a normal range of daily activities due to physical and/or psychological consequences. 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 can 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 accidents can also result in a variety of long-term psychiatric and psycho-social problems (Peden et al, 2004).

Major EU research studies – SUSTAIN and SafetyCube – have recently been launched by the Commission to assess and improve the estimation of the numbers of serious road injuries; determine and quantify health impacts of serious road injuries; estimate economic and immaterial costs related to serious road injuries and identify key risk factors related to serious injuries and their health impacts. For discussion on different aspects of serious injury data, see ERSO Serious Injuries web text.

2.3 Socio-economic costs and the value of prevention

The average value for the prevention of a road fatality across EU 28 is estimated at €1,87 million (based on 2010 prices and using the willingness to pay method (Ricardo-AEA, 2014). The European Transport Safety Council, using a similar good practice methodology estimates that the value of preventing a road fatality for the EU 28 in 2014 was €1,94 million (ETSC, 2015). The annual value of prevention (rehabilitation, healthcare, material damages, etc.) of road fatalities and injuries is estimated to be of at least €100 billion (European Commission, 2016). The average annual socio-economic cost (or the value of preventing fatalities and injuries in road traffic accidents) in the first decade of the 21st century has been estimated at around 2% of EU 27 countries' gross domestic product - around Euro 176 billion and twice the EU's annual budget (ETSC, 2011). Research indicates that 50% of the total social costs of road accidents in high, middle and low-income countries relate to injuries. Two thirds of these are serious injuries.

However, the long-term impacts of transport-related injuries within the EU are to a large extent unknown (ETSC, 2007). Many national estimates do not take account of the cost of long-term disability and associated intangible costs resulting from road traffic accidents. Injuries reported as being minor at the time of accident can often lead to costly long-term disability. One British study (Murray et al, 2001), 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 four-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 many costs – both tangible and intangible – to the patient and family.

The EU SafetyCube project (2015), which has commenced recently, will estimate the health impacts of road traffic injuries in terms of impairment and disability with reference to the International Classification of Functioning Disability and Health (ICF) (WHO, 2001). Health impacts will be quantified by calculating YLDs (Years Lived with Disability) and social costs of serious injuries will be examined. Such information on serious health loss in road traffic accidents is urgently needed to inform policymaking in EU countries.

2.4 The costs and benefits of post-impact care

Surprisingly little work has been conducted on the costs of post-impact care versus the benefits for reducing trauma in road traffic accidents.

However, studies have shown that improved organization and planning for emergency care can be carried out at a reasonable cost and can lead to more appropriate use of resources, improved care, and better outcomes (White et al, 1996). In developing countries, most effective pre-hospital strategies are basic and inexpensive, and the lack of high-tech interventions need not deter efforts to provide good care. Even where resources allow them, the more-invasive procedures performed by physicians in some pre-hospital settings, such as intravenous access and fluid infusion or intubations, do not appear to improve outcomes, and evidence suggests that they may, in fact, be detrimental to outcomes (Kobusingye et al, 2006). Information on the annual costs of aspects of post-impact care in Norway is presented in Table 1.

Studies show that significant reductions in preventable deaths can be achieved through improvements in the trauma care system. 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% reduction in mortality as a result of improvements (Simons et al, 1999; Mann et al, 1999; Brennan et al, 2002). The risk of death is significantly lower when care is provided in a trauma centre than in a non–trauma centre (MacKenzie et al, 2006). Costs per life saved and per life-year saved are very low compared with other comparable medical interventions (Durham et al, 2006; Rotondo et al, 2006).

Table 1: Annual costs of post-impact care in Norway

Measure	Costs NOK	Costs from year
Emergency medical services	-	-
Rescue helicopters (per mission)	180.000	1997
Automatic crash notification – investment infrastructure, per unit	240.000 – 400.000	2006
Automatic crash notification – training of personnel, per person	2.400 – 4.000	2006
Automatic crash notification – vehicle equipment, per vehicle	1.200 – 2.400	2006

Source: Elvik et al, 2009

Cost-benefit analyses in Norway of specific post-impact services (excluding emergency medical services) are provided in Table 2.

Table 2: Benefit-cost ratios of post-impact care

Measure	Benefit-cost ratio
Provision of medical services	-
Rescue helicopters: Ambulance missions	5,9
Automatic crash notification (ACN)	0,23 – 1,65

Source: Elvik et al, 2009

2.5 Time between road accident and road death?

A study by medical experts in European high-income countries found that about 50% of deaths from road traffic accidents 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 accident, but around 35% occurred after 4 hours (Buylaert, 1999). A meta-analysis of studies found that the proportion of road deaths occuring within the first minutes after an accident is between 37% and 50% (CEC, 2003). 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 (Hirsch & Eppinger, 1984). The World Health Organisation has identified three phases of deaths from severe injury, as outlined in Box 1.

Box 1: 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.

Source: Sasser et al, 2005

As the World Report on Road Traffic Injury Prevention (Peden et al, 2004) underlined, there is not so much a "golden hour" (Lerner and Moscati, 2001) in which interventions have to take place as a chain of opportunities for intervening across a longer timescale.

2.6 Survivable and non-survivable road traffic injury?

The appropriate management of road casualties following an accident is a crucial determinant of the chance and quality of survival. The faster and the more effectively an injured person is treated medically, the greater are the chances of surviving and making a full recovery.

A Spanish study concluded that reducing the time between accident occurrence and arrival of emergency medical services from 25 to 15 minutes could reduce deaths by one third (Rocío Sánchez-Mangas et al, 2010).

A Swedish study into survivability in fatal road traffic accidents 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 transported quickly to an advanced trauma centre (Hendriksson, et al, 2001).

A UK study estimated that 12% of road accident victims with serious skeletal trauma went on to have significant preventable disability (McKibbin et al, 1992). Research has indicated that the prevention of trauma - unspecific, extensive, and life-threatening injury - should be treated within 10 minutes, and more extensive medical care should be provided within 1 hour, preferably at a specially equipped trauma centre (Champion, 2005). When not treated with timely and adequate response, trauma may lead to incapacitating injuries or death. Less serious injuries and injuries that lead to immediate death are to a lesser degree dependent on immediate treatment.

2.7 Post-impact care and road safety plans and targets

Post-impact care is now acknowledged globally as a key road safety strategy and fundamental to a Safe System approach (see ERSO Road safety management and Work - related road safety web texts).

Decade of Action - the Global Plan 2011-2020

Improving post-impact care is a key strategy promoted by the World Report on Road Traffic Injury Prevention (Peden et al, 2004) and is a Pillar of Action in the Global Plan for the Decade of Action towards addressing new Sustainable Development goals relating to road safety (UN, 2010; UN, 2011; UN, 2015). See Box 2.

Box 2: Global Plan - Pillar 5: Post accident response

Increase responsiveness to post-accident emergencies and improve the ability of health and other systems to provide appropriate emergency treatment and longer term rehabilitation for accident victims.

Activity 1: Develop pre-hospital care systems, including the extraction of a victim from a vehicle after an accident, and implementation of a single nationwide telephone number for emergencies, through the implementation of existing good practices.
Activity 2: Develop hospital trauma care systems and evaluate the quality of care through the implementation of good practices on trauma care systems and quality assurance.
Activity 3: Provide early rehabilitation and support to injured patients and those bereaved by road traffic accidents, to minimize both physical and psychological trauma.
Activity 4: Encourage the establishment of appropriate road user insurance schemes to finance rehabilitation services for accident victims through:

- Introduction of mandatory third-party liability; and
- International mutual recognition of insurance, e.g. green card system.

Activity 5: Encourage a thorough investigation into the accident and the application of an effective legal response to road deaths and injuries and therefore encourage fair settlements and justice for the bereaved and injuries.
Activity 6: Provide encouragement and incentives for employers to hire and retain people with disabilities.
Activity 7: Encourage research and development into improving post-crash response.

The World Health Organisation has produced guidance on post-impact care in its Road Safety Training Manual (WHO, 2006), as well as essential trauma care guidelines (Mock et al, 2004)

and pre-hospital trauma care systems (Sasser et al, 2005) and more recently, guidelines for trauma quality improvement programmes (WHO, 2009).

An Australian review (Wall et al, 2014) notes that WHO's Global Status Report 2013 asks countries to supply data to assist with measuring and comparing emergency response capabilities in seven areas:

- whether or not a Vital Registration System (for accurate recording of deaths and death circumstances) is functional in the country (NB not whether it covers the whole country),
- whether or not an Emergency Room-based Injury Surveillance System is in place in the country (though the WHO report does not specify what comprises such a surveillance system),
- whether a standard telephone number exists for accessing emergency services,
- the proportion of seriously injured who are transported by ambulances (based on expert opinion),
- the proportion of the population who are permanently disabled due to road accidents (but only if from a robust source),
- whether there is formally recognised emergency medicine training for doctors (e.g. post-graduate qualification),
- whether there is formally recognised emergency medical training for nurses.

The review compiled data from WHO (2013b) for five OECD countries, shown in Figure 2.

Figure 2: Emergency Response Capability Data

	Sweden	United Kingdom	Switzerland	Germany	Canada	Australia
Vital Registration System	Yes	Yes	*	Yes	Yes	Yes
Emergency room based Injury Surveillance System	Yes	Yes	No	No	No	Yes
Emergency access telephone number	Yes	Yes	Yes	Yes	Yes	Yes
Seriously injured transported by ambulance	≥ 75%	*	*	≥ 75%	≥ 75%	≥ 75%
Permanently disabled due to road crash	6%	*	*	*	*	*
Emergency training for doctors	Yes	Yes	Yes	Yes	Yes	Yes
Emergency training for nurses	Yes	Yes	Yes	No	Yes	Yes

* *Data not supplied by the country to WHO, or was not available*

Source: Wall 2014, based on WHO, 2013

In the road safety assessment framework used by the World Bank in road safety management capacity review (Bliss & Breen, 2009), the checklist shown in Table 3 highlights the need to assess jurisdictional post-impact care arrangements.

Table 3: Checklist for recovery and rehabilitation of accident victims from the road network

Questions	Yes	Partial	Pending	No
Have comprehensive safety standards and rules and associated performance targets been set to govern the recovery and rehabilitation of accident victims from the road network to achieve the desired focus on results? ▪ Pre-hospital? ▪ Hospital? ▪ Long-term care?				
For each category of post-impact service (pre- hospital, hospital, and long-term care) are compliance regimes in place to ensure adherence to the specified safety standards and rules to achieve the desired focus on results?				
Do the specified safety standards and rules and related compliance regimes clearly address the safety priorities of high-risk road user groups to achieve the desired focus on results?				
Do the specified safety standards and rules and related compliance regimes compare favourably with international good practice?				

Source: Bliss and Breen, 2009

EU road safety strategy and post-impact care

In terms of intervention, post-impact care falls mainly within the competence of Member States. The EU also plays a key role. Improved emergency and post-injury services are included as a pillar in the European Commission's Policy Orientations on Road Safety 2011-2020 – the current road safety strategy (European Commission, 2010). The European Commission has taken first steps in the development of an injuries strategy in which improving emergency medical response emergency following a road traffic accident is a key element (European Commission, 2013). An independent study commissioned by the European Commission towards their interim evaluation of the road safety strategy 2011-2020 made several recommendations (Breen, 2015).

Box 3: Independent review recommendations for Policy Objective 6: Improve emergency and post-injuries services

- Commission a study to review the scope of post-impact care in reducing deaths and serious injuries in road collisions.
- Include first responder training in EU provisions for commercial and public transport driver training and emergency services personnel.
- Monitor and rank annually through EU databases the role of road traffic injury as cause of death and disability compared with other mortality and morbidity.

Source: Breen, 2015

National strategies and post-impact care

Post-impact care, however, 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 typically the Ministry of Transport in Europe.

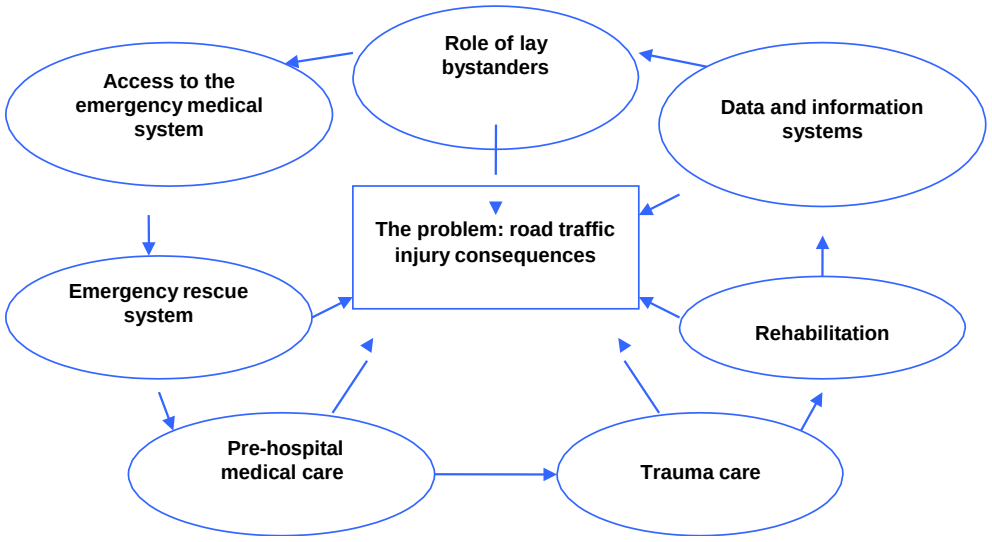
Good inter-governmental coordination arrangements can ensure that attention is given to this key area in target-setting and plans. New Zealand's Road Safety to 2010 strategy, for example, targeted a specific reduction in hospitalisations, the number of people hospitalised for more than one day and the number of people hospitalised for more than three days. Improving trauma management systems was one of the priorities of the strategy (LTSA, 2003).

The NSW Road Safety Strategy 2012 – 2021 includes a specific focus on post-impact response and road trauma treatment, particularly better coordination between emergency retrieval and medical services and the Motor Accidents Authority, as well investigating options for automatic crash notification systems (Wall et al, 2014).

3 The chain of help

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 accident, access to the pre-hospital medical care system, emergency rescue, pre-hospital medical care, trauma care and helping road accident victims who have suffered debilitating injury to re-integrate into work and family life. See Figure 3.

Figure 3: The chain of help



The effectiveness of such a chain depends upon the strength of each of its links (Buylaert, 1990).

4 The role of lay bystanders

4.1 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 an accident. 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 accidents, 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 accident 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.

4.2 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 Organisation (Sasser et al, 2005), 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.

Before the introduction of a national ambulance system, a study in Ghana established that commercial taxi and minibus drivers trained in first aid in Ghana could provide effective pre-hospital care (Mock et al, 2002). See Box 3.

Box 4: First aid training of professional drivers in Ghana

Improving Trauma Care in the Absence of a Formal Ambulance System

Background: The efficacy of a program that builds on the existing, although informal, system of prehospital transportation in Ghana was assessed. In Ghana, the majority of injured persons are transported to the hospital by some type of commercial vehicle, such as a taxi or bus.

Methods: A total of 335 commercial drivers were trained using a six-hour basic first-aid course. The efficacy of this course was assessed by comparing the process of prehospital trauma care provided before and after the course, as determined by self-reporting from the drivers.

The course was conducted with moderate amounts of volunteer labor and gifts in kind, such as transportation to the course. The actual cost of the course amounted to US$3 per participant.

Results: Follow-up interviews were conducted on 71 of the drivers a mean of 10.6 months after the course. In the interviews, 61 percent indicated that they had provided first aid since taking the course. There was considerable improvement in the provision of the components of first aid in comparison to what was reported before the course:

Component of first aid	Before (percent)	After (percent)
Crash scene management	7	35
Airway management	2	35
Bleeding control	4	42
Splint application	1	16
Triage	7	21

Conclusions: Even in the absence of a formal EMS, improvements in the process of prehospital trauma care are possible by building on existing, although informal, prehospital transportation.

Source: Mock and others 2002.

Source: Kobusingye et al, 2006

4.3 Would first aid training for the general public help?

For EU countries, EC Directive 2000/56 provides for Member States to take measures to ensure that: applicants for driving licences know how to behave in the event of an accident; they can assess road accident victims including emergency action such as evacuation of passengers and basic knowledge of first aid. When obtaining a driving licence it is in many countries mandatory to take a first-aid course and e.g. in Germany all drivers are obliged to provide first aid when arriving at an accident scene (CEC, 2003).

The Word Health Organization holds the view that training 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 (Bull, 1985).

5 Access to the emergency medical system

5.1 Telephone notification

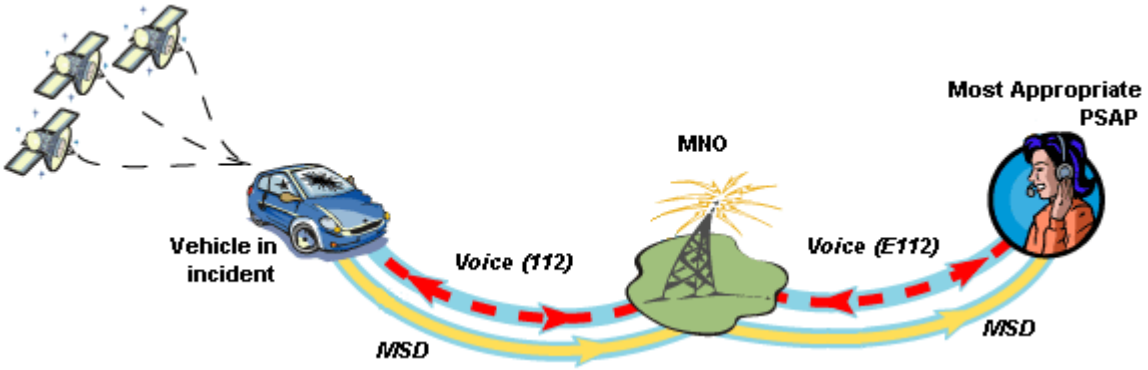
A national emergency number speeds up the process and aims for all relevant agencies to be warned and involved. In high-income countries, access to the emergency medical system is almost always made by telephone, but the coverage and reliability of the telephone link varies between countries. The very rapid growth in the use of mobile telephones across EU countries provides opportunities for better accident notification, as does the recent development on automatic crash notification.

The emergency notification number for the European Union is 112 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 is 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 all 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. For further information see the European Emergency Number Organisation website: http://www.eena.org/

5.2 In-vehicle emergency notification systems - eCall

Automatic Crash Notification (eCall) which is available in several car models today aims to provide emergency responders with data that indicates the severity of the accident and the nature of injuries sustained. It automatically dials 112 - Europe's single emergency number. The aim of eCall is to reduce the time between the accident and arrival of the emergency services. The eCall communicates the vehicle's exact location to emergency services, the time of incident and the direction of travel even if the driver is unconscious or unable to make a phone call. An eCall can also be triggered manually by pushing a button in the car, for example by a witness of a serious accident.

Figure 4: The eCall process (EC, 2016)



Source: https://ec.europa.eu/digital-single-market/en/ecall-time-saved-lives-saved

The eCall system will be mandatorily fitted to all new EU-registered cars from April 2018. The Regulation (EU) 2015/758 was published in the Official Journal on 19 May 2015. Separate legislation (2014) already requires Member States to put in place the infrastructure to handle eCalls.

Since 2010, Euro NCAP's Advanced Rewards has recognised car manufacturers who make available new safety technologies which demonstrate a scientifically proven safety benefit for consumers and society. Several car models have received rewards points for fitting eCall. In 2011 it was estimated more than 765.000 vehicles fitted with eCall were sold in 11 European countries (Chauvel and Haviotte, 2011).

The EU supported the development of eCall through first the eMerge project and later its deployment through the HeERO that developed the pan-European in-vehicle emergency call service based on 112, the common European Emergency number. During four years (HeERO phase 1 in 2011-2013 & HeERO phase 2 in 2013-2014), 15 countries carried out the start-up of an interoperable and harmonised emergency call system.

While no empirical studies of the effects of injury outcomes have been found, some prospective studies have estimated likely effects on fatalities and serious injuries. An overview of the results from these studies is given in Table 4. The results are shown as intervals of the estimated likely upper and lower limits of the possible reductions of fatalities and severe injuries. Studies that do not provide a comprehensible description of the methods are not included in the overview (Elvik et al, 2009).

Table 4: Effects on numbers of fatalities and serious injuries of automatic crash notification

Accident Severity	Types of accidents affected	Number of fatalities/ Injuries in the study	Percentage change in the number of fatalities
Clark & Cushing, 2002 (USA)	All accidents-	30.875	(-1,5; -6)
Evanco, 1999 (USA)	Accidents in rural areas	25.761	(-7; -12)
Virtanen, 2005 (Finland)	All accidents	919	(-3;-8)

Source: Elvik et al, 2009

The studies assumed that all vehicles were equipped with the eCall terminal and that each terminal would function properly. They were unable to evaluate the impact of the precise location information given by eCall, on the swifter arrival of rescue units at the accident site. in evaluating decreases in road traffic deaths nor the overall impact of the system which involves additional players.

A French study (Chauvel and Haviotte, 2011) looked at the effectiveness of eCall in 202 accidents in France and found 2,8% reduction in fatalities. A global assessment of studies carried out to date presented in the report is shown in Table 5.

Table 5: Effectiveness of eCall

Study references	Effectiveness (number of death reduced)	Countries studied
E- Merge	5 - 10%	European Union 15
AINO Study	4 - 8%	Finland
Elmpact	3,6%< 5,8%<7,3%	European Union 25
SEISS	5 - 15%	European Union 25
TRACE	10,80%	Australia
SBD	3%	UK
Eric Country ACN field test	20%	USA- New York
Czech eCall study	3 - 9%	Czech Republic
Swedish eCall study	2 - 4%	Sweden
Dutch eCall study	1 - 2%	Netherlands
CEESAR- LAB ("*a priori*" methodology)	5,1%	France
CEESAR- LAB ("*a posteriori*" methodology)	2%	France

Source: Chauvel and Haviotte, 2011

A cost benefit study based on Norwegian data (see Table 6) indicated that the benefits are larger than the costs only under the assumption of high benefits (8% fatality reduction). Under the assumption of medium or low benefits, the costs exceed the benefits, independent of the costs. These figures are similar to the results from (Virtanen et al, 2006), according to which the cost-benefit ratio is 0,55 under the assumption of small benefits and high costs, and 2,32 under the assumption of large benefits and low costs.

Table 6: Cost-benefit ratios of automatic crash notification under different cost and benefit assumptions

	High benefit (-8% fatalities)	Medium benefit (-4% fatalities)	Low benefit (-1,5% fatalities)
High costs	1,22	0,61	0,23
Low costs	1,65	0,82	0,31

One study estimated that Automatic Crash Notification (ACN) would provide an average accident to Emergency Medical Services (EMS) notification time of one minute, which represented a three-

minute reduction in the total accident-to-hospital (Fildes et al, 2008). Another study also indicates that rural EMS travel times can be significantly shortened by the use of GPS guidance devices (Gonzalez et al, 2009).

The European Commission estimates that 112 eCall can speed up emergency response times by 40% in urban areas and 50% in the countryside and can reduce the number of fatalities by at least 4% and the number of severe injuries by 6% (DG MOVE, 2016).

See ERSO eSafety webtext for further information.

5.3 Telephone answering by the emergency services

An efficient call receiving system within the emergency medical system is essential to avoid wasted time. A variety of models exists but has not been studied yet. 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. European medical experts favour a priori direct contact over indirect contact (Buylaert, 1999). It is not known whether all countries have standards for call receipt, although several countries have developed call receipt performance indicators.

5.4 Emergency Medical Dispatch

In Europe, calls received by the Emergency Medical System result in either automatic dispatch of an emergency ambulance requiring the call taker to give accurate identification of the location of the incident and to mobilise the emergency crew, or selective dispatch depending on the perceived nature and urgency of the incident. The process of doing the latter is known as Emergency Medical Dispatch.

The functions of the Emergency Dispatch System are:

- Prioritisation by level of urgency (triage) to determine the speed of response.
- Prioritisation 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 (Buylaert, 1999).

A computerised system which promotes the call taker, records responses, supports decision-making and provides information for audit and quality assurance is considered essential (Nicholl, 1997). 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, the audit of operations and the training of dispatchers (Buylaert, 1999).

6 Emergency rescue systems

6.1 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.

6.2 Training of emergency personnel

Emergency medical technicians staffing an ambulance and carrying out basic pre-hospital care techniques can save lives and limit disability. At the same time, there is no evidence for the effectiveness of training pre-hospital care paramedical personnel in advanced life-saving skills (Kobusingye et al, 2006). Research shows that the level of training and the degree of professionalism involved varies (Chamberlain, 1998; Huemer et al, 1994). 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 (Buylaert, 1999). 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 organised in many Member States to this effect. Evaluation has shown that by a 3-day cross-sectoral team training course, the extrication and on scene-time may be reduced by as much as 40-50% (Ersson et al, 1999). One issue, in particular, is the need for awareness of the rescue services of special hazards, such as undeployed airbags, in order to safely extract accident victims.

6.3 The availability and response times of ambulances

Land ambulances are used in the majority of attendance at the scene 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 accidents involving ambulances (Buylaert, 1999).

A research overview (Elvik et al, 2009) 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 accidents is lowest where ambulance availability is best and highest where ambulance availability is poor.

Response times depend amongst other things on the distance to the nearest hospital, the availability of ambulances and ambulance personnel, road and traffic conditions and the accurateness of the descriptions of the accident location (Elvik et al, 2009).

Shorter pre-hospital times, in general, are considered an important parameter of the quality of pre-hospital care. These times have the following components:

- Notification time is the time elapsed from occurrence of injury or recognition of severe illness until the EMS system is notified.
- Response time is the time elapsed from notification until arrival of an ambulance to the site of the ill or injured person.
- Scene time is the time taken by pre-hospital providers from arrival at until departure from the scene.
- Transport time is the time elapsed from leaving the scene until arrival at the hospital or other treatment facility (Kobusingye et al, 2006).

A recent US review highlighted the unique challenges for emergency medical service (EMS) systems presented by rural accidents (TRB, 2013). Compared with urban areas, a greater percentage of rural accidents result in multiple fatalities and higher rates of head-on collisions, roll overs, and ejected accident occupants. The review noted that in the US, rural EMS systems often rely on a volunteer force, with less financial resources for staffing, equipment, and training. Response times in rural areas are longer owing to the greater travel distances required to reach the scene of an accident. Additionally, some rural EMS systems operate in areas with limited telecommunication options. The review found that prehospital times for accident occupants were substantially longer for rural accidents, averaging 25 minutes in urban areas and 42 minutes in rural areas. EMS arrive at the scene within 10 minutes of notification in more than 85% of urban fatal accidents but less than 54% of the time in rural accidents. Shorter prehospital times are correlated with lower mortality rates. The Center for Disease Control and Prevention found that severely injured accident occupants who receive care at a Level I trauma centre within 1 hour had a 25% reduction in risk of death (TRB, 2013).

6.4 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 accident risk (Elvik et al, 2009; Buylaert, 1999). No cost-benefit analyses of improved provision of medical services for those injured in road accidents have been found. A cost-benefit analysis of the national air ambulance helicopter service (Elvik, 1996) 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 (Buylaert, 1999).

A US review found that the evidence of a positive impact of the use of air medical transport and its impact on patient outcomes is not definitive; however, patient injury severity, rather than distance, appears to be the factor that benefits most from air transport (TRB, 2013).

7 Pre-hospital medical care

7.1 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 (Buylaert 1999). A survey of pre-hospital literature found only 24 randomised controlled trials and concluded there was insufficient data to provide a strong evidence base for the effectiveness of many common pre-hospital interventions (Bunn et al, 2001). The World Health Organisation (Sasser et al, 2005) 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 specialised medical equipment and to limit further damage in the period preceding the arrival of specialised, 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 specialised technical equipment, infusion of fluids and drugs aimed to stabilise 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, the 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 randomised 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 (Sasser et al, 2005).

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 victims 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 manoeuvres started for immobilizing possible fractures to prevent further damage are also considered to be essential treatments (Buylaert, 1999).

7.2 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.

7.3 Which hospital? The importance of field triage

Different factors need 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 in order 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 (Sasser et al, 2005).

7.4 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, anaesthesiology 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 (Sasser et al, 2005).

7.5 Planning and care in multiple casualty accidents?

Major road accidents involving multiple casualties: Contributory factors include fog and excess speed (Buylaert, 1999). 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 (Sasser et al, 2005). 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 (Buylaert, 1999).

7.6 Legislative framework for pre-hospital care

Establishing a legislative framework for pre-hospital care standards and their compliance forms the basis of a national system. The following areas are commonly addressed by law or by administrative regulation (Sasser et al, 2005):

- 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 inter-facility 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.

A case study on establishing a legislative and compliance framework for Emergency Medical Services compiled from information published by the World Health Organisation is presented in Box 5.

Box 5: Establishing a legislative framework for EMS in Romania – a case study

Between 1990 and 2000, Romania made progress in its provision of emergency medical services (EMS). A network of governmental ambulance services had existed in the country before 1990, and fire departments in some areas had also started running ambulance services. At the same time, several hospitals throughout the country had been upgrading and improving the organization of their emergency departments. Despite these important improvements in trauma and emergency care, Romania's EMS system remained extremely fragmented. The quality and availability of EMS depended on local county resources and motivation, both for pre-hospital ambulance services and hospital emergency care.

In 2006 Health System Reform Law was introduced which defined emergency care as a duty of the state, distinguishing it from other aspects of health care. A major implication of this is that emergency care for all is paid for by the state, whereas all other medical care is paid for by insurance or other means. The Ministry of Health was assisted by an expert Consultative Committee for Emergency and Disaster Medicine, which addressed both pre-hospital and hospital-based components of EMS.

Under this legislation, the criteria and definitions for different levels of hospital emergency departments in terms of staffing, physical resources and financing were outlined. The Consultative Committee also established standards for ambulances, detailing the resources required for each ambulance in terms of medications, materials and staffing. Further decrees were issued in conjunction with other governmental departments to establish the criteria for several types of ambulance vehicle, ranging from first response vehicles to mobile intensive care unit vehicles. The competencies of ambulance personnel were defined and the limits of what each level of personnel could perform in the field were established. Logistical and safety regulations were created and a partnership established with the police force responsible for enforcing these standards through spot checks. Several decrees followed which established standards for different levels of hospital critical care capabilities (including intensive care units) and for different levels of hospital emergency departments, including human resources, equipment, drugs and infrastructure.

In 2007, the Ministry of Health created a Ministerial position – the Under-Secretary of State for Emergency and Disaster Medicines - specifically responsible for the administration of EMS and for implementation of the provisions of the EMS section of the Health System Reform Law. This position has autonomous decision- making power and has enabled documented advances in the organization, administration, enforcement, monitoring and performance of Romania's EMS.

Source: WHO, 2010

8 Trauma care

8.1 What is trauma care?

Trauma care involves the provision of appropriate care at a medical establishment to road accident 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 system needs to be operated by every hospital receiving patients with major trauma.

8.2 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 (Mock et al, 2004). 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% reduction in mortality as a result of improvements in the trauma care system (Simons et al, 1999; Mann et al, 1999; Brennan et al, 2002). 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 (Nathens et al, 2000a; Nathans et al, 2000b). A 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 (MacKenzie et al, 1996).

8.3 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 centres 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 centres 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 (Mock et al, 2004).

International essential trauma care guidelines have been established by the World Health Organisation (Mock et al, 2004). 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 (Peden et al, 2004; Buylaert, 1999; Coats & Davies, 2002). The US vision of a national trauma system is set out in Box 6 and Box 7 (NHTSA, 2006).

The latest detailed requirements for trauma centre capability were set out in 2006 by the American College of Surgeons (ACSTC, 2006).

Box 6: 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.

Source: NHTSA, 2006

Box 7: 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.

Source: NHTSA, 2006

8.4 Regional trauma care plans

Regionalisation of care to specialist trauma centres reduces mortality by 25% and length of stay by 4 days (Mackenzie et al, 2006). Clinical experts recommend that each region should have a major trauma plan which defines the pathway of care for severely injured patients, identifies the location and capability of each trust/hospital within the trauma system and outlines ambulance bypass protocols and thresholds for transferring patients to more specialist units. Within each geographical region there should be a network of units geared to treat trauma patients ranging from those with life threatening conditions, to those with less complex injuries. This 'trauma system' would need to integrate pre-hospital care (i.e. the care delivered by paramedics at the scene of the injury), the initial journey to a suitable unit, inter-hospital transfer (where required for patients in need of more specialist treatment), definitive hospital treatment and rehabilitation (Royal College of Surgeons of England Orthopaedic Association, 2000 and 2007).

8.5 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 anaesthesiologists, 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. 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 (Bunn et al, 2001). For example, in one study on trauma resuscitations, resuscitation time was halved in the presence of an organized trauma team (Driscoll and Vincent, 1992).

8.6 The trauma team leader

In Europe trauma team leaders tend to be emergency physicians, surgeons (orthopaedic surgeons, neurosurgeons, general surgeons), anaesthesiologists or 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 pol trauma as well as team training. Studies have shown that the presence of a trauma team leader improved resuscitation time (Hoff et al, 1997; Sugrue et al, 1995).

8.7 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) (Buylaert, 1999).

Education and training of trauma team: Each trauma centre is responsible for 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.

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 (Mock et al, 2004).

9 Rehabilitation

9.1 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 (EFRTV, 1997).

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.

9.2 Victims' concern about the treatment of road traffic offences

Victims organisations point out that driving offences often fail to include a charge that death or injury had resulted, contributing to the misperception that driving offences are victimless crimes. This aggravates the suffering of victims and calls for more serious treatment of road traffic offences. A global call has been made for better collision investigation, better enforcement and prosecution, civil compensation and acknowledgement of victims' rights (FEVR, 2015).

10 Data and information systems

10.1 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-impact care. The recording of injury severity in hospitals, the measurement of road accident 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 accident data are actions that could improve the quantity and quality of available data on road traffic injury consequences (Buylaert, 1999). Data should be collected by all Member States of the European Union for auditing the performance of the Emergency Medical Services. The review also highlighted the need for regulations for performing post-mortems or radiological investigations in all road traffic deaths should be formulated.

10.2 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 (Ware and Gandek, 1998) 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.

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.

A review of evaluation parameters in use by Hakkert et al (2007) and Gitelman et al (2008) included:

- At the EMS Level (Mock et al, 1993; Nathens et al, 2004).
- 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 (Smith et al, 1990): arrival at scene, treatment in the field, arrival for definitive treatment in hospital (are they within "the golden hour" rule?). See example from Victoria in Table 7 below.
- Type of field treatment.
- Treatment implementation according to protocols, to the extent that protocols exist.

Table 7: 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

Accounting for the limitations of data available in the countries, a core set of performance indicators has been recommended for emergency medical response (Gitelman et al, 2008).

This core set of safety performance indicators includes:

- the number of EMS stations per area,
- the number of EMS transportation units per road length,
- the number of EMS transportation units per citizens,
- percent of physicians and paramedics out of the total EMS staff,
- percentage of highly-equipped transportation units out of the total,
- the demand for response time,
- average response time of EMS,
- percentage of EMS responses meeting the demand,

- the number of trauma care beds per citizens.

10.3 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 (Cameron et al, 2005). They contain detailed information on trauma care. Trauma registries, however, are not common in Europe (Hakkert et al, 2007; Gitelman et al, 2008).

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.

Box 8: Countries participating or supporting the EuroTARN initiative

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

EuroTARN has concluded that it is possible to collect and collate outcome data from established trauma registries across Europe with minimal additional infrastructure using a web-based system. Initial analysis of the results reveals significant international variations.
The network has potential as a source of data for epidemiological and clinical research and for optimal trauma system design across Europe.

Hospital inspection: A review of hospital inspection requirements is provided in the World Health Organization's), essential care guidelines (Mock et al, 2004).

Performance indicators: A review of evaluation parameters in use by Gitelman et al (2009), included:

At the Hospital Level

- Level of coverage: to what extent do critical patients arrive at trauma centres 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 (Barell 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.
- the percentage of beds in trauma centres and trauma departments of hospitals out of the total trauma care beds
- the number of total trauma care beds per 10.000 citizens

For outcomes

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

10.4 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 accident 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 (IRCOBI, 2006). 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 (Campion, 1989).

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 (Boyd et al, 1987.

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 (Hirsch and Eppinger, 1984), Gustafsson et al, 1985), (Bull, 1985) – 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) (AAAM, 1994). 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) (Mackenzie et al, 1996) was proposed.

The Glasgow Outcome Scale has also been used in 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 (Mackenzie et al, 1996). 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 (IRCOBI, 2006). Validation for the Functional Capacity Index in Europe may be required (EuroTarn, 2007).

Functional Independence Measure: The Functional Independence Measure (FIM) scale assesses physical and cognitive disability and focuses on the burden of care.

A study comparing the responsiveness of the Glasgow Outcome Scale (GOS), GOS- Extended (GOSE), Functional Independence Measure (FIM), and modified FIM in major trauma patients, with and without significant head injuries found that the GOSE was the instrument with greatest responsiveness and the lowest ceiling effect in a major trauma population with and without significant head injuries and is recommended for use by the authors by trauma registries for monitoring functional outcomes and benchmarking care (Williamson et al, 2011) .

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 (EuroQuol Group, 1990).

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 (Ware and Gandek, 1998).

References

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

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

American College of Surgeons, Trauma Committee (2006), Resources for optimal care on the injured patient: 2006, ISBN 1-880696-30-4, Chicago.

Bliss, T. and Breen, J. (2009) Implementing the Recommendations of the World Report on Road Traffic Injury Prevention: Country guidelines for the conduct of road safety management capacity reviews and the related specification of lead agency reforms, investment strategies and safety programs and projects, Global Road Safety Facility, World Bank, Washington.

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

Breen (2015) Road safety study for the interim evaluation of Policy Orientations on Road Safety 2011-2020, 12 February 2015, Brussels.

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.

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

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.

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

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.

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

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

Champion, H. R. (2005) New tools to reduce deaths and disabilities by improving emergency care. Paper Number 05-0191.

Chauvel C, Haviotte C (2011) eCall System: French A Posteriori Efficiency Evaluation, Paper Number 11.0208 Enhanced Safety of Vehicles Conference, Washington DC.

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

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.

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

Durham R.J, Prachet E., Orban, B., Lottenburg L., Tepas J, Flint J (2006) Evaluation of a Mature Trauma System, Annals of Surgery: 2006:243;775-785.

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

Elvik, R. Vaa T, Hoye A and A Erke A and M Sorensen Eds (2009) The Handbook of Road Safety Measures, 2nd revised edition Emerald Group Publishing Limited, ISBN: 9781848552500.

Ersson, A., Lundberg, M., Wramby, C.O. and Svensson, H. (1999) Extrication of entrapped victims from motor vehicle accidents: the crew concept. European Journal of Emergency Medicine 7: pp. 341- 347.

European Commission Communication (2010) Towards a European road safety area: policy orientations on road safety 2011-2020, COM (2010) 389 final.

European Commission (2011) CARE data, European Commission website
http://ec.europa.eu/transport/road_safety/pdf/observatory/historical_evol_popul.pdf

European Commission (2013) Commission Staff Working Document on the implementation of Objective 6 of the European Commission's Policy Orientations on Road Safety 2011-2020 – First milestone towards an injury strategy, SWD (2013) 94 final, Brussels, 19.3.2013.

European Commission (2016) European Commission – Fact Sheet 2015 road safety statistics: What is behind the figures? Brussels, 31 March 2016.

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

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

EuroTARN (2007) A comparison of European Trauma Registries. The first report from the EuroTARN Group, Resuscitation (2007) 75, 286—297.

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

ETSC (2007) The social and economic consequences of road traffic injury in Europe, ETSC, Brussels.

ETSC (2011) Road Safety Target Outcome: 100.000 fewer deaths since 2001, 5th Road Safety PIN Report, European Transport Safety Council, Brussels.

ETSC (2015) Ranking road safety performance across the EU, Brussels.

FEVR (2015) Justice and the post crash response in the UN Decade of Action for Road Safety. Briefing prepared for the 2nd High Level Global Conference on Road Safety, Brasilia November 18-19, 2015.

Fildes, B.N., Fitzharris, M.P., Lahausse, J.A., Page, Y. (2008) The potential for automatic crash notification systems to reduce road fatalities. 52nd AAAM Annual Conference, Annals of Advances in Automotive Medicine.

Gitelman, V., Auerbach K., Doveh E., Avitzour M. and Hakkert , S. (2008) Safety Performance Indicators for Trauma Management: Theory Update. Deliverable D3.11b of the EU FP6 project SafetyNet.

Gonzalez, R.P., G.R. Cummings, M.S. Mulekar, S.M. Harlan, and C.B. Rodning (2009) Improving Rural Emergency Medical Service Response Time with Global Positioning System Navigation, The Journal of Trauma Injury, Infection, and Critical Care, Vol. 67, No. 5, Nov. 2009, pp. 899–902.

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.

Hakkert, A.S., Gitelman, V., and Vis, M. A. (Eds.) (2007) Road Safety Performance Indicators: Theory. Deliverable D3.6 of the EU FP6 project SafetyNet.

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

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.

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.

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

IHME (2013) Global Burden of Disease: Generating Evidence, Guiding Policy, Institute of Health Metrics and Evaluation, University of Washington, Seattle.

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

Kobusingye, O.C., Hyder A.A., Bishai D.,Joshipura M., Romero Hicks, E., Mock, C., Emergency Medical Services. (2006) Disease Control Priorities in Developing Countries (2nd Edition), ed. 1.261-1.280. New York: Oxford University Press. DOI: 10.1596/978-0-821- 36179-5/Chpt-68.

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

Land Transport Safety Authority (2003) Road Safety to 2010, Wellington.

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

Mackay GM (2005) Quirks of Mass Accident Data Bases, Journal of Traffic Injury Prevention 6:4 (308-311), December 2005

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

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

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.

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.

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.

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.

Mock, C. N., Tiska, M., Adu-Ampofo, M. and Boakye, G. (2002) Improvements in Prehospital Trauma Care in an African Country with No Formal Emergency Medical Services. Journal of Trauma 53 (1): 90–97.

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

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.

Nathens, AB, Jurkovich, GJ; Rivara, FP. MD; Maier, RV (2000a) 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.

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

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.

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

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

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.

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.

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.

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

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.

Ricardo-AEA (2014) Update of the Handbook on External Costs of Transport, Final Report for the European Commission: DG MOVE, ED57769 Issue Number 1.

Sánchez-Mangas, R., García-Ferrer, A., de Juan, A. and Martín Arroyo, A. (2010) The probability of death in road traffic accidents. How important is a quick medical response? Accident Analysis and Prevention 42 (2010) 1048.

Rotondo M.F., Bard, M.R., Sagraves, S.G., Toschlog, E.A., Schenarts, P.J., Goettler, C.E., Newell, M.A., Robertson, M.J. (2006) What price commitment – What Benefit? The cost of a saved life in a developing Level 1 trauma center. AAST 2006 Annual Scientific Meeting.

Royal College of Surgeons of England/British Orthopaedic Association (2000) Better care for the severely injured, London.
Royal College of Surgeons of England (2007) Provision of Trauma Care Policy Briefing, London.

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

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

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

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.

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.

TRB (2013) Emergency Medical Services Response to Motor Vehicle Crashes in Rural Areas, A Synthesis of Highway Practice, NCHRP SYNTHESIS 451, Washington.

United Nations (2010) United Nations General Assembly resolution 64/255, March 2010, Geneva.

United Nations Road Safety Collaboration (2011) Global Plan for the Decade of Action for Road Safety 2011 – 2020, World Health Organization, Geneva.

United Nations (2015) Transforming Our World - the 2030 Agenda for Sustainable Development, Geneva.

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

Wall, J.A., Woolley, J.B., Ponte, G.B. and Bailey, T.B. (2014) Post-crash response arrangements in Australia compared to other high performing road safety nations. Proceedings of the 2014 Australasian Road Safety Research, Policing & Education Conference 12 – 14 November, Melbourne.

Ware, J.E. and 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.

White, K. L., Williams, T. F. and Greenberg, B. G. (1996) The Ecology of Medical Care. 1961. Bulletin of the New York Academy of Medicine 73 (1): 187–205.

Williamson O.D, Gabbe, B.J., Sutherland AM, Wolfe R, Forbes A. Cameron P (2011) Comparing the Responsiveness of Functional Outcome Assessment Measures for Trauma Registries Journal of Trauma-Injury Infection & Critical Care: July 2011 - Volume 71 - Issue 1 - pp 63-68.

World Health Organisation (2006) Road traffic injury prevention training manual, Geneva.

World Health Organisation (2009) Eds. Mock C, Juillard C, Brundage S, Goosen J, Joshipura M. Guidelines for trauma quality improvement programmes, Geneva.

World Health Organisation (2010) Strengthening care for the injured: Success stories and lessons learned from around the world, ISBN 978 92 4 156396 3, Geneva.

Notes

1. Country abbreviations

	Belgium	BE		Italy	IT		Romania	RO
	Bulgaria	BG		Cyprus	CY		Slovenia	SI
	Czech Republic	CZ		Latvia	LV		Slovakia	SK
	Denmark	DK		Lithuania	LT		Finland	FI
	Germany	DE		Luxembourg	LU		Sweden	SE
	Estonia	EE		Hungary	HU		United Kingdom	UK
	Ireland	IE		Malta	MT			
	Greece	EL		Netherlands	NL		Iceland	IS
	Spain	ES		Austria	AT		Liechtenstein	LI
	France	FR		Poland	PL		Norway	NO
	Croatia	HR		Portugal	PT		Switzerland	CH

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4. Disclaimer

5. Please refer to this Report as follows:
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