

Prehospital trauma care systems



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Prehospital trauma care systems



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Preface

Injury is a major cause of premature death and disability worldwide. Most existing injury control strategies focus on primary prevention – that is, avoiding the occurrence of injuries or minimizing their severity – or on secondary prevention – providing adequate medical response to enhance treatment and thereby minimize harm following an injury. In many instances the prompt provision of emergency care and rapid movement of injured victims from the scene of injury to a health-care facility can save lives, reduce the incidence of short-term disability and dramatically improve long-term outcomes. Unfortunately, the capacity to provide this basic level of medical care does not exist in many parts of the world.

In 2000, a group of international experts attending a special meeting convened by the World Health Organization (WHO) in Geneva agreed that there is a pressing need to strengthen the quality and availability of systems of prehospital trauma care throughout the world. To achieve this goal, they proposed a collaboration that would identify the core strategies, equipment, supplies and organizational structures needed to create effective and adaptable prehospital care systems for injured persons worldwide.

This document is the realization of this objective. It focuses on the most promising interventions and components of prehospital trauma care systems, particularly those that require minimal training and relatively little in the way of equipment or supplies. These elements can and should form the foundation of any emergency care system, regardless of the level of resources available. Once these elements are in place, additional components may be added at the discretion of local, regional or national planners and policy-makers, contingent on available resources and a clear understanding of the likely costs and benefits of each intervention. Recommended organizational strategies for training, record-keeping, supervision and accountability are also included.

This document is based on several fundamental principles.

- An effective prehospital trauma care system should be simple, sustainable, practical, efficient and flexible.
- Whenever possible, prehospital care should be integrated into a country's existing health-care, public health, and transportation infrastructures.
- Effective systems for prehospital trauma care will form the foundation for all emergency care wherever they are established and will also quickly be tasked

with the responsibility of addressing a broader range of health concerns, including paediatric, adult medical and obstetrical emergencies.

The principles outlined in this document should be valid for the care of injured people in the majority of emergency situations, whatever their cause or consequence. It is important to keep in mind, however, that this document is not a treatment manual. References that provide in-depth coverage of prehospital care techniques are listed in the Reference section and in the Selected Readings list.

The focus of this document is on the development of prehospital trauma care systems. Accordingly, it addresses key elements of such a system, including organization and oversight, accountability, documentation of care, communications, and important ethical and legal considerations.

The lack of empirical data on the benefit of many prehospital care interventions is a serious problem. This document is not an evidence-based review because there is insufficient evidence to prove or disprove the benefit of many interventions in widespread use. Rather, this document can be more accurately characterized as a product of expert consensus. The individuals who contributed to this report were drawn from around the world, and represent a wide range of disciplines, perspectives, experiences and viewpoints.

In light of the dearth of well-controlled studies of prehospital care, the authors and editors of this report issue an unequivocal call for clinical trials that are carefully designed to fill the large gaps in our knowledge. This is the only way planners can ensure that resources spent on prehospital care and other public health interventions produce the greatest possible benefit for the largest number of people.

On behalf of everyone who worked on this project, I express our collective hope that the information contained in this document will lead to the implementation of effective and sustainable prehospital trauma care programmes worldwide.

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I. Executive summary

Injury is one of the leading causes of mortality and morbidity worldwide. The burden that injuries place upon societies is particularly large in countries with limited resources. The mission of the Department of Injuries and Violence Prevention at the World Health Organization (WHO) is not only to prevent injuries and violence but also to mitigate their consequences and enhance the quality of life of people with disabilities. The department recognizes that the prehospital care of people who have been injured is an important aspect of this goal, so a working group of experts was convened to draft a document outlining key concepts for developing prehospital trauma care systems. The document that follows embodies this vision. It is designed to promote the core values of simplicity, sustainability, practicality, efficiency and flexibility. The recommendations it contains are intended to be used by individuals and groups working at policy-development and implementation levels.

Premise

Some might argue that the measures proposed in this document are too basic. However, there is scant evidence that more advanced and costly approaches to prehospital care are inherently superior to less expensive but effective treatments. Considerable good may be accomplished by ensuring that severely injured people receive simple but life-sustaining care within minutes of injury. At the heart of this document is the notion that selected bystanders, community volunteers and other citizens with minimal training, working in concert with professional health-care providers and the formal medical care structures, can provide effective and sustainable prehospital trauma care, regardless of a nation's level of resources.

Core components

Every effective prehospital care system must have certain core administrative and programmatic elements. When available, a country or region's existing emergency medical service should be utilized and strengthened, with input from community leaders and members of the population that it serves. Various structural models of prehospital care systems exist. The one chosen for a particular locale should take into account local factors and resources. At the national level, a lead agency should be designated to

promote prehospital trauma care. In some countries, this role may be adopted by the ministry of health, while in others it may reside in the ministry of the interior, the transportation ministry or elsewhere. Because prehospital trauma care involves public safety as well as public health, intersectoral cooperation is essential.

Regardless of how simple or sophisticated a given prehospital trauma care system might be, certain elements are essential in order to decrease preventable morbidity and mortality. These elements include, at a minimum, prompt communication and activation of the system, the prompt response of the system, and the assessment, treatment and transport of injured people to formal health-care facilities, when necessary. Whenever and wherever possible, existing clinics, hospitals, and health services should be utilized to ensure efficient mobilization of health-care resources. This is as true in remote or rural areas as in more urban areas.

First responder care

Where no prehospital trauma care system exists, the first and most basic tier of a system can be established by teaching interested community members basic first aid techniques. These first responders can be taught to recognize an emergency, call for help and provide treatment until formally trained health-care personnel arrive to give additional care. It may be possible to identify particularly motivated or well-placed workers, such as public servants, taxi drivers, or community leaders, and train them to provide a more comprehensive level of prehospital care. In addition to learning a more extensive range of first-aid skills, this group could be taught the basic principles of safe rescue and transport. With this level of training, a kit of simple equipment and supplies and access to a suitable vehicle, these individuals can provide an acceptable level of trauma care while transporting an injured person to an appropriate health-care facility.

Basic prehospital trauma care

The second tier of care can be provided at the community level by those who have been trained in the principles of basic prehospital trauma care (also known as basic life support). These providers should have extensive formal training in prehospital care, scene management, rescue, stabilization and the transport of injured people. Those who provide this basic care form the backbone of formal prehospital trauma care systems, where these presently exist.

Advanced prehospital trauma care

If local considerations and imperatives dictate and if sufficient resources can be secured, a third, significantly more sophisticated, tier of prehospital care may be added: advanced prehospital trauma care (also known as advanced life support). The decision to provide this level of care should not, however, be made at the expense of the more basic elements of prehospital care described above.

Examples of third-tier care interventions include the establishment of complex regional call management centres and highly integrated communications networks as well as the provision of advanced invasive techniques. On a system level, advanced prehospital interventions include call management centres, the development of integrated wireless communication networks and the purchase and maintenance of a fleet of sophisticated ground ambulances or air ambulances. Broadly termed “advanced life support”, clinical services like these generally require the skills of a professional prehospital care provider – either a physician or a non-physician paramedic with hundreds, or even thousands, of hours of training.

Despite the high costs of advanced life support interventions, there is little evidence that advanced prehospital interventions benefit more than a small subset of the most critically ill or injured victims. If adopted without regard for cost, advanced life support programme techniques can inadvertently harm prehospital systems by diverting precious resources from less glamorous but clearly effective interventions that benefit far more people. For this reason, we urge planners to use caution when considering whether to adopt advanced life support options and to base their decisions on a clear understanding of the costs of implementation versus the anticipated benefits.

Core administrative elements

In addition to implementing basic systems of care, certain administrative elements must be in place to ensure that a prehospital care system is both effective and sustainable. For example, each episode of care should be documented, not only because it is important to monitor the processes and outcomes of care, but also because incident records provide important insights into the nature and location of community hazards and how many injuries might be prevented.

Legal and ethical considerations

Finally, for prehospital trauma care systems to function effectively, certain ethical and legal principles must be established and followed. Bystanders must feel both empowered to act and confident they will not suffer adverse consequences, such as legal liability, as a result of aiding someone who has been injured. Most of the legal and ethical concepts that underlie the provision of prehospital care are universally respected, regardless of a country’s religious, ethical and cultural traditions.

A call to action

The global burden of injury, which is already a major cause of death and disability worldwide, is growing. If steps are not taken, the rapid increase in the availability of motor vehicles in developing countries will dramatically increase the human toll of injuries during the next decades. This must not be allowed to happen.

Policy-makers can prevent many injuries in their own country and reduce the human and economic toll of those that occur by implementing basic prehospital care systems.

Governments can enhance their health-care capacity and improve access to care for a wide range of emergency problems and conditions by closely linking these systems to the existing public health and health-care infrastructures in their countries. In the pages that follow, we describe a simple but effective approach that can be taken to achieve this goal.

2. Introduction

2.1 Injury prevention and control: the magnitude of the problem

Every year, approximately 5 million people worldwide die from injuries (1). In 2002, road traffic-related injuries, self-inflicted injuries, interpersonal violence, burns and drowning were among the 15 leading causes of death occurring among people aged between 5 years and 44 years (Table 1) (2). In addition to the millions who die each year, millions more are temporarily or permanently disabled. This toll is expected to increase in coming years (3).

Injuries, whether due to road traffic crashes, violence or other causes, affect not only the immediate victim, but also his or her family and members of the surrounding community. Injuries exact a large societal and economic toll on society. The economic burden of injury is great – both in terms of the direct costs of medical care and the indirect economic costs of premature death and disability. This burden is magnified when one or more family members are forced to leave work to care for a disabled family member or relative. Countless hours of productivity are lost as family, friends and society adapt to the death or disability of loved ones.

Rates of injury are high, particularly in the developing world. Numerous factors contribute to the high rate of injury in developing countries. These include, but are not limited to, hazardous environments and workplaces, income and gender inequalities, poorly designed roads, inadequate enforcement of traffic regulations, poorly maintained motor vehicles, alcohol abuse, lack of efficient emergency medical response systems and overburdened health-care infrastructures.

TABLE 1. **15 most common causes of death worldwide by age group, 2002^a**

Rank	Leading cause of death by age group ^b						All ages
	0–4 years	5–14 years	15–29 years	30–44 years	45–59 years	≥60 years	
1	Lower respiratory infections (1 890 008)	Childhood cluster diseases (219 434)	HIV/AIDS (707 277)	HIV/AIDS (1 178 856)	Ischaemic heart disease (1 043 978)	Ischaemic heart disease (5 812 863)	Ischaemic heart disease (7 153 056)
2	Diarrhoeal diseases (1 577 891)	Road traffic injuries (130 835)	Road traffic injuries (302 208)	Tuberculosis (390 004)	Cerebrovascular disease (623 099)	Cerebrovascular disease (4 685 722)	Cerebrovascular disease (5 489 591)
3	Low birth weight (1 149 168)	Lower respiratory infections (127 782)	Self-inflicted injuries (251 806)	Road traffic injuries (285 457)	Tuberculosis (400 708)	Chronic obstructive pulmonary disease (2 396 739)	Lower respiratory infections (3 764 415)
4	Malaria (1 098 446)	HIV/AIDS (108 090)	Tuberculosis (245 818)	Ischaemic heart disease (231 340)	HIV/AIDS (390 267)	Lower respiratory infections (1 395 611)	HIV/AIDS (2 818 762)
5	Childhood cluster diseases (1 046 177)	Drowning (86 327)	Interpersonal violence (216 169)	Self-inflicted injuries (230 490)	Chronic obstructive pulmonary disease (309 726)	Cancers of the trachea, bronchus or lung (927 889)	Chronic obstructive pulmonary disease (2 743 509)
6	Birth asphyxia and birth trauma (729 066)	Tropical cluster diseases (35 454)	Lower respiratory infections (92 522)	Interpersonal violence (165 796)	Cancers of the trachea, bronchus or lung (261 860)	Diabetes mellitus (749 977)	Diarrhoeal diseases (1 766 447)
7	HIV/AIDS (370 706)	Fires (33 046)	Fires (90 845)	Cerebrovascular disease (124 417)	Cirrhosis of the liver (250 208)	Hypertensive heart disease (732 262)	Tuberculosis (1 605 063)
8	Congenital heart abnormalities (223 569)	Tuberculosis (32 762)	Drowning (87 499)	Cirrhosis of the liver (100 101)	Road traffic injuries (221 776)	Stomach cancer (605 395)	Childhood cluster diseases (1 359 548)
9	Protein-energy malnutrition (138 197)	Protein-energy malnutrition (30 763)	War (71 680)	Lower respiratory infections (98 232)	Self-inflicted injuries (189 215)	Tuberculosis (495 199)	Cancers of the trachea, bronchus or lung (1 238 417)
10	STDs excluding HIV (67 871)	Meningitis (30 694)	Hypertensive disorders (61 711)	Poisoning (81 930)	Stomach cancer (185 188)	Colon or rectal cancer (476 902)	Malaria (1 221 432)
11	Meningitis (64 255)	Leukaemia (21 097)	Maternal haemorrhage (56 233)	Fires (67 511)	Liver cancer (180 117)	Nephritis or nephrosis (440 708)	Road traffic injuries (1 183 492)
12	Drowning (57 287)	Falls (20 084)	Ischaemic heart disease (53 870)	Maternal haemorrhage (63 191)	Diabetes mellitus (175 423)	Alzheimer disease and other dementias (382 339)	Low birth weight (1 149 172)
13	Road traffic injuries (49 736)	Interpersonal violence (18 551)	Poisoning (52 956)	War (61 018)	Lower respiratory infections (160 259)	Liver cancer (367 503)	Diabetes mellitus (982 175)
14	Endocrine disorders (42 619)	Poisoning (18 529)	Childhood cluster diseases (48 101)	Drowning (56 744)	Breast cancer (147 489)	Cirrhosis of the liver (366 417)	Hypertensive heart disease (903 612)
15	Tuberculosis (40 574)	Malaria (15 372)	Abortion (43 782)	Liver cancer (55 486)	Hypertensive heart disease (129 634)	Oesophageal cancer (318 112)	Self-inflicted injuries (874 955)

Source: Statistical Annex, WHO Global Burden of Disease project, 2002, version 1.

^aDeaths due to injury are highlighted in bold.^bFigures in parentheses are number of deaths.

The incidents that produce serious or fatal injuries are not random or unpredictable events. In many cases, they can be identified and acted upon. During the past few decades, research has shown that many injuries can be prevented or their severity reduced through the implementation of simple measures. Innovative solutions that engage different sectors of society have resulted in cost-effective interventions that can prevent injuries at work, at home and on the street. Examples include the use of motorcycle helmets and restraining systems, such as seat-belts and child restraints in automobiles; the design of safer workplaces; the development of flame-resistant sleepwear; the use of smoke detectors; and the installation of fencing around hazards such as wells or deep pools of water. Many of these strategies are highly cost effective. A host of interventions have also shown promise in reducing violence-related injuries or limiting their severity. These include programmes on substance abuse, parent training schemes and school-based violence prevention programmes, as well as the use of home visits and efforts to clear landmines.

2.2 Prehospital care

2.2.1 The need

Generally, the best way to reduce rates of death or disability from life-threatening injuries is to prevent them. However, it is often possible to minimize the consequences of serious injury, including long-term morbidity or mortality, by promptly providing effective prehospital care.

Deaths from severe injury occur in one of three phases (Figure 1). They:

1. **occur immediately** or occur quickly as a result of overwhelming injury;
2. **occur during the intermediate or subacute phase.** These deaths occur within several hours of the event and are frequently the result of treatable conditions;
3. **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.

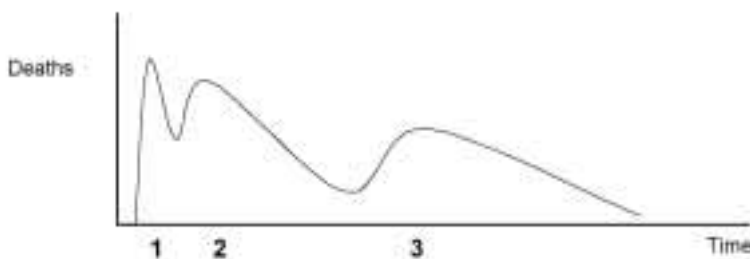


Figure 1. Trimodal distribution of deaths from road traffic injuries (4). (This curve does not represent actual quantitative data. Time is represented on a logarithmic basis).

Many fatal injuries may be prevented or their severity reduced by adequate prehospital trauma care (5–12). The major benefits of prehospital care are realized during the second phase of trauma, when the timely provision of care can limit or halt the cascade of events that otherwise quickly leads to death or lifelong disability. Without prehospital care, many people who might otherwise survive their injuries may die at the scene or en route to the hospital. Most deaths in the first hours after injury are the result of airway compromise, respiratory failure or uncontrolled haemorrhage. All three of these conditions can be readily treated using basic first aid measures.

Prompt prehospital care may also prevent a number of delayed deaths from trauma. Measures that are useful for preventing deaths in this phase include proper wound and burn care, adequate immobilization of fractures, support of oxygenation and blood pressure during the first hours after a traumatic brain injury, as well as other measures that reduce the likelihood of complications developing later.

Deaths occurring in the first, immediate phase of injury cannot be directly prevented by improving the quality of prehospital care and hospital-based emergency care, but an organized system of care may support injury prevention efforts by systematically collecting data that are useful for implementing prevention programmes, such as identifying high-risk settings, high-risk behaviours, high-risk products and high-risk groups.

Unfortunately, most of the world's population does not have access to prehospital trauma care. In many countries, few victims receive treatment at the scene and fewer still can hope to be transported to the hospital in an ambulance. Transport, when it is available, is usually provided by relatives, untrained bystanders, taxi drivers or truck drivers, or a police officer. As a result, many victims may needlessly die at the scene or during the first few hours following injury.

2.2.2 Advanced prehospital trauma care

Over the years, many countries have developed increasingly complex and costly systems for providing emergency medical care and trauma care. In these countries, particularly in urban and suburban areas, prehospital care is commonly provided by professional (paid) rescuers while community volunteers with basic training may play a part in providing care in rural or sparsely populated areas. In many of these countries, firefighters or police officers are often the first officials to reach the scene; they are often followed by an ambulance equipped to render advanced prehospital trauma care that is staffed by a physician or non-physician paramedics.

Once trained personnel arrive, the injured person is assessed and treated at the scene and may receive one or more interventions associated with advanced prehospital trauma care, such as intravenous fluids, endotracheal intubation, and even a highly invasive intervention such as needle decompression or cricothyroidotomy. Transportation is then provided in a large ground or air ambulance that is equipped with sophisticated monitoring devices, a wide range of medicine, and one or more modes of wireless communication.

While advanced systems are impressive and undoubtedly benefit some patients, there is little evidence that they are inherently superior to systems that offer basic prehospital care (13–23). This is particularly true in situations in which basic care is quickly and consistently applied. In fact, most of the benefits of prehospital trauma care can be readily realized if vital interventions are applied in a timely manner.

Some authors recommend that policy-makers and system planners in developing countries reject costly approaches to emergency care used in developed countries until they have been proven to be effective through well designed clinical trials (24). In fact, with few exceptions (such as early defibrillation for victims of cardiac arrest), most advanced interventions have not been scientifically proven to be effective because the necessary randomized trials have not been conducted. In contrast, improved outcomes have been documented after bystanders and health-care providers have been educated to provide the fundamental elements of trauma care (25–27).

2.2.3 Prehospital care in the community

Considerable good may be accomplished by ensuring that victims receive life-sustaining care within a few minutes of injury. Even in countries with limited resources, many lives may be saved and disabilities prevented by teaching motivated people what to do at the scene. The foundations of an effective prehospital system may be laid by recruiting carefully selected volunteers and non-medical professionals and giving them special training as well as the basic supplies and equipment they need to provide effective prehospital care. (Please see the resource matrix in section 5 for further information).

Ideally, each community should identify the best locally available means of transporting injured people to the nearest appropriate health-care facility, whether it is a community clinic or a district hospital. Once there, a health-care provider who has received more formal training can assess and treat the victim. If the victim's injuries can be managed at the local level, treatment may be provided there and the patient can return home. If, however, the extent of injury exceeds the capabilities of the local provider, the patient should be transferred to the nearest hospital or trauma unit for definitive care. In certain instances, patients who are seriously injured may benefit from bypassing a nearby facility and instead being directly transported to the closest hospital with a trauma unit. If this facility is a considerable distance from the scene, it may be more prudent to take the patient to a clinic or health-care facility so their condition can be stabilized.

Widespread adoption of simple prehospital care strategies could produce many benefits including:

- engaging motivated citizens in the care of their neighbours;
 - providing these citizens with the knowledge and skills they need to provide first aid to people with severe injuries;
 - creating community capacity to render assistance to injured victims at the scene;
- and

- enhancing a community's and a nation's capacity to handle mass-casualty events, such as earthquakes, the collapse of a building or a bombing.

2.3 About this document

2.3.1 Background

In 2000, a meeting of international experts was convened in Geneva, Switzerland, by WHO to discuss how to strengthen prehospital care around the world, especially in low-income and middle-income countries. The group decided to write a document that could assist policy-makers in implementing highly economical but effective prehospital care systems. An editorial committee (listed in the Contributors section) was charged with creating the first draft of this document, which described current practices in and knowledge about setting up such systems. To ensure broad consensus, progressively refined drafts were peer-reviewed by diverse groups of experts from Europe, Africa, Australasia and the Americas. The drafts were also discussed by a large group of attendees at the 6th World Conference on Injury Prevention and Safety Promotion in Montreal, Canada in May 2002.

After further revisions and additional expert input, the penultimate draft of this document was presented for comment to the attendees of a special symposium for trauma care experts that had been convened in conjunction with the 7th World Conference on Injury Prevention and Safety Promotion in Vienna, Austria, in June 2004. The document then underwent final review at the Prehospital Care Meeting at WHO headquarters in Geneva in December 2004. This monograph is the culmination of these discussions, and represents the consensus opinions of experts from around the world.

2.3.2 Goals

The specific goals of this document are to:

- identify essential skills, supplies and equipment that will enable lay people and health-care providers to assess, stabilize and transport injured victims to facilities that can provide definitive care;
- describe an efficient and sustainable approach to prehospital trauma care that will increase the likelihood that severely injured patients survive and reach the nearest hospital or other formal health-care setting;
- assist governments in prioritizing their spending by identifying systems of care that maximize survival, reduce the incidence of long-term disability and generate the basic surveillance and quality improvement data required to support effective programmes for injury prevention and control.

2.3.3 Target audience

There is little information on how best to implement prehospital trauma care systems, especially in regions of the world with limited resources. Although many prehospital

care manuals teach specific trauma care techniques, none have attempted to describe how to set up a system, especially in low-income and middle-income settings. We aim to identify effective organizational strategies that can be applied in any country, regardless of its economic resources. This document is designed to help governments, officials in ministries of health and other decision-makers to establish, regulate and maintain prehospital trauma care systems that are simple, sustainable and efficient.

2.3.4 Scope

This manual specifically focuses on trauma care delivered during the prehospital phase (i.e., before arrival at a hospital, clinic and other fixed health-care setting). Prehospital care is only one point on a continuum of care that includes public health, prehospital (emergency) care and transport, community-based primary care, outpatient care, hospital-based care and, ultimately, rehabilitation or long-term care.

Our recommendations focus only on the treatment of burns and injuries caused by mechanical trauma arising from everyday events regardless of intent (intention or unintentional), cause (e.g., motor vehicle, violence or occupation) or consequence (e.g., physical trauma, mental trauma or social trauma). A comprehensive discussion of the processes of care required to respond to situations in which there are large numbers of casualties arising from natural disasters or man-made events exceeds the scope of this manual but it is widely agreed that the best way of preparing for these types of events is to develop systems of care that are capable of treating victims of serious injury on a daily basis. Nonetheless, we recognize that any prehospital care system, no matter how narrowly defined, will be called upon to respond to all types of emergencies, including acute adult and paediatric illnesses, cardiovascular disorders and obstetrical emergencies. The elements of the system we describe are broad enough to be useful in providing care to patients with a wide range of conditions.

This manual is not intended to be clinical in orientation, describing specific trauma care manoeuvres or techniques. Rather it is a set of policy recommendations designed to guide health-system planners and policy-makers at the development and implementation levels who have the responsibility for making decisions about the allocation of resources.

Because there is a dearth of well designed rigorous research trials of many commonly used prehospital treatments and interventions, these guidelines should not be considered definitive. There is a striking lack of evidence from studies, making it difficult to judge the value of prehospital interventions. Thus this document represents the consensus opinion of a wide range of injury and public health experts. It will benefit from ongoing development, assessment, research and refinement. Because there are few clear-cut answers about which strategies are best, the recommendations contained in this document are sufficiently flexible to allow planners to modify them to suit local social, economic and political considerations.

2.3.5 Overview

At the heart of this manual is the notion that community members and non-medical professionals can be trained to work collaboratively within a country's existing health-care infrastructure to provide a basic level of prehospital care to people who are seriously injured, and that it is possible to do this affordably. This idea is not new. Community members in Africa and South America have been successfully trained to provide effective emergency care using locally available resources (28–32). (See the case study on Ghana in Box 1.)

We outline key considerations in planning and implementing cost-effective prehospital care systems. Because different settings call for different approaches or offer access to different levels of resources, several programmatic options are presented. It is important to view these options as incremental additions to a core system rather than as substitutes for more basic elements of trauma care. The core components of an effective prehospital system should not be short changed in order to implement more costly services of uncertain value.

Box 1. **Case study: Ghana**

Building on informal systems of care: first-aid training for commercial drivers (31, 33)

In Ghana, most of the severely injured people who make it to a hospital are taken there in a commercial vehicle, such as a taxi or bus. In some cases relatives pay the drivers, and in others the drivers act as good Samaritans, taking injured people from the scenes of accidents that they come across in their work. Furthermore, these drivers may provide elements of first aid, but only rarely do they have any formal training.

Between 1998 and 2000, commercial drivers in Ghana participated in a first-aid training programme. This programme was designed to provide information at an educational level appropriate to most of Ghana's drivers. It relied heavily on demonstrations of care, active learning and practise sessions rather than on didactic lectures and written material.

A total of 335 drivers participated. The efficiency of this course was assessed by comparing self-reports of the process of prehospital care provided before the course with self-reports of the process of care provided after the course.

Follow-up interviews were conducted with 71 of the drivers at a mean of 10.6 months after the course. Altogether, 61% indicated that they had provided first aid since taking the course, showing that the training was not just of academic interest but was actually being used. After the drivers had taken the course, there was considerable improvement in the type of first aid they provided: 7% provided crash scene management before the course versus 35% after; 2% provided airway management before versus 35% after; 4% provided external bleeding control before versus 42% after; and 1% provided splinting of injured extremities before versus 16% after. Two years after the course, nurse interviewers were asked to rate the quality of first aid provided by trained and untrained drivers. Nurses scored the drivers' actions on a scale from 0 (potentially harmful) to 10 (perfect). Scores for the first aid provided by 50 trained drivers were notably higher (median = 7) than those for a comparison group of 19 untrained drivers (median = 3). The actual financial cost of the course was US\$ 4.00 per driver.

The training programme for drivers in Ghana should be seen as pilot studies. They show that even in the absence of a formal emergency medical service, improvements in the process of prehospital trauma care can be made by building on existing, although informal, patterns of prehospital care and transport. These patterns vary across the world. Hence, innovative solutions to improving prehospital trauma care in the absence of formal emergency medical services need to be developed using each environment's unique characteristics; these then should be pilot tested and the success of the scheme evaluated.

3. Designing and administering the system

3.1 Setting up the system

Prehospital trauma care systems cannot function in isolation. They must be fully integrated into a nation's existing public health and health-care infrastructure. Prehospital systems are designed to provide citizens with prompt, safe and effective access to the health-care system in times of urgent need. Each 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.

When available, existing emergency medical service systems should be utilized and strengthened. This will enable countries to leverage their existing infrastructure and local expertise to maximum advantage. However, this approach may prove difficult if new concepts and operational reforms are regarded as threats to individuals and established patterns of practice. To avoid duplication of effort or needless competition, existing regional health-service administration structures should be incorporated whenever feasible. Decisions about the allocation of resources should be based on objective measures of need. At the regional level, an administrator should be identified and assigned the responsibility of monitoring the training, operations, reporting and quality assurance activities of the local prehospital systems within his or her jurisdiction.

To facilitate buy-in, local community leaders and members of the populations being served should be directly involved in developing and administering the system. Community members should be asked to share their insights, provide suggestions and assist in designing the system. Ensuring that community members are involved from the beginning increases the likelihood that they will accept, support and sustain the system. The definition of a community member may be different in different areas.

The financing of emergency care systems varies around the world. In Mexico, for example, most of those who provide prehospital care belong to voluntary or nonprofit organizations. In contrast, in Karachi, Pakistan, most prehospital care providers work for profit-generating businesses, although some work for nonprofit organizations. In other countries, systems may be supported by municipal or governmental financing.

The key elements in administering a prehospital trauma care system are summarized in Box 2.

Box 2. Key elements in administering a prehospital trauma care system

- **Lead national agency:** Designate a lead national agency to govern the system. This agency's responsibilities should include legislative development, regulatory oversight, organization of the system and financing.
- **Support:** Ensure there is regional and local support and involvement that includes members of the local community.
- **Local administration:** Develop local administration and oversight, taking into account the local context and resources.
- **Medical direction:** Ensure that medical director is providing the essential coordination of care, training and education, and quality improvement initiatives.
- **Political support:** Develop political and legislative support. These are essential for ensuring the operational and financial viability of the system.

3.2 Identifying a lead organization

The safe operation of a prehospital system requires leadership at several levels. National and regional leadership is essential not only to develop the system but also to educate citizens about its use. Ideally, a lead agency should be identified to oversee the implementation of the system. It may be necessary to enact legislation to ensure the success of the system. The lead agency or ministry should have the authority to implement changes when necessary and should be held accountable for developing the programme. This lead agency must assume responsibility for the overall organization of the system and for its financing. In some countries, the ministry of health or department of health may assume this role. In others, the interior ministry or transportation ministry may serve as the lead agency. Regardless of which agency holds primary responsibility for prehospital care, all appropriate sectors of the government (e.g., transportation, health and public safety) must be involved in planning and implementing the system. Once the enabling framework is established, the creation of a separate agency to manage the prehospital system on an ongoing basis should be considered.

An entity must also be responsible for coordinating prehospital care at the local level. In many instances a regional hospital may be the most appropriate organization. This is because the most severely injured patients are transported to hospitals and the greatest concentration of medical expertise is often found there. Additionally, the physical facilities, equipment for training and data for quality assurance are most likely to exist in a hospital setting.

3.3 System models

At the community or regional level, a variety of approaches have been used to develop, organize and regulate prehospital systems see p15 (34–38). Thus, the model itself may determine which individual or agency is best suited to administering the system, including hiring personnel, financing the system, training prehospital care providers, conducting quality assurance audits, managing communications, exercising medical direction, providing logistical support and overseeing operations.

The most common models are:

- **National systems:** These systems may be designed, developed and controlled by a country's central governmental authority (for example, the ministry of health).
- **Local or regional systems:** In line with other public safety agencies, municipal prehospital systems are administered by local or regional governments, and they may use existing infrastructure (e.g., police, fire or public health systems) or a separate nonprofit infrastructure (e.g., a nonprofit authority) to deliver prehospital care.
- **Private systems:** Private emergency medical service companies, operating either as nonprofit or for-profit organizations, may contract with authorities to provide prehospital services throughout a specific neighbourhood, city or region.
- **Hospital-based systems:** These systems are often the simplest to establish and maintain because they utilize the personnel, resources and infrastructure of a central or referral hospital. The hospital and its staff govern all aspects of the system.
- **Volunteer systems:** These systems depend on prehospital providers who donate their time and services to their community. This model is particularly common in rural and remote areas.
- **Hybrid systems:** Many systems combine components of the models described above to provide prehospital care for a particular community. The decision about whether to combine different models depends on local political, financial and administrative concerns.

3.4 Medical direction

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 prehospital 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 prehospital care in their community, whether it is delivered through paid health-care providers or local volunteers.

The medical director should recruit and train care teams, conduct needs assessments, oversee the continuing education of providers, develop and refine clinical protocols, take part in quality improvement efforts, review reports, provide direct feedback to teams and conduct critical-incident debriefings.

The importance of securing a capable and motivated medical director to oversee the clinical operations of the system cannot be overemphasized. Standards and protocols articulated at the national level will have little local impact if they are not conscientiously applied and vigorously enforced by a medical director.

3.5 Disaster planning

Every prehospital care system, regardless of its budget, size and location, may be required to respond to a large-scale natural disaster or man-made incident that injures many people. Local agencies, governments and organizations must prepare for these events to ensure that they, and the residents of their communities, can cope with them.

A disaster planning document should aim to strengthen the capacity of local and regional governments, health-care providers and public health organizations to react to such events. Essential components of a proactive disaster plan include developing a way of assessing the situation, coordinating care and requesting outside assistance when necessary. A wealth of information can be accessed without charge from various international organizations (Box 3). The best way to prepare for a disaster and other mass-casualty events is to establish a robust and sustainable emergency system.

Box 3. **Web-based resources for disaster planning**

- International Federation of Red Cross and Red Crescent Societies
<http://www.ifrc.org/what/disasters/>
- United States Federal Emergency Management Agency
<http://www.fema.gov/library/dizandemer.shtml>
- World Health Organization
<http://www.euro.who.int/eprise/main/WHO/Progs/EHA/Home>
- United Nations Disaster Management Training Programme
<http://www.undmtp.org>
- The Sphere Project
<http://www.sphereproject.org>
- International Search and Rescue Advisory Group (intergovernmental network under the umbrella of the United Nations)
<http://ochaonline.un.org/webpage.asp?Page=549>

3.6 Other considerations

3.6.1 Financial considerations

Because prehospital trauma care is a potentially life-saving or limb-saving service, access should not be restricted only to those who can pay for it. However, it may be necessary to make reasonable efforts to recover costs in order to ensure the financial viability of the service, and various financing schemes may be needed to fund the system, such as health insurance or public funding. Nonetheless, care should not be withheld because a patient or his or her family is unable to pay at the time of care, nor should fear of the cost of treatment hinder appropriate requests for care.

It is challenging to invest in and maintain a prehospital care system, especially in countries where competing priorities in health budgets make it difficult to secure adequate funding. In addition, the absence of health insurance and cost-recovery mechanisms may further complicate the issue. In these instances, stakeholders may want to explore innovative strategies for generating resources, such as dedicating a proportion of highway construction budgets; allocating a proportion of vehicle registration fees, traffic fines and penalties; or levying a tax on fuel.

3.6.2 Political considerations

The support of high level government and political leaders is essential in order to ensure the operational and financial viability of any prehospital system. Emergency care services cannot function adequately without leaders from the community, politics and government who are engaged with the system and who are willing to draft enabling legislation and regulations, secure adequate funding and support the efforts of local medical directors to enhance the quality and availability of prehospital care. A lack of political support and the presence of corruption or administrative infighting may undermine the best efforts of prehospital care personnel.

Because prehospital care frequently unfolds in public settings it is inherently political. However, the interaction between systems of prehospital care and politics must be kept in balance. If the prehospital system is consistently in the spotlight, decisions such as where personnel or resources are deployed may be driven by political rather than medical considerations. This can disrupt the functioning and efficiency of the system. The medical directors of these systems must have the backing of the political community and be free from interference when making decisions.

Legislative advocacy is often necessary to engender the political will needed to create and sustain public health programmes. To ensure the broad-based support of the community and its political leadership, those who work in prehospital care systems should educate the public as well as key elected and appointed officials about the importance of this care. Leaders of prehospital care systems should closely monitor legislative and regulatory activities and make policy recommendations when necessary. Medical professionals can play a particularly helpful part in this process because they are often viewed as credible and influential members of the community. In addition, patients who have survived serious injury may form powerful lobbying and advocacy groups as a result of their first-hand experience of the human and economic consequences of injury. They should be encouraged to share their stories with the public and with governmental and political leaders.

Medical professionals must learn about the legislative decision-making processes in their jurisdiction to be able to influence policy effectively. Although the political process is frequently complicated, a thorough understanding of how decisions are made is essential for medical professionals hoping to influence the direction of public policy. Gaining support for issues may involve collaborating across public and private lines to secure the cooperation of several branches of government in different political jurisdictions. It may also involve facilitating consensus. Policies implemented on the basis of impulsive decisions are usually less successful and less likely to be sustainable than sound planning decisions made by building support for important issues.

3.6.3 Legislative and regulatory considerations

Although specifics vary from country to country, the authority to operate a prehospital trauma care system is usually derived from laws adopted by the country's governing

bodies. More detailed regulations are frequently adopted by an administrative agency. Those who provide prehospital emergency care and medical directors should be familiar with their country's laws and regulations.

If there is no legislation establishing or regulating emergency medical services, those who provide prehospital care and physicians should work together to ensure that legislation is put into place. Legislation and regulation help to ensure public health and safety, ensure that the expectations and legal authority of each agency and individual are clearly delineated, and promote a consistent level of care and systems response throughout the nation. In addition, legislation often plays a crucial role in primary prevention efforts (for example, by enacting laws requiring the mandatory use of helmets).

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

- training, certification and licensure of providers of prehospital emergency medical services, including minimum skills requirements and provisions for disciplinary actions;
- scope of practice (allowable skills) of prehospital providers and the conditions under which they may use these skills;
- scope and authority of medical direction, including protocols determining a patient's destination, triage guidelines and protocols for interfacility transfer;
- licensure or authorization of emergency medical services, including medical direction and training, and vehicles, including equipment, communications and others;
- complaint investigation procedures;
- quality improvement;
- financing;
- designation of medical facilities as specialty care centres if appropriate;
- data collection, reporting and confidentiality;
- accreditation of education programs;
- 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 catchment areas and mutual aid requirements;
- disaster response.

Please see Box 4 for a case study on system development.

Box 4. Case study: Thailand**Developing and implementing a prehospital care system**

Each year, there are more than 12 million visits to Thailand's emergency departments; these are the result of acute trauma and emergency medical conditions. In 1994, the Ministry of Public Health recognized the importance of developing an effective prehospital care system to address this need and improve care. A long-term strategic plan was subsequently adopted and implemented in three phases.

- Phase 1 lasted from 1994–2000 and focused on developing the model. This phase addressed four important components: administration and management (establishing provincial boards, regulations and standards of practice, and developing a system of evaluation), personnel (designating prehospital personnel as nurse paramedics, intermediate-level emergency medical technicians, basic-level emergency medical technicians, and first responders; and developing job descriptions, clinical practice guidelines and evaluation systems), ambulance standards (establishing required equipment and maintenance standards), and communication systems (establishing an emergency call system using a nationwide number, delivering public education and developing the rescue network).
- During phase 2 (2000–2004), an organization (known as the National Board) was created to develop a master plan for implementing the prehospital care system and to formulate a budget (approved by the Ministry of Public Health at a cost of 10 Thai baht per person; 1 Thai baht = approximately 0.02 euros).
- During phase 3 (2004) the focus was on analysing the implementation of the model at the provincial level. An initial review of data from Khon Kaen Province (with a population of 1.7 million people) from 2003 showed that there were 1000 prehospital care personnel and 80 ambulances and that 7835 emergency calls had been answered. Altogether, 90% of responses had been performed in less than 10 minutes, and 90% had a scene time (time spent at the scene of an event, after arrival and prior to transport) of less than 10 minutes.
- This process is continuing, and prehospital care continues to develop in Thailand. However, four issues remain for further consideration: the establishment of national prehospital care legislation, further development of the national central alarm centre, the establishment of national standards and direction for personnel development and implementation of a sustainable budget system.

4. Prehospital trauma care providers

The quality of any health-care system is largely determined by the ability and attitudes of its personnel. This is particularly true in the prehospital environment, where providers encounter frequent challenges. In developing a system of prehospital care, it is essential to establish in advance the knowledge and skills that will be required of providers working at different levels in the system.

Most prehospital care systems worldwide are composed of providers with one or more of the following levels of training and skill.

First responders

In many communities, the most basic level of prehospital trauma care is provided by laypeople known as “first responders”. They comprise the first level, or tier, of the prehospital system. First responders are trained to render basic emergency care. Within this framework, there exist two complementary groups.

The first group is made up of “basic first-aid providers”. In many parts of the world, motivated laypeople from the community or people from specific occupational groups, such as taxi drivers or truck drivers, soldiers, students or workers, are trained through voluntary or mandatory programmes to recognize an emergency, call for help and provide basic treatment until more formally trained rescuers arrive. The training session usually lasts only a few hours. (See Box 1 for an example of a programme in Ghana.)

Simple teaching materials and pamphlets exist, including some that have been specifically prepared to train members of populations where literacy is low. Figure 2 shows illustrations from *When someone is hurt: a first aid guide for laypersons and community workers* (39). (See Selected Readings for additional information.)



Figure 2. These illustrations show simple measures for cleansing wounds and splinting suspected extremity fractures (39).

We call the second group “advanced first-aid providers”. Within the general population of community-based first-aid providers it may be possible to recruit a subset of particularly motivated or strategically placed individuals to receive additional training. Alternatively, key occupational groups, such as those mentioned above as well as Red Cross or Red Crescent volunteers, may be enlisted for this purpose. In the course of their daily duties members of these groups are much more likely than average citizens to encounter victims of serious or life-threatening injury. They are also more likely to be available for debriefing, supervision, evaluation and retraining.

People who have been chosen to provide more advanced levels of first aid may be taught the principles of rescue, limb immobilization and how to prepare and transport patients safely. These specially trained laypeople can be provided with a small kit of equipment. Supplies and equipment for this level of care are highlighted in the matrix in section 5.

If no other level of prehospital care is feasible or affordable these individuals may provide an acceptable alternative to a more formally organized prehospital system, particularly if a community’s advanced first-aid providers have access to vehicles capable of transporting seriously injured people to an appropriate health-care facility. Depending on the scope of duties envisioned for this group, initial training might last from 1 day to several weeks. Refresher training can be accomplished in shorter periods of time.

Basic prehospital trauma care

Many countries with established prehospital emergency medical services and trauma care systems already have a core group of providers who have received training in trauma care and thus have knowledge and skills beyond those expected of bystanders or first responders. This second tier of care allows professionals to offer a wider range of interventions, including extrication and rescue, immobilization, the administration of oxygen and more detailed patient assessment. Many paid ambulance personnel around the world are trained to this standard. A typical training programme for providers of this level of care requires professional instruction comprising both theory and practical experience. Training generally lasts from 100 hours to 400 hours.

Advanced prehospital trauma care

Although many effective prehospital care systems worldwide are limited to one or both of the first two levels of prehospital care, urban and suburban areas of many high-income and middle-income countries provide a third tier of care known as advanced prehospital care. Those who provide advanced prehospital care are most often physicians or highly skilled non-physician paramedics. They are trained to manage a wide range of injury processes and acute diseases. These providers generally perform a wide range of invasive interventions, including inserting intravenous lines and administering intravenous medications and using advanced airway adjuncts. They may also perform endotracheal intubation, needle decompression of a pneumothorax and cricothyroidotomy. These

providers typically receive thousands of hours of classroom and field instruction in the context of both the emergency medical system and in the hospital. This type of care is also known as advanced life support.

For the majority of injured people, the value and cost effectiveness of this third tier is unclear. Along with our interdisciplinary team of reviewers, we feel strongly that national efforts to implement prehospital trauma care must not be hindered or sidetracked by well intentioned but ill advised schemes to emulate emergency care systems in developed countries. The implementation of costly advanced life support interventions may be counterproductive if it siphons scarce resources away from the core elements of prehospital care. Accordingly, the remainder of this chapter focuses on the care provided by first responders and basic prehospital trauma care providers. Annex I briefly addresses advanced prehospital trauma care and care in fixed facilities issues. We recognize that in many countries the lines between basic life support and advanced life support are often not distinct, and that resources and circumstances may dictate that many advanced life support procedures (such as intravenous access and intubation) may be performed by specially trained providers of basic prehospital care.

4.1 The first tier: care by first responders

4.1.1 Basic first-aid providers

In a number of countries people are actively recruited to provide first aid and initiate prehospital care (Box 5). A growing body of literature supports this practice (11,40–46). Even the most sophisticated and well equipped prehospital trauma care system can do little if bystanders fail to recognize the seriousness of a situation, call for help and provide basic care until help arrives. This is particularly important in remote rural areas.

Bystanders are often present when an injury occurs or they quickly reach the scene. The first minutes after a serious injury occurs represent a window of time during which potentially life-saving measures can be initiated, such as opening an obstructed airway, assisting breathing and applying direct pressure to a wound to reduce external bleeding. The likelihood that an injured individual will live or die depends on the timeliness of these actions. The odds of survival may be greatly enhanced if bystanders promptly initiate first aid.

Box 5. **First there, first care programme, United States**

This American programme is designed to teach bystanders to perform five basic actions at the scene of a crash or some other emergency. These actions are:

1. stop to help
2. call for help
3. assess the victim
4. start the breathing
5. stop the bleeding

Individuals who acquire this training are encouraged to keep certain items in their vehicles, such as gloves and bandages, so they can stop and give aid if they are the first rescuer to reach the scene (47)

Training programmes developed and implemented in high-income countries prove that motivated volunteers can be quickly taught a limited number of essential first-aid skills. These courses, which cover topics such as first aid and basic cardiopulmonary resuscitation, show that motivated volunteers can be quickly taught a limited number of key skills and use them to render life-saving assistance. Programmes in low-income countries have likewise shown that community members apply the life-saving knowledge they have learnt, even when resources may be scarce (11, 31). By encouraging local people to learn these techniques, communities can create a group of first responders. Each country should define the specific tasks a first responder may perform and enact a legal framework to oversee and legally protect this activity.

Tasks usually taught to first aid providers are briefly discussed below and are also listed in the matrix in section 5. The critical tasks required of a basic first-aid provider include the following:

1. Getting involved

Objective: encourage first responders to decide to become involved in assisting a victim of serious injury.

Nothing will happen if a bystander does not choose to help. There are many fears that may prevent someone from getting involved. These include a lack of knowledge about what to do, fear of legal consequences if one's actions are ineffective or harmful, fear of involvement in a subsequent investigation, fear that one's actions will be interpreted as taking sides in a conflict, fear of exposure to blood or body fluids, and the belief that a victim's fate is predetermined. Programmes designed to encourage and train citizens to serve as first responders must address these issues.

2. Calling for help

Objective: encourage first responders to rapidly activate the prehospital or emergency response system using locally available technology.

Once an emergency situation is recognized, bystanders need to call for help. They may need:

- help from more highly trained providers who can treat the injured person
- help transporting the injured person by the most appropriate available means
- help giving first aid and calling for more assistance.

Those providing basic first aid need to know in advance how to call for help and how to secure transport if needed. Depending on local circumstances and the circumstances of the injury, they may need to call an ambulance, taxi driver, a private medical practitioner, the local fire or rescue service, a police officer or someone else.

To facilitate this task, many countries have adopted a nationwide telephone number that connects the caller to the nearest health-care facility or ambulance dispatch centre. However, help should be called for using whatever methods are available.

3. Assessing the safety of the scene

Objective: encourage first responders to prevent harm to themselves and bystanders and avoid further harm to the victim.

One of the most important and challenging tasks is to teach first responders (and even trained prehospital personnel) to assess the safety of the scene before giving assistance. For traffic injuries, special attention should also be given to preventing collisions with additional vehicles. Important considerations include learning how to manage crowds and traffic, becoming aware of potentially hazardous materials and preventing fires. Rescuers must take steps to avoid exposure to infectious diseases such as tuberculosis, hepatitis B and C, and HIV/AIDS.

4. Assessing the victim

Objective: encourage first responders to ascertain whether injuries are life-threatening or limb-threatening and whether immediate care is needed.

First responders must be taught the basic skills of assessment. Failing to recognize a medical condition or injury as a true emergency may lead to an increased risk of death or permanent disability (48–50).

5. Providing immediate assistance

Objective: encourage first responders to provide timely but simple vital interventions.

After completing an initial assessment and calling for help, trained first responders should attempt to give immediate assistance within the limits of their skills. Several training programmes exist to teach these skills. The best results are obtained when trainers focus on teaching a limited number of psychomotor skills well, rather than attempting to teach a wider range of skills in a superficial manner.

6. Securing essential equipment and supplies

Objective: encourage first responders to use readily available materials.

Since bystanders rarely have immediate access to equipment or supplies, they should be taught to use materials that are close at hand. In places where large crowds gather or serious injuries are common, it may be prudent to have a simple kit of supplies (such as bandages, gloves, etc) already in position.

4.1.2 Advanced first-aid providers

In addition to acquiring a wider range of clinical skills than those taught to the first responders outlined in the section above, individuals working at the level of an advanced first-aid provider should be trained to extricate victims from wreckage and transport them to an appropriate health-care facility. (For more details, please see the matrix in section 5.)

Because their role is more formally defined than that of someone who is trained to provide only basic first aid, people trained to a more advanced level should be supervised, evaluated and periodically retrained to maintain their skills.

Depending on local circumstances and the level of demand for their services, individuals trained to provide advanced first aid may provide care either on a voluntary basis or be paid for their services.

With sufficient training and supervision, those who provide advanced first aid can form the backbone of an inexpensive but effective prehospital care system in all countries.

4.2 The second tier: basic prehospital trauma care

Those who provide basic prehospital trauma care have had formal training in prehospital care, scene management, rescue, stabilization and transport. In some countries, individuals who possess these skills are called emergency medical technicians (EMTs). Individuals trained to provide this type of care usually transport patients to the hospital in an ambulance or another vehicle that has been modified or borrowed for this purpose.

In low-income and middle-income settings, seriously injured people may be brought to neighbourhood or village clinics that ordinarily provide only primary medical care. Staff at these clinics should thus be trained to provide at least basic trauma care so they can adequately assess injured people, provide stabilizing care and determine whether the patient needs to be transported to a facility providing a higher level of care. Clinic providers who practise in remote settings that are far from the nearest hospital should be trained to provide the essential elements of advanced trauma care. (For additional information, please see section 4.3 and section 5.)

All prehospital care providers, particularly those who work in remote settings, should be trained to recognise when a victim is unlikely to survive. This will spare rescuers and mortally injured victims from the distress of attempting to reach a hospital.

Box 6 reviews the initial steps taken to establish an emergency rescue service in Pakistan.

Box 6. Case study: Pakistan

Establishing the first emergency rescue medical service

Over the past several years, attempts have been made to provide prehospital emergency care in Pakistan. However, because no single entity has had the authority and responsibility for developing the system, efforts have not been sustained. Local physicians in Punjab proposed that a separate emergency rescue medical service should be established and become part of the prehospital emergency care infrastructure.

Although it has taken several years to foster the support and commitment necessary to the project, in December 2004 the Government of Punjab launched the first trained and equipped emergency rescue medical service in Pakistan. An independent directorate of the emergency and ambulance service (known as Rescue 1122) has been created in order to provide efficient rescue and transport for victims of accidents and emergencies.

The service was launched within 6 months of the implementation decision being made. Training material was developed in Urdu; motivated rescuers were recruited in Lahore; training institutes were established; and trainers were put in place. The recruits completed a rigorous, internationally monitored fitness and training programme at the police training school in Lahore. The curriculum included modules on rescue, triage and basic life support skills.

Additionally, specially designed vehicles and ambulances with essential rescue and medical equipment have been developed locally; a toll-free emergency code has been established with the help of the Telecommunications Authority and has been put into use by all landline and mobile phone companies; and a tracking system and recording software have been developed and installed at the Central

Emergency Control and Communication Centre to ensure the quality of the service. To support the emergency rescue medical service, one central station and five substations have been established. Although it is a new service, there have already been improvements in responses to emergencies: trained rescuers are more often present at the scene, triage and transport operations run more smoothly, and mass-casualty situations are better managed.

4.3 The third tier: advanced prehospital trauma care

Those who provide advanced prehospital trauma care are trained to use a range of costly and sophisticated interventions. These interventions generally extend beyond the scope of people trained in basic trauma care (see section 5). In many middle-income and nearly all high-income countries, paid professionals provide this third tier of prehospital care. Depending on the specific model used in a country, providers of this level of care may answer calls for help, provide immediate stabilization of the victim at the scene, perform a number of invasive procedures and transport the victim to the nearest hospital while providing further treatment en route. This type of care is also known as advanced life support.

There is little published research on the incremental value of adding this third tier of interventions to more basic (and much less expensive) trauma care measures. Although advanced prehospital interventions clearly benefit some patients, they may also hinder the overall provision of prehospital 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.

In remote areas where roads are inadequate, transporting a severely injured patient to a regional hospital or an advanced health-care facility may take many hours or days. In these situations, it may be advisable to teach local health-care providers relatively sophisticated techniques, such as wound management, fracture care and other advanced skills, so they can stabilize patients who require transport to enable them to survive the rigours of long-distance transport. Box 7 outlines a programme designed to reduce morbidity from landmines.

Box 7. Case study: save lives, save limbs (11, 51)

Time is a critical factor in treating injuries from landmines. A simple but systematic prehospital training programme aimed at people living in villages was developed and introduced in western Cambodia and northern Iraq.

It focused on basic life support techniques, including airway management and controlling bleeding without the use of tourniquets. Instruction in these skills was combined with training in selected advanced life-saving skills. These types of programmes can be organized safely and cheaply.

Systematic “chains of survival” were organized in rural communities where emergency medical services were scarce, ambulances few and evacuation times long. The idea of creating a “village university” was used to bring academic medical knowledge and skills to rural areas and train local people to help themselves. The knowledge was further spread using cascade training systems, ensuring that the local language was used, local culture was acknowledged, and local instructors “owned” the programme.

Following the introduction of this programme and 4 years of training and network building at the village level in western Cambodia and northern Iraq, prehospital mortality from landmine injuries dropped from above 40% to below 10%.

4.4 Recruiting and training providers

The required level of training depends on local and cultural considerations, the availability of transportation, the amount of time members of the selected target group can dedicate to training and, for those who provide first-aid, the willingness of community members to acquire and use their training. The length of the training and the proportion of theoretical and practical sessions will vary from country to country. The training and education of prehospital providers must be undertaken in a manner that makes optimal use of local resources and personnel and ensures compatibility with local cultural norms, practices and traditions.

Training may be conducted by individuals or organizations, or both, but all trainers must have among their areas of expertise prehospital care and system development as well as experience of the local health-care system, the local culture and societal norms. In some instances, the initial training may involve international organizations and individuals who participate in “train the trainer” programmes. There are many educational tools and training manuals available (Box 8). To be effective, however, they must be translated into locally appropriate languages.

In addition to the clinical and patient management skills these courses teach, they must also give providers a common language with which to communicate among themselves in order to provide a team approach to caring for injured people. These programmes should be conducted under the auspices of local health-care organizations, governments and their administrations, and should be designed to develop local trainers who will serve both as leaders and as resources for future educational efforts.

Developing dedicated career paths for prehospital care providers may assist in recruiting and retaining staff as well as providing long-term stability of the system.

Box 8. Training materials for prehospital providers

- Husum H, Gilbert M, Wisborg T. *Save lives, save limbs*. Penang, Malaysia, Third World Network, 2000.
- *International harmonization of first aid: first recommendations on life saving techniques*, International Federation of Red Cross and Red Crescent Societies, Geneva, 2004 (<http://www.ifrc.org>).
- *First aid in the community: a manual for trainers of RCIRC volunteers in Africa*, International Federation of Red Cross and Red Crescent Societies, Geneva, 1995 (<http://www.ifrc.org>).
- Werner D, Thurman C, Maxwell J. *Where there is no doctor: a village health handbook*. 2nd ed. Berkeley, CA, Hesperian Foundation, 1992.
- Varghese M, Mohan P. *When someone is hurt: a first aid guide for lay persons and community workers*. New Delhi, The Other Media Communications, 1998.
- Henry M, Stapleton E. *EMT prehospital care*. 3rd ed. St. Louis, MO, Mosby, 2004..
- Basic Trauma Life Support International – <http://www.btls.org>
- Prehospital Trauma Life Support – <http://www.phtls.net/>
- United States Department of Transportation, National Highway Traffic Safety Administration – <http://www.nhtsa.dot.gov>
- The Sphere Project – <http://www.sphereproject.org>
- Systematic Approach to Victim Entrapment Rescue (SAVER Foundation) – <http://www.savertraining.org>

5. Resource matrix for prehospital trauma care systems

5.1 Background

The following section outlines those resources that we feel are essential to providing effective prehospital trauma care services. These are presented in a matrix that describes in depth the vital services and related equipment needed during initial evaluation and resuscitation efforts, especially for immediately life-threatening injuries.

These services are incremental in nature. Every government should seek to train large numbers of laypeople to provide first aid. Governments should provide a basic level of trauma care either by training and equipping those who can provide basic first aid or by training selected community members to provide an advanced level of first aid. However, the use of advanced life support interventions, equipment and techniques in the prehospital setting should not be considered unless the more basic elements of prehospital care can be consistently assured.

The first column in the matrix lists the specific elements of trauma care that are needed. These are divided into two categories: knowledge and skills, and equipment and supplies. The category of knowledge and skills describes the training needed to perform diagnostic and therapeutic activities safely and successfully for different levels of provider and also assumes that these skills will be maintained through continuing education. The category of equipment and supplies lists the items that should be available to assist all patients who need them, without consideration of ability to pay, especially in life-threatening emergencies. It also assumes that they are not only physically present but are also readily available. Thus, organizational and administrative mechanisms must exist to quickly replace depleted or expired stocks of supplies and medicines and to quickly repair equipment when needed. The quality control mechanisms necessary to assure the provision of supplies and the quality of medical care provided are addressed in section 8.

For further details and discussion of trauma services functioning within fixed facilities, please see WHO documents *Guidelines for essential trauma care (52)* and *Surgical care at the district hospital (53)*. Detailed discussion of these items is beyond the scope of this publication.

5.2 Terms and definitions

For each cell within the matrix we recommend which resources (in the first column) should be provided by specific levels of the prehospital trauma care system. Each item

has been designated as essential, desired, possibly required or irrelevant according to the criteria described below.

- **Essential resources:** These resources are given the designation “E”. They represent the lowest common denominator of prehospital interventions that should be provided in all regions, including those where access to resources is severely limited. We feel that these essential items can be provided at little cost, primarily by making improvements in organization and planning, and that they require a modest level of expenditure.
- **Desired resources:** These resources are designated as “D”. A desired item represents a capability that increases the probability of achieving a successful outcome from trauma care but that the resource does not rise to the level of being essential. Most of the desired items add to a system’s cost. A number of these items are not likely to be cost effective for all systems; this is particularly true for those located in environments that have the least access to resources. However, for countries with access to more resources, some of these items may be considered essential in a national plan. Likewise, there are some services for which only low-cost physical resources would be required and for which the training of providers would be feasible. In order for this training to be considered essential, however, mechanisms must be put in place to ensure that it is available to all providers at a specific level within acceptable time constraints and that it does not hinder the acquisition of other essential skills. In cases in which it does not seem reasonable to provide such training nationwide, these services are designated as desirable, especially in prehospital services that regularly contend with a large volume of trauma cases or patients whose injuries have a high level of complexity.
- **Resources that may possibly be required:** These are designated as “PR”. In physically remote or war-torn areas where people lack access to health-care facilities, it may be advisable to shift some trauma treatment capabilities, such as , multiple casualty triage and intravenous fluid replacement, to lower levels of the prehospital system if doing so will increase their availability to patients who might die without this care. Such services usually can be provided at minimal cost. Shifting these services to more basic levels of the prehospital system usually requires that providers with little trauma-related training and skills be taught and tasked to perform procedures that are normally restricted to more highly trained personnel. Hence, we emphasize that the PR designation means something quite different from the desirable designation. It is anticipated that the PR designation will apply particularly to settings in low-income countries where access to health-care facilities is restricted.
- **Irrelevant resources:** These are designated as “I”. This term describes capabilities that are not desirable or appropriate to a particular level of the prehospital trauma care system, regardless of the community’s economic and health-care resources.

Deciding on priorities

During the development of country-specific prehospital trauma care plans, we anticipate that some health planners may decide to adopt one or more of the items designated as desirable along with the items in the essential category. We must emphasize that if this is done, it should not be at the cost of the essential equipment, skills and capabilities needed to provide that level of prehospital care. Throughout this chapter, more detail is provided on the elements of care that our experts deemed essential. Prehospital trauma care capabilities and skills designated as essential at the level of first response and basic trauma care are those that should be available to all injured people in all countries of the world, regardless of the patient's income. Hence, the essential items are applicable to all prehospital systems at that level of care.

5.3 Resource matrix

This matrix reflects the consensus of several large, geographically and professionally diverse groups of experts from the fields of trauma care, public safety and injury control. Due to the scarcity of controlled clinical trials in the prehospital setting, few trauma care interventions are evidence-based. Nevertheless, the logic behind their inclusion is overwhelming (54).

The matrix is explicitly focused on trauma and injury care; it does not cover clinical skills, equipment, supplies or medicines commonly used to treat medical or obstetrical problems.

The equipment recommended for inclusion at various levels of care should be available for both adult and paediatric patients, when these options are available.

The recommendations included in this matrix are designed to be flexible. Different countries may choose to scale up these capabilities to be more expansive or modify them to fit in with environments where resources are more limited.

All of the recommendations included in this matrix assume that severely injured patients can be transported to the closest appropriate fixed health-care facility in a reasonable amount of time. Different considerations may apply to prehospital trauma care rendered in remote settings or areas affected by war or other conflicts, where rapid evacuation is not an option.

TABLE 2. **Matrix of essential knowledge, skills, equipment and supplies for prehospital providers***

	Type of provider in prehospital setting			
	Basic first aid	Advanced first aid	Basic prehospital trauma care	Advanced prehospital trauma care
Knowledge and skills				
Alert				
Able to call for help	E	E	E	E
Scene survey				
Assess scene safety (physical and environmental hazards)	E	E	E	E
Establish need for additional help	E	E	E	E
Assess cause of injury	D	D	E	E
Provider safety				
Receive training in universal precautions	E	E	E	E
Limit exposure to HIV, hepatitis B and C, using available supplies	E	E	E	E
Limit exposure to airborne pathogens	D	D	E	E
Patient assessment				
Initial assessment				
Evaluate adequacy of airway	E	E	E	E
Evaluate adequacy of breathing	E	E	E	E
Evaluate extent of external bleeding	E	E	E	E
Recognize level of consciousness	D	E	E	E
Recognize when injuries are not survivable	D	E	E	E
Establish priorities for immediate care	D	E	E	E
Conduct triage for multiple patients	PR	D	E	E
Recognize at-risk patients and arrange transport	D	E	E	E
Detailed assessment				
Assess head injury	I	D	E	E
Assess spinal injury	I	D	E	E
Assess chest injury	I	D	E	E
Assess abdominal injury	I	D	E	E
Assess extremity injury	I	D	E	E
Assess neurological function	I	D	E	E
Assess patient for psychological trauma	I	D	E	E
Recognize presence of life-threatening or limb-threatening injury	D	D	E	E
Evaluate level of discomfort	D	E	E	E
Recognize hypothermia	D	D	E	E
Assess evidence of shock	D	D	E	E
Assess wounds for potential mortality and disability	I	D	E	E
Assess degree of burns (depth and extent)	I	D	E	E
Formulate differential diagnosis of cause of shock	I	I	E	E
Recognize platysmal penetration	I	I	I	E
Interventions				
Scene management				
Manage rescue situation	PR	D	E	E
Manage safe rescue to prevent further neurovascular damage	PR	D	E	E
Manage crowds, traffic and other threats	D	E	E	E
Avoid secondary collisions and injury	D	E	E	E
Manage transport of patient	D	E	E	E
Document incident	I	D	E	E
Airway and breathing				
Remove foreign bodies from airway (e.g., using Heimlich manoeuvre)	E	E	E	E
Restore open airway using manual manoeuvres (e.g., chin lift, jaw thrust)	E	E	E	E
Restore open airway using recovery position	E	E	E	E
Provide respiratory support (mouth-to-mouth resuscitation)	PR	E	E	E
Use suction devices	I	D	E	E

5. RESOURCE MATRIX FOR PREHOSPITAL TRAUMA CARE SYSTEMS

Insert oropharyngeal or nasopharyngeal airway	I	D	E	E
Provide respiratory support (use pocket mask for mouth-to-mask ventilation)	I	D	E	E
Assist ventilation using bag–valve–mask device (BVM)	I	D	E	E
Administer oxygen	I	D	E	E
Use airway adjuncts (i.e., blind insertion devices)	I	I	D	E
Use three-way dressing	I	I	D	E
Use endotracheal intubation	I	I	I	E
Use oesophageal detection device	I	I	I	D
Perform needle cricothyroidotomy	I	I	I	E
Perform surgical cricothyroidotomy	I	I	I	PR
Perform gastric decompression	I	I	I	E
Perform needle thoracostomy for thoracic decompression	I	I	I	E
Perform tube thoracostomy	I	I	I	PR

Circulation, hypothermia and shock

Control external haemorrhage through direct pressure	E	E	E	E
Elevate victim's legs if there is evidence of shock	D	D	E	E
Immobilize the patient to ease pain, reduce bleeding and complications	D	D	E	E
Splint fractures for haemorrhage control and pain control	D	D	E	E
Prevent heat loss with a blanket or other material	D	D	E	E
Use external rewarming for hypothermia (e.g., blankets)	D	D	D	E
Measure and record blood pressure and pulse rate	I	E	E	E
Monitor body temperature	I	D	E	E
Apply arterial tourniquet (in extreme situations)	I	PR	E	E
Understand parameters of fluid resuscitation	I	I	PR	E
Wrap pelvic fractures for haemorrhage control	I	I	D	E
Establish peripheral percutaneous intravenous access	I	I	PR	E
Administer intravenous fluid replacement	I	I	PR	E
Establish peripheral venous cutdown access	I	I	I	PR
Establish intraosseous access for children < 5 years	I	I	I	E
Transfusion knowledge and skills	I	I	I	PR

Wounds

Nonsurgical management of wounds (e.g., dressings)	E	E	E	E
Use deep interfacial packing for severe wounds (e.g., landmine injuries)	I	I	D	E
Administer tetanus prophylaxis (toxoid)	I	I	I	PR
Administer tetanus antiserum	I	I	I	PR
Use minor surgical management of wounds (e.g., cleaning, suturing)	I	I	I	PR

Burns

Cool the burn area with water	E	E	E	E
Cover the skin with clean dressings	E	E	E	E
Control risk of hypothermia	D	D	E	E
Cover the skin with sterile dressings	I	I	D	E
Use intravenous therapy for burn > 15% body surface area	I	I	PR	E

Injuries to extremities and fractures

Use basic immobilization for fractured extremities	E	E	E	E
Use available material for splints	D	D	E	E
Use spine board	I	I	D	E
Use skin traction	I	I	D	E
Use closed reduction	I	I	I	PR

Head and spinal injuries

Use spinal precautions when extricating or moving patients	E	E	E	E
Use selective immobilization (e.g., C-collar, backboard)	I	I	E	E
Properly manage immobilized patient to prevent complications	I	I	E	E
Maintain normotension and oxygenation to prevent secondary brain injury	I	I	D	E
Monitor neurological function	I	I	D	E

Pain management

Manage pain without medicine using ice, elevation, immobilization	D	E	E	E
Manage pain with non-narcotic analgesics	I	I	PR	E
Manage pain with narcotic analgesics	I	I	I	E

Medicines

Apply topical antibiotic dressing, disinfectants or antiseptics as appropriate	I	I	D	E
Administer vaccines and antibiotics (e.g., tetanus prophylaxis)	I	I	I	PR
Administer other medicines	I	I	PR	E

Equipment and supplies				
Communications				
Wireless communication (e.g., radio, mobile phone)	I	D	D	D
Protection				
Non-sterile single-use gloves in size medium–large	D	E	E	E
Eye protection (plastic or glass goggles with side shields)	D	E	E	E
Light-reflective clothing (e.g., waistcoat) for identification and protection	D	D	E	E
Flags or other traffic control devices	D	D	E	E
Torch plus spare batteries and bulb or reflector or candle	D	D	E	E
Soap or bactericidal foam for hand washing	D	E	E	E
Cleaning solution	D	E	E	E
Towel	D	D	E	E
Protective clothing, gowns or aprons	I	D	E	E
Disinfectant solution for equipment	I	D	E	E
Plastic bags for non-biohazard waste	I	D	E	E
Waterproof matches	I	D	D	E
Incineration bags for biological waste	I	I	E	E
Fire extinguisher	I	I	E	E
Sharps container	I	I	E	E
Extrication				
Basic extrication equipment (e.g., machetes, crowbars, car jacks)	I	D	E	E
Other extrication equipment (e.g., shears, saw, rope, shovel, protective clothing)	I	PR	D	E
Short-board for extrication	I	I	E	E
Specialized extrication equipment (e.g., cutters, spreaders, rams)	I	I	PR	D
Immobilization and patient transfer				
Long, rigid wood, metal or plastic board	D	D	E	E
Boards for limb splints	I	D	E	E
Stretcher (wooden, plastic or cloth device)	I	D	E	E
Head immobilization device	I	I	E	E
Cervical collar	I	I	E	E
Airway and breathing management				
Face shield	I	D	E	E
Pocket mask (e.g., for mouth-to-mask breathing)	I	D	E	E
Bag–valve–mask	I	D	D	E
Nasopharyngeal and/or oropharyngeal airways (for infants, children and adults)	I	D	D	E
Nasal cannula and associated tubing	I	D	E	E
Tongue depressor	I	D	E	E
Fixed oxygen equipment and administration equipment	I	D	E	E
Non-rebreather face mask	I	I	E	E
Suction device(manual or powered)	I	I	E	E
Yankauer or other rigid suction tip	I	I	E	E
Blind insertion device	I	I	PR	D
Laryngoscope handle and blades	I	I	I	E
Endotracheal tube and connector	I	I	I	E
Introducing stylet/bougie	I	I	I	E
Splinter forceps	I	I	I	E
Oesophageal detector device	I	I	I	E
Magill forceps	I	I	D	E
Needle and syringe	I	I	I	E
Needle for thoracostomy	I	I	I	E
Haemorrhage control and skin injuries				
Potable water	D	D	E	E
Bandages	I	D	E	E
Elastic bandages	I	D	E	E
Gauze rolls	I	D	E	E
Compresses	I	D	E	E
Absorbent cotton wool	I	D	E	E
Adhesive tape	I	D	E	E
Oral rehydration solution	I	D	E	E
Blankets	I	D	E	E
Adhesive dressing bandage (wound plaster)	I	I	E	E

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4 X 4 bandages, triangular bandages	I	I	E	E
Arterial tourniquet	I	I	E	E
Needles and syringes	I	I	E	E
Sterile compresses	I	I	E	E
Intravenous infusion set (lines and cannulas)	I	I	I	E
Intraosseous needle or equivalent	I	I	I	E
Burns				
Vaseline or paraffin gauze	I	I	E	E
Sterile dressing	I	I	D	E
Dressing for burns	I	I	I	D
Diagnosis and monitoring				
Clock or watch with second hand	I	D	E	E
Stethoscope	I	D	E	E
Blood-pressure measuring device	I	D	E	E
Penlight	I	I	E	E
Torch (flashlight)	I	D	E	E
Thermometer	I	I	D	E
Pulse oximeter	I	I	I	D
Electronic cardiac monitoring device	I	I	I	D
Medicines				
Oxygen	I	D	E	E
Topical antibiotic dressing	I	I	D	E
Diazepam (or equivalent)	I	I	I	D
Controlled substances lockbox	I	I	I	D
Morphine sulfate	I	I	I	D
Acetylsalicylic acid	I	I	I	D
Ibuprofen (or equivalent)	I	I	I	D
Paracetamol (acetaminophen)	I	I	I	D
50% dextrose solution	I	I	I	E
Crystalloid solutions (normal saline)	I	I	I	E
Water for injection	I	I	I	E
Miscellaneous				
List of local emergency contacts	D	E	E	E
Knife, scissors	I	D	E	E
Flask for drinking water or bottles of water	I	I	E	E
Container for supplies and equipment (e.g., shoulder bag, backpack or box)	I	I	E	E
Rescue blanket (silver/silver or silver/gold)	I	I	E	E
Shovel	I	I	D	E
Triage tags	I	I	D	E
Lubricating jelly	I	I	E	E
Writing material				
Pencil	I	D	E	E
Permanent marker	I	D	E	E
Notepad	I	I	E	E
Charts for documenting patient care and incident	I	I	D	E

^a Items in the resource matrix are categorized as E for essential, D for desirable, PR for possibly required, and I for irrelevant.

6. Documenting care

A high quality prehospital care system cannot be created and sustained without ongoing assessment and review and without making improvements in prevention and treatment programmes. Treatment records are thus needed for quality assurance reviews. In addition, if properly used, documentation of prehospital care can be used to establish a basic level of public health surveillance. To accomplish both goals, each incident of prehospital trauma care should be documented. The key points in documenting prehospital care are shown in Box 9.

Using only basic information, clinical supervisors can monitor the performance of their personnel and take corrective action if necessary; planners can assess the performance of the system; and policy-makers can define the public health impact of injuries, target preventive measures and evaluate their effectiveness.

Box 9. Documenting prehospital care

- Documenting prehospital care is essential to developing a sustainable system
- Documentation assists with system evaluation, preparedness and quality assurance
- Key elements of data needed include who, what, when, where and how (outcome)

Although data should ideally be collected at all levels, it may be difficult to document the care provided by bystanders or even by those trained to give advanced first-aid. In these instances, documenting the process and outcomes of prehospital care becomes the responsibility of health-care providers in fixed facilities. Additional information about hazards in the prehospital environment can be obtained through population-based surveys. Facts about prehospital care can be obtained by interviewing the patient, if he or she is physically capable of reporting this information. However, systematic data collection should be encouraged at all levels.

Format and coding

Ideally, the formatting and coding of data should be consistent with national and international norms (as referenced below). Local adoption of standard methods for formatting and coding data allows regional and national data to be aggregated.

Uniform prehospital data

The following data represent the information necessary to support the ongoing evaluation of prehospital care systems. The patient care record should be based on the *International Classification of External Causes of Injury (55)* and the *WHO Injury Surveillance Guidelines (1)*. 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)?

An expanded optional dataset might include the additional information described below.

- **Who** was injured and who provided care? An expanded dataset might include the patient's name, age, sex and activity at time of injury. It might also assign a unique number to each report (an incident number). These numbers may be assigned at the time an ambulance is sent out to an incident. Patients might also be assigned a patient care record number. And the ambulance number may also be recorded along with a crew member identifier number.
- **What** caused the injury and **what** was done to treat it? Additional data that might be recorded include a description of the incident, the signs and symptoms of injury reported by the rescuer, a description of the injury (such as the parts of the body injured), a clinical description of the injury, whether the patient is suspected of using drugs or alcohol, the patient's pulse rate and respiratory rate, as well as systolic blood pressure and Glasgow Coma Score. Rescuers may also record the safety equipment used by the patient at time of injury (e.g., airbags, seatbelts, helmets, goggles). Additionally, a record of any procedures, treatments or medicine given may also be kept.
- **When** did it occur? The date and time of the incident might be recorded as well as the time the rescuer arrived at the scene and the time the patient arrived at a fixed health-care facility.
- **Where** did the injury occur? The record could include information on the address where the incident occurred as well as the setting (e.g., home, workplace, street).
- **How** did the patient respond to treatment (outcome)? Additional data collected could include the destination facility, the patient's status on arrival at the facility and the patient's condition at the time of discharge.

7. Transportation and communication

7.1 Transportation options

In most circumstances, a severely injured victim should be transported from the scene of injury to definitive care at a fixed facility, such as a district hospital, regional hospital or trauma unit, as quickly and safely as possible. In settings where this is feasible, transport is best done using an ambulance that is appropriately designed, equipped and staffed. However, most of the world's population has no access to formal prehospital emergency care. Not only do they have little likelihood of being transported by an ambulance, they are also unlikely to receive any type of treatment in the field. In such resource-poor settings, the only way a patient can gain access to formal medical care is to travel via informal transport, such as in a private or commercial vehicle or a cart.

Countries that have ambulance services often face significant challenges. Factors that compromise the provision of these services include the use of inadequate vehicles, poor interagency coordination (such as between fire services, police and the emergency medical service), excessive demand relative to supply, poor roads, severe traffic, inadequate law enforcement, lack of funding and limited communication throughout the system. Globally, very few people have access to medical transport by air or advanced prehospital trauma care.

In urban settings where ambulances are unavailable or unaffordable, system planners should explore the feasibility of recruiting and training taxi drivers and other public service drivers to stop, give first aid and transport the victim to the nearest hospital. Some level of compensation should be provided to encourage and support these activities.

A number of factors make transport in rural settings more challenging than in urban areas. These include the scarcity of vehicles, the poor quality or non-existence of roads, rugged terrain, prolonged response and transport times and a general lack of health-care infrastructure. In light of the long transport times associated with injuries in rural communities, if possible transport should not be initiated before a seriously injured patient is adequately stabilized.

When striving to create a prehospital transport system where none exists system planners should consider every available resource and whether there are any alternatives. In some communities, specialized vehicles are readily available and well maintained. In others, there are no motor vehicles at all. Although local modes of transportation, such

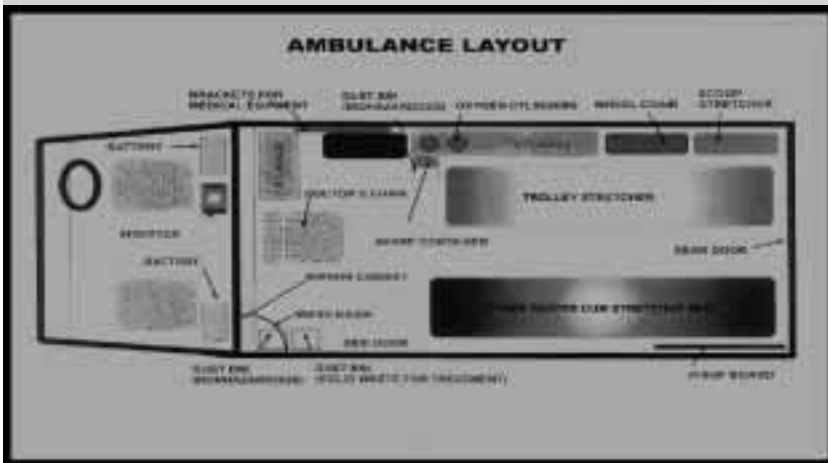
as carts or boats, may not be ideal for moving those who are critically injured, they may be the only options. In such circumstances, the benefits of a long-distance trip to definitive care must be weighed against the associated costs and risks (both for the patient and for the health system), the time required for evacuation, the expenditure of human resources, the patient's level of discomfort and the likelihood that he or she will survive the journey. Nonetheless, regardless of what type of transportation is available, it is important to have plans for moving victims who have life-threatening injuries rather than having to improvise.

7.1.1 Ground transportation

Many vehicles can be adapted to fill the role of a ground ambulance. Whenever possible, the best available option should be identified in advance, so that prehospital providers are familiar with its operation and limitations. Vehicles that can be maintained and repaired locally are preferable to imported vehicles, which may prove difficult to maintain. If a vehicle is specifically acquired or structurally modified to transport severely injured patients, a number of design features should be considered (Box 10). When deciding where vehicles are to be based, decision-makers should consider factors such as local catchment areas, identified target populations and expected run or call volumes. Planning for ground transportation must be approached comprehensively so that all types of emergencies, the need for interhospital transfers and other uses are considered.

Box 10. Ambulance design in India

Stakeholders involved in the provision of emergency medical care in Delhi, India, recognized there was a need to improve their conventional ambulance, so they recently revised the design. The new design is based on vehicles used in the Netherlands, the United Kingdom and Zimbabwe. It provides improved safety features for patients and personnel, a modular structure that allows for local and regional flexibility in stocking equipment and supplies, and a place for basic extrication tools.



7.1.2 Air medical transport

In places where airborne medical services are available, their use may markedly reduce the time required to transport a victim to a facility for definitive care and may thereby maximise his or her chance of making a successful recovery. In remote locations, air transport may be the only means of reaching a health-care facility. This is particularly true when transportation involves travel over rugged terrain.

The costs associated with developing and maintaining an air transportation capability (such as a helicopter or fixed-wing transport), include the purchase, operation, maintenance and training of crew. These costs are extremely high. For example, in the United States of America, the annual cost of operating an airborne medical programme is estimated to be about US\$2000 per transported patient (56, 57). In the United Kingdom, the cost per mission varies between £515 and £2235 (58). Many countries will find these costs prohibitive and thus reasonably conclude that improving existing modes of transportation (or devising affordable alternatives) may be more feasible.

Where air transport is available, well-defined criteria are needed to ensure wise use of this resource. Various approaches can be adopted to organize and support a medical air transport service. Whether financed privately, supported by a charitable group, based on a military model or run by the government, collaboration with local citizens, health-care providers and health-care institutions is essential.

7.2 Importance of field triage

Triage is the term applied to the process of classifying patients according to the severity of their injuries to determine how quickly they need care. Careful triage is needed to ensure that resources available in a community are properly matched to each victim's needs. If too many patients regularly bypass the local clinic in favour of the regional hospital, the latter facility will be overwhelmed. If, however, severely ill or injured patients are seen at a local clinic rather than being stabilized and promptly transferred to a facility providing a higher level of care, needless deaths will result. If a victim has sustained devastating injuries and the nearest hospital is more than a day's travel away, it may be more prudent and even compassionate to provide palliative treatment at the local level instead of subjecting the patient to the discomfort and rigours of a transfer that he or she may not survive.

Formal algorithms or protocols must be developed to ensure that community resources are used properly to care for trauma patients; these algorithms must exist for both the prehospital and hospital setting. Failure to develop protocols may lead to over-triage or under-triage.

Over-triage

Over-triage occurs when non-critical patients are sent to facilities offering the highest level of care; the facility thus expends resources treating patients who have minor injuries or complaints. If this occurs, the hospital's staff may be too busy to properly focus their attention on more seriously injured patients. In situations in which there are numerous

casualties, over-triage has been reported to correlate with increased mortality for critically injured individuals (59–61).

Under-triage

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 can result in increased morbidity and mortality among patients with otherwise treatable injuries. Because triage decisions may be influenced by multiple factors, including distance from a facility, transportation options, locally available resources and legal considerations, there are no universal guidelines for prehospital triage (62). Therefore, as always, planners must take regional constraints into account.

Whichever protocol or procedure is adopted, it should be developed in advance to determine when, how and where a victim will be transported, the capabilities of the receiving facility and the distance involved (63).

7.3 Communication

A prehospital care system functions best when it is supported by an effective communications network. All levels of care should be linked to one another; this linkage should include ambulances, village clinics and community or regional hospitals. A prerequisite to establishing such a system is an assessment of local needs and resources. Local or national telecommunications services must also be involved to ensure wide coverage. Any locally available communications technologies may be utilized. The following discussion focuses on prehospital communications and activation of the response system.

7.3.1 The role of the communication network

Patient care

A call for help is the first step in securing assistance for victims. In most situations, this is issued spontaneously by a bystander. The proliferation of mobile phones and cellular or satellite communications technology is rapidly changing the nature of communications, particularly in the prehospital setting.

In a number of high-income and middle-income countries, an emergency medical system already exists. In these instances, it is important to ensure that the call for help reaches appropriate individuals and a timely and appropriate response is triggered.

The main role of the communications system is to transmit information about the event and the patient's condition to prehospital providers so that help can be quickly sent to the scene. Once the prehospital providers arrive and give assistance, communications technology enables them to transmit information about the victim's condition to the receiving health-care facility. Proper communication allows the receiving hospital to anticipate the resources required to meet the patient's needs so they can be mobilized prior to the patient's arrival. Relevant information that should be transmitted

includes the mechanism and nature of the injury, the number of victims, their condition en route to the hospital and the estimated time of arrival at the hospital.

Quality improvement

Bi-directional communication through wireless systems can also be used to improve quality of care by facilitating direct medical oversight of the ambulance crew. For example, the supervisor or medical director of the crew may monitor communication between the crew and the health-care facility. In most instances, the medical director will simply note that care is proceeding appropriately; alternatively, the medical director may transmit specific instructions for treatment. However, in some cases, it may be necessary for the medical director to interrupt the flow of communication to dictate a change in care or alter the planned disposition of the patient. For example, the medical director may divert an inbound ambulance to an alternative facility that is more appropriate to the patient's needs.

To ensure that medical oversight achieves appropriate levels of competence and is delivered uniformly, it is preferable for a single facility (generally the local or regional hospital) to handle wireless communications between ambulances and directors in the local catchment area.

Education

Communication networks can also be used to improve the quality and scope of training in prehospital care. Once considered beyond the reach of many countries, technologically sophisticated options, such as video conferencing and video training, have become increasingly affordable and are, therefore, used increasingly widely. The mass media can be used to educate the public to recognize emergency medical situations, to call for help, and learn how to provide first aid. The introduction of satellite communications technology, which is capable of maintaining a clear signal even in remote locations, may make distance education increasingly feasible in the future.

7.3.2 Setting up a “universal” telephone number

Many countries have established nationwide emergency telephone numbers to facilitate access to emergency services. If a country establishes a nationwide number, it should be well publicized and easy to remember. The use of a universal telephone number is desirable, but coverage is often less than universal, particularly in rural areas. Also, the specific telephone number that is reserved for emergency use varies from country to country, so no telephone number is truly universal.

Ideally, a universal emergency telephone number should:

- be valid throughout the catchment area
- be available from every telephone device (landline or mobile)
- be readily accessible (e.g., available through emergency call boxes)
- be easy to remember and dial (i.e., limited to 3 or 4 digits)
- be free of charge

- provide access to a nearby vehicle dispatch centre
- guarantee the confidentiality of the caller.

7.3.3 Centralized call processing

All calls requiring public safety resources (such as fire and rescue services, police, and emergency medical services) should be routed through a central reception centre, commonly called a public safety answering point (Box 11). This will ensure that calls are distributed appropriately to the correct agencies. The coordinated management of an emergency response is best achieved by sharing dispatch functions or by using a secure electronic connection between centres that has the capability to immediately transfer calls. When the technology is available and affordable, automatic location identification systems and number identifiers may be incorporated into the call centre and the centre to ensure the calling number and location are retained in the event that the connection is lost. Automatic location identification is much easier to achieve with landlines than with wireless communication. Because wireless communications technology is being rapidly adopted by large numbers of people, it represents a formidable obstacle to the automatic localization of calls even in high-income countries.

Box 11. Case study: Romania

Integrated emergency dispatch in Mures county

In Mures county, Romania, until 2001, emergency calls were received by different dispatch centres, one serving each emergency response agency (police, medical and fire). There were 27 independent dispatch centres throughout the county. Significant delays in response times occurred with the introduction of mobile phones (which when used for emergency numbers routed all calls to a central dispatch centre that did not have the ability to send calls to the other centres) and the presence of two emergency medical service providers (each requiring call triage and dispatch services).

In March 2001, with funds received mainly from local authorities, a single county-level integrated emergency dispatch centre was created; those needing to use the system dial 112 for all emergencies. The old emergency numbers have been kept in place but are diverted to the new centre. The implementation of the single dispatch centre proved to be an economical solution, replacing the multiple, inefficient and expensive centres with one that was less costly, more efficient and equipped to a higher level.

From an operational point of view, the new centre allows county-level coordination and management of emergency vehicles and responses between different agencies. Alerting all agencies to a major event can now be done in less than 1 minute. In addition, the new model allows professional protocols to be implemented county-wide to make better and more efficient use of the system.

Altogether, 21 people work in the centre. During each shift, a minimum of three dispatchers, a chief of shift and a coordinating physician are present. The physician's role is to aid in the triage of emergency calls and to provide medical control for the first response units.

The dispatch centre processes more than 800 calls a day, out of which a significant number are false alarms.

For a summary of key considerations for transportations and communication see box 12.

Box 12. Key considerations for transportation and communication

- Transportation strategies should be developed within the context of locally available resources
- Designated transport vehicles must meet minimum requirements for safe transportation of the patient
- Utilize air transport only after careful evaluation of costs, benefits and availability
- Consider developing a “universal” telephone number to be used for all emergencies
- Develop methods for communicating within the prehospital environment

8. Quality improvement

A medical director or field supervisor of emergency services is best placed to effect quality improvement. The medical director or field supervisor has several simple but effective ways of ensuring the quality of prehospital care.

- **Listening in on radio or other communications:** When technically feasible, listening in on radio communications may give a medical director insight into the knowledge, thinking and actions of those who are providing prehospital care. Listening in also allows the medical director to interrupt communications to order a change in management if it is necessary to safeguard the patient's health or safety.
- **Direct observation:** Periodically, a supervisor may work alongside a prehospital care team to observe their actions. Although it is likely that teams behave differently when they know they are being observed, this technique nonetheless enables supervisors to determine whether a team is capable of taking appropriate action.
- **Report review:** Supervisors should regularly review documents written by prehospital providers and emergency transport crews. Reviewing written reports may reveal whether the provider responded in a timely manner, whether the appropriate physical findings were documented, and whether the care given was appropriate. Obviously, the validity of record reviews is only as good as the accuracy and completeness of the documents on which it is based. However, poor documentation often indicates poor care. If and when record reviews reveal a problem, feedback should be given to the provider or providers involved in the case. Undesirable patterns of judgement or behaviour, and adverse trends in performance that involve a broad cross-section of personnel, can usually be corrected by providing written and verbal directives. In some cases, it may be necessary to reinforce these directives with additional training.
- **Critical incident review:** Much can be learnt by analysing mistakes, poor outcomes and near-misses (events during which an error was made but no harm was done). Morbidity and mortality reviews, which have long been a fixture of teaching hospitals, can be used effectively as a teaching tool. However, it is important to adopt a modified approach to this process that breaks with the

traditional concept of incident reviews. Rather than simply assigning blame to an individual for making a mistake (a strategy that rarely improves performance and frequently deters others from disclosing errors), supervisors should identify the root causes, conditions, actions and policies that may have contributed to the mishap or adverse outcome. Once these factors are known, they can be systematically addressed to reduce the probability of future adverse events.

- **Outcome studies:** One of the most useful approaches to quality assurance involves selecting one or more clinical conditions of interest (for example, near-drowning or a pedestrian being struck by a motor vehicle) and obtaining follow-up information on these patients to determine their outcome. Outcome studies, coupled with an analysis of data on injury incidence and the process of care, can help supervisors determine whether their prehospital system is accomplishing its goal: saving lives and decreasing long-term disability (see Box 13).
- **Continuing education:** Continuing education is essential in maintaining the knowledge and skills of providers, particularly when they do not work on a regular basis or when the skills in question are used infrequently. Continuing education may involve any or all of the following methods: periodically retraining personnel in the basics of emergency medical and trauma care, introducing new treatment strategies or modifying old ones, orienting staff to the use of new equipment or medicines, giving feedback from the auditing of radio traffic, directly observing performance in the field, or retrospectively reviewing care reports. There is no widely accepted standard that indicates how often continuing education should be offered. Knowledge and skills that are used frequently may require little updating or review. However, skills that are used less frequently should be reviewed at least annually.
A wealth of didactic information can be secured from a variety of sources at little or no cost. Information is available in many forms and from the Internet. Most of these materials are available only in English.
- **Discipline:** It is absolutely vital that prehospital trauma care supervisors and medical directors have the authority to maintain discipline and take corrective action when a provider does not follow directives or cannot function at an acceptable level. In many instances, clarifying expectations or providing remedial education will correct the problem. If improvement does not occur, it may be necessary to suspend the provider's patient care privileges or terminate his or her position as a prehospital trauma care provider.

Box 13. Case study: Mexico**Improving care in Monterrey (32, 64, 65)**

Mexico has undergone changes in the predominant causes of mortality over the past half century, with trauma becoming the leading killer of working-aged adults and the young.

In an effort to call attention to this problem, a study was designed to assess the areas needing improvement in the prehospital trauma system in Monterrey, Mexico. The study, conducted during 1992–1993, compared trauma mortality patterns in this city with those in Seattle, WA, USA. A group of seriously injured adults was identified in each location. Prehospital deaths, emergency-room deaths, and in-hospital deaths were analysed. The mortality rate was higher in Monterrey (55%) than in Seattle (34%), primarily because there was a preponderance of prehospital deaths and emergency-department deaths. In Monterrey, 40% of seriously injured patients died at the scene and 11% in the emergency room compared with 21% at the scene in Seattle and 6% in the emergency room. The trauma systems functioned at different levels, with longer prehospital times and a lower level of prehospital treatment in Monterrey in comparison with Seattle.

Since this study was conducted, significant progress has been made. For example, in Monterrey, improvements have been made in the emergency medical service infrastructure, and increased training has been given to prehospital providers. Also, the number of ambulance dispatch sites has been increased from two to four. A two-day in-service training programme has been provided to all paramedics in the ambulance service. These changes have resulted in a decrease in the mean response time from 16 minutes to 10 minutes and a decrease in mortality. However, these improvements increased the budget for emergency medical services by 16%. This is not an insignificant amount, but administrators felt it was sustainable, and, indeed, these changes in infrastructure and training have been continued and become part of the system.

In addition, there have been other changes in the emergency medical services in Monterrey and the surrounding metropolitan area. Many cities now have a unified emergency response centre where all emergencies are handled and triaged by trained staff, allowing greater coordination between police, fire and emergency medical services, as well as coordination between different ambulance services.

However, challenges continue, and these issues will continue to be addressed over the next few years. These issues include increasing medical direction and supervision, developing training and education capacity, standardizing equipment and improving interactions with governmental bodies.

9. Ethical and legal considerations

Regardless of a nation's social, cultural or religious traditions, emergency care should be based on certain universal principles.

Professionalism

All health-care providers, whether working in a hospital, clinic or at the scene of an emergency, have an ethical obligation to act in the best interests of their patients. It is also important for health-care professionals to respect the limits of their training by not attempting procedures they are unqualified to perform. The only time exceptions should be made to this rule are during a major disaster or an event causing large numbers of casualties, when the need for care may overwhelm immediately available resources. In these cases, prehospital providers must focus their efforts on saving those who have the highest likelihood of surviving. Sometimes this may require providers to perform life-saving procedures that would otherwise be outside the scope of their usual practise.

Autonomy of the patient

Patients who are mentally competent and able to make decisions should not be forced to accept treatment or transport against their will. If treatment involves significant risk (for example, transport to a distant facility), these risks should be explained to patients in language that they can readily understand. Patients cannot make informed decisions about whether to accept care without knowing how serious their condition is, the anticipated risks and benefits of treatment, and whether there are any alternatives to treatment. The only time that informed consent may not be required is when patients are too young, too ill, too injured or too mentally impaired to exercise independent judgement. In these circumstances, rescuers should presume consent and provide care.

Confidentiality

In the course of providing emergency care, providers may learn information that if disclosed could cause the patient emotional distress or even result in physical harm. Health-care personnel must respect their patients' rights to confidentiality. Exceptions

should only be made if a patient clearly expresses an intention to harm others or to harm himself or herself. Prehospital care providers should also respect the confidentiality of bystanders who gave first aid or anyone who called for help.

Neutrality

In areas where there is, for example, gang violence or civil disorder, the simple act of providing prehospital care may place rescuers in danger. This may be true if aiding a particular victim is seen as “taking sides” in the conflict and prompts retaliation against the rescuers. Bystanders and health-care workers should be considered by all parties to be acting neutrally and allowed to give aid without it being construed by either side as a political act.

Immunity

In some cultures, rescuers whose attempts to give aid are unsuccessful risk being held morally and even legally responsible if a patient dies or is left with a permanent disability. Although prehospital care improves the odds of survival, it does not guarantee it. Holding individuals responsible for poor outcomes in the challenging setting of prehospital care is not only unfair but it is also highly unwise because bystanders and health-care workers may be deterred from attempting to help those who need care. Unless there is compelling evidence of gross negligence, wilful disregard for the patient’s welfare or clear evidence of abuse, emergency personnel should not be punished for poor outcomes. This is the best way to encourage prehospital care providers to act decisively to save lives and reduce disability (Box 14).

Box 14. Caring for injured people: legal immunity in India

Parmanand Katara v. Union of India; Supreme Court of India, case number 286, 1989

In this judgement, the Supreme Court of India ruled that the state has an obligation to preserve life, and that it is the professional obligation of doctors, public or private, to provide immediate care to injured people. Additionally, the court noted that the effort to save a person’s life should be the top priority not only of medical professionals but also of anyone (such as police or bystanders) who is present at the scene of an accident. This ruling allows citizens to help acutely injured people without fear of unnecessary legal harassment.

10. Conclusion

This document describes some of the essential and desired components of an effective prehospital trauma care system. The most basic elements of the system are easily affordable and will benefit large numbers of victims of serious and life-threatening injury. One of the most basic ways to provide prehospital care is by engaging community members. Involving them in this process may have the additional benefit of helping them identify and address hazardous conditions and behaviours in their local environment. Thus, promoting trauma treatment may further the goals of injury prevention.

This document can be used to define the minimum elements of an effective system of prehospital care for injured patients. We hope that it will help those planners and policy-makers who are responsible for implementing public health and medical-care systems on the national, regional or district level.

The different levels and components of prehospital trauma care described here should be considered incremental. Policy-makers interested in adopting these recommendations should strive to secure the most basic elements of a functioning prehospital and hospital-based trauma care system before committing scarce resources to more costly optional aspects of the system.

Widespread adoption of this monograph and its companion document, *Guidelines for essential trauma care* (52), will enable countries to provide emergency care affordably (Box 15). Implementing the cost-effective strategies and policies described in these two documents will not only increase the likelihood that injured victims survive to reach the nearest health-care facility but will also ensure that they benefit from their subsequent surgery, inpatient treatment and post-hospital care. Effective implementation will depend, in turn, on the ingenuity, commitment and leadership of WHO, its Member States, local governments, individual health-care providers and engaged citizens.

The financial and social benefits of reducing premature death and minimizing disability from injury are potentially enormous, and these benefits may play a major part in promoting a nation's economic and human development.

In addition to enhancing the health and well-being of injured individuals, effective prehospital trauma care systems clearly benefit patients with potentially life-threatening medical disorders, such as cardiovascular and infectious diseases, and other medical emergencies, such as paediatric emergencies and complications of childbirth.

Finally, adopting these principles will dramatically increase a nation's capacity to respond to natural and man-made disasters. The best way to prepare for mass casualty events is to establish a prehospital care system that functions efficiently and well and that is able to effectively manage emergency events on a daily basis.

Box 15. The Essential Trauma Care Project: improving facility-based care of injured people (52, 66, 67)

Prehospital trauma care systems has emphasized the care of the injured in the prehospital environment. Improvements in prehospital care must go hand in hand with an adequate level of facility-based trauma care – that is, improving the care of the injured at the scene only to bring them to facilities that cannot adequately care for them is less than optimal. Many of the injuries that cause disability and death are readily amenable to simple low-cost improvements in human resources (training and staffing), physical resources (equipment and supplies), and organization and planning.

It is with these improvements in mind that WHO and the International Society of Surgery established the Essential Trauma Care Project. The collaborative Working Group for Essential Trauma Care includes members of these organizations along with stakeholders from several countries, including trauma care clinicians from at least one country on every continent. A variety of other national stakeholders have also been involved, such as the Academy of Traumatology (India), the Mexican Association for the Medicine and Surgery of Trauma, the Ghana Medical Association and the Trauma Society of South Africa.

During the past 3 years, this Working Group has defined 14 core services that are essential to trauma care, such as ensuring that “obstructed airways are opened and maintained before hypoxia leads to death or permanent disability”. To deliver such services worldwide, 260 items of human and physical resources have been designated as either essential or desirable (that is, useful but not as cost effective as essential items) for different levels of facilities, ranging from rural clinics to tertiary care facilities. These have been described in *Guidelines for essential trauma care* (52), published by WHO in 2004. The guidelines also suggest ways to implement changes in areas such as training, quality assurance, hospital inspection and by encouraging interactions among stakeholders.

Some progress in using the guidelines in real-world circumstances has already been made. They have been used to assess trauma care needs in Ghana, Mexico and Viet Nam. In Gujarat State, India, and in Mexico, WHO country offices, local governments, professional societies and other stakeholders have adapted the guidelines to reflect local needs and have developed preliminary implementation plans.

We hope that use of the guidelines will increase and build on the examples provided by early pilot work. These efforts should be made along with efforts to improve prehospital care.

Annex I.

Advanced prehospital trauma care and care in fixed facilities.

The emergency way station

Advanced prehospital trauma care, also known as advanced life support (ALS), the third tier of prehospital support, involves using highly sophisticated interventions to sustain life. Because it is quite costly, it is most often provided in high-income countries.

Where the resources exist to fund ALS, it usually offered by special ambulances staffed by highly trained, professional prehospital providers. In many countries in western Europe, physicians fill this role. In Australia, Canada and the United States, the care is provided by non-physician paramedics.

In low-income and middle-income countries, an acceptable proxy for ALS may be created by formally incorporating village and community clinics into the prehospital care system, using them as emergency way stations where seriously ill and injured patients can be stabilized prior to being transported to a facility providing a higher level of care. Way stations may be especially important if the nearest hospital is far from the scene of the crash. Care at these clinics might include definitive airway management using endotracheal intubation or another airway adjunct, provision of intravenous hydration and administering parenteral pain medication and antibiotics.

When it is possible to adequately treat the victim without referral to a higher level of care, this should be done in order to conserve resources. If, however, the victim's injuries are too challenging or complex to be definitively managed at the local level, he or she should be promptly transferred to a regional hospital.

Skills required

To effectively function as an ALS way station, a village clinic must be staffed by health-care workers who have had supplemental training in trauma care. These individuals must also be given the supplies and equipment they need to evaluate and stabilize seriously injured patients. (Please refer to the resource matrix in section 5 for more information.)

Clinic-based ALS providers should be trained to provide all aspects of care rendered by bystanders and those trained to provide basic life support. In addition, they should be trained and equipped to perform the additional tasks outlined in the matrix in section 5.

Surgical care in fixed facilities

Every physician who treats seriously injured patients should receive core training in how to evaluate and stabilize their condition. An “Advanced Trauma Life Support[®]” course has been designed for this purpose by the American College of Surgeons. It has been taught throughout the world. This course, and others like it, is designed to help physicians acquire basic skills in injury assessment and stabilization. It does not teach physicians the surgical techniques needed to definitively manage severe injuries or burns. Because these courses are focused on resuscitation and stabilization, they form only part of a comprehensive strategy to improve trauma care. For this reason, physicians working in rural hospitals and remote areas where evacuation is extremely difficult will need additional surgical skills to definitively manage the majority of trauma patients. This will improve outcomes and minimize the number of patients who need to be transported to a facility providing a higher level of care.

Additional information can be found in *Guidelines for essential trauma care* (52) and *Surgical care at the district hospital* (53) for more information.

Regionalizing trauma care

Experts in developing trauma care systems recommend taking an inclusive approach to trauma care: one that involves all levels and types of health centres. This is preferable to an exclusive approach that commits most of a country’s resources to a small number of highly specialized trauma centres. In general, more good can be done for more people by establishing trauma teams within existing regional and municipal hospitals than by creating one or more national trauma hospitals. Within each hospital, doctors and nurses with expertise in trauma care should be identified and organized so they can efficiently provide high-quality trauma care to injured patients. The American College of Surgeons has developed criteria for designating hospitals as trauma centres (63). Where such expertise is not available, national or local governments must initiate training programmes in essential trauma care for doctors and nurses.

References

1. Holder Y et al., eds. *Injury surveillance guidelines*. Geneva, World Health Organization, 2000.
2. Peden M, McGee K, Krug E, eds. *Injury: a leading cause of the global burden of disease*. Geneva, World Health Organization, 2002.
3. Murray CJL, Lopez A, eds. *The global burden of disease: a comprehensive assessment of mortality and disability from diseases, injuries and risk factors in 1990 and projected to 2020*, vol. 1. Cambridge, MA, Harvard School of Public Health on behalf of the World Health Organization and the World Bank, 1999 (Global Burden of Disease and Injury Series).
4. Dobson M, Wilkinson D. *Primary life support: a proposal to increase survival and reduce disability following trauma in developing countries*. Oxford, 1996.
5. Beaglehole R, ed. Neglected global epidemics: three growing threats. In: *The world health report 2003: shaping the future*. Geneva, World Health Organization, 2003.
6. Hargarten SW, Karlson T. Injury control: a crucial aspect of emergency medicine. *Emergency Medicine Clinics of North America*, 1993, 11:255–62.
7. Anderson RJ, Taliaferro EH. Injury prevention and control. *Journal of Emergency Medicine*, 1998, 16:489–98.
8. Tsai MC, Hemenway D. Effect of the mandatory helmet law in Taiwan. *Injury Prevention*, 1999, 5:290–1.
9. Cohen L, Swift S. The spectrum of prevention: developing a comprehensive approach to injury prevention. *Injury Prevention*, 1999, 5:203–7.
10. Marson A, Thomson J. The influence of prehospital trauma care on traffic accident mortality. *Journal of Trauma*, 2001, 50:917–20.
11. Husum H et al. Rural prehospital trauma systems improve trauma outcome in low-income countries: a prospective study from north Iraq and Cambodia. *Journal of Trauma*, 2003, 54:1188–96.
12. Hussain LM, Redmond AD. Are prehospital deaths from accidental injury preventable? *British Medical Journal*, 1994, 308:1077–80.
13. Varghese M. Technologies, therapies, emotions and empiricism in prehospital care. In: Mohan D, Tiwari G, eds. *Injury prevention and control*. London, Taylor and Francis, 2000.
14. Demetriades D et al. Paramedic vs. private transportation of trauma patients. Effect on outcome. *Archives of Surgery*, 1996, 131:133–8.
15. Brunn F et al. Effectiveness of prehospital trauma care, Cochrane Injuries Group, 2001 (<http://www.cochrane-injuries.lshtm.ac.uk/Pre-HospFINALReport2.pdf>, accessed 11 March 2005).

16. Eckstein M et al. Effect of prehospital advanced life support on outcomes of major trauma patients. *Journal of Trauma*, 2000, 48:643–8.
17. Cooke MW. How much to do at the accident scene? *British Medical Journal*, 1999, 319:1150.
18. Osterwalder JJ. Insufficient quality of research on prehospital medical emergency care – where are the major problems and solutions? *Swiss Medical Weekly*, 2004, 134:389–94.
19. Callahan M. Quantifying the scanty science of prehospital emergency care. *Annals of Emergency Medicine*, 1997, 30:785–90.
20. Murray JA et al. Prehospital intubation in patients with severe head injury. *Journal of Trauma*, 2000, 49:1065–70.
21. Stockinger ZT, McSwain NE. Prehospital endotracheal intubation for trauma does not improve survival over bag–valve–mask ventilation. *Journal of Trauma*, 2004, 56:531–6.
22. Eckstein M et al. Effect of prehospital advanced life support on outcomes of major trauma patients. *Journal of Trauma*, 2000, 48:643–8.
23. Liberman M, Mulder D, Sampalis J. Advanced or basic life support for trauma: meta-analysis and critical review of the literature. *Journal of Trauma*, 2000, 49:584–99.
24. Hauswald M, Yeoh E. Designing a prehospital system for a developing country: estimated cost and benefits. *American Journal of Emergency Medicine*, 1997, 15:600–3.
25. Bwale P, Husum H, Gilbert M. Prehospital trauma care: a training model in less resourced countries: examples from Angola, Cambodia, and Mozambique. In: *6th world conference on injury prevention and control: abstracts*. Montreal, Les Presses de l'Université de Montréal, 2002:1004–5.
26. Razzak JA, Kellermann AL. Emergency medical care in developing countries: is it worthwhile? *Bulletin of the World Health Organization*, 2002, 80:900–5.
27. Ali J et al. Trauma patient outcome after the prehospital trauma life support program. *Journal of Trauma*, 1997, 42:1018–22.
28. Schmid T et al. Transportation for maternal emergencies in Tanzania: empowering communities through participatory problem solving. *American Journal of Public Health*, 2001, 91:1589–90.
29. Tiska M et al. Appropriate prehospital trauma care training: a model devised in Ghana. In: *6th world conference on injury prevention and control: abstract*. Montreal, Les Presses de l'Université de Montréal, 2002: 1003–4.
30. Kobusingye O, ed. Emergency care saves lives. *Injury Control News: Newsletter of the Injury Control Centre-Uganda*, 2002, 3:3.
31. Mock CN et al. Improvements in prehospital trauma care in an African country with no formal emergency medical services. *Journal of Trauma*, 2002, 53:90–7.
32. Arreola-Risa C et al. Low cost improvements in prehospital trauma care in a Latin American city. *Journal of Trauma*, 2000, 48:119–24.
33. Tiska M et al. A model of prehospital trauma training for lay persons devised in Africa. *Emergency Medicine Journal*, 2004, 21:237–9.

34. Van Rooyen et al. International emergency medical services: assessment of developing prehospital systems abroad. *Journal of Emergency Medicine*, 1999, 17:691–6.
35. United States National Highway Traffic Safety Administration. *Guide for preparing medical directors*, 2001 (<http://www.nhtsa.dot.gov/people/injury/ems/2001GuideMedical.pdf>, accessed 11 March 2005).
36. VanRooyen MJ. Development of prehospital emergency medical services: strategies for system assessment and planning. *Pacific Health Dialog*, 2002, 9:86–92.
37. Blackwell T. Principles of emergency medical services systems. In: Marx JM, ed. *Rosen's emergency medicine concepts and clinical practice*, 5th ed. St. Louis, MO, Mosby, 2002:2616–25.
38. Pozner CN et al. International EMS systems. The United States: past, present, and future. *Resuscitation*, 2004, 60:239–44.
39. Varghese M, Mohan P. *When someone is hurt: a first aid guide for lay persons and community workers*. New Delhi, The Other Media Communications, 1998.
40. Peterson TD et al. Bystander trauma care training in Iowa. *Prehospital Emergency Care*, 1999, 3:225–30.
41. Bur A et al. Effects of bystander first aid, defibrillation and advanced life support on neurologic outcome and hospital costs in patients after ventricular fibrillation cardiac arrest. *Intensive Care Medicine*, 2001, 27:1474–80.
42. Lateef F, Anantharaman V. Bystander cardiopulmonary resuscitation in prehospital cardiac arrest patients in Singapore. *Prehospital Emergency Care*, 2001, 5:387–90.
43. Husum H, Gilbert M, Wisborg T. Training prehospital trauma care in low-income countries: the “Village University” experience. *Medical Teacher*, 2003, 25:142–8.
44. Tiska MA et al. A model of prehospital trauma training for lay persons devised in Africa. *Emergency Medicine Journal*, 2004, 21:237–9.
45. Pelinka LE et al. Bystander trauma care – effect of the level of training. *Resuscitation*, 2004, 60:289–96.
46. Angus DC et al. Recommendations for life-supporting first-aid training of the lay public for disaster preparedness. *Prehospital Disaster Medicine*, 1993, 8:157–60.
47. United States National Highway Traffic Safety Administration. *First there, first care*. Washington, DC, US Department of Transportation, 2000.
48. Gove S et al. Development and technical basis of simplified guidelines for emergency triage assessment and treatment in developing countries. WHO Integrated Management of Childhood Illness (IMCI) Referral Care Project. *Archives of Disease in Childhood*, 1999, 81:473–7.
49. Sodemann M et al. High mortality despite good care-seeking behaviour: a community study of childhood deaths in Guinea-Bissau. *Bulletin of the World Health Organization*, 1997, 75:205–12.
50. Fawcus S et al. A Community-based investigation of avoidable factors for maternal mortality in Zimbabwe. *Studies in Family Planning*, 1996, 27:319–27.

51. Husum H, Gilbert M, Wisborg T. *Save lives, save limbs*. Penang, Malaysia, Third World Network, 2000.
52. Mock C et al. *Guidelines for essential trauma care*. Geneva, World Health Organization, 2004.
53. World Health Organization. *Surgical care at the district hospital*. Geneva, WHO, 2003 (<http://www.who.int/surgery/publications/en/SCDH.pdf>, accessed 18 May 2005).
54. Smith GCS, Pell JP. Parachute use to prevent death and major trauma related to gravitational challenge: systematic review of randomised controlled trials. *BMJ*, 2003, 327:1459–61.
55. ICECI Coordination and Development Group. *International Classification of External Causes of Injuries (ICECI): version 1.2. Volume 1: tabular lists*. Amsterdam, Consumer Safety Institute and Adelaide, AIHW National Injury Surveillance Unit, 2003 (<http://www.iceci.org/csi/iceci.nsf/718cb626c970def7c1256a8d0060b3d2/859823ddd67275de00256a2a0058e08e!OpenDocument>, accessed 18 May 2005).
56. Bagian JP, Allen RC. Aeromedical transport. In: Auerbach PS, ed. *Wilderness medicine: management of wilderness and environmental emergencies*, 4th ed. St. Louis, MO, Mosby, 2001:660–72.
57. Gearhart PA, Wuertz R, Localio AR. Cost-effectiveness analysis of helicopter EMS for trauma patients. *Annals of Emergency Medicine*, 1997, 30:500–6.
58. Nicholl J et al. *A review of the costs and benefits of helicopter emergency ambulance services in England and Wales: final report to the Department of Health*, 2003 (<http://www.shef.ac.uk/scharr/mcru/reports/HEASrev.pdf>, accessed 11 March 2005).
59. Frykberg ER. Terrorist bombings in Madrid. *Critical Care*, 2005, 9:20–2.
60. Frykberg ER. Medical management of disasters and mass casualties from terrorist bombings: how can we cope? *Journal of Trauma*, 2002, 53:201–12.
61. Frykberg ER, Tepas JJ. Terrorist bombings: lessons learned from Belfast to Beirut. *Annals of Surgery*, 1988, 208:569–76.
62. Cone DC et al. Field triage systems: methodologies from the literature. *Prehospital Emergency Care*, 2004, 8:130–7.
63. American College of Surgeons, Committee on Trauma. *Resources for optimal care of the injured patient*. Chicago, IL, American College of Surgeons, 1999.
64. Arreola-Risa C et al. Trauma care systems in urban Latin America: the priorities should be prehospital and emergency room management. *Journal of Trauma*, 1995, 39:457–62.
65. Mock CN et al. Trauma mortality patterns in three nations at different economic levels: implications for global trauma system development. *Journal of Trauma*, 1998, 44:804–12.
66. Joshipura M et al. Essential trauma care: strengthening trauma systems round the world. *Injury*, 2004, 35:841–5.
67. Mock C, Joshipura M, Goosen J. Global strengthening of the care of the injured. *Bulletin of the World Health Organization*, 2004, 82:241.

Selected readings

1. Ali J et al. Trauma outcome improves following the advanced trauma life support program in a developing country. *Journal of Trauma*, 1993, 34:898–9.
2. Ali J et al. Effect of the prehospital trauma life support program (PHTLS) on prehospital trauma care. *Journal of Trauma*, 1997, 42:786–90.
3. American College of Emergency Physicians, American College of Surgeons. *Equipment for ambulances*, 2000 (<http://www.acep.org/library/pdf/ambulance equip.pdf>, accessed 11 March 2005).
4. Angus DC et al. Recommendations for life supporting first aid training of the lay public for disaster preparedness. *Prehospital Disaster Medicine*, 1993, 8:157–60.
5. Bazzoli GJ. Community-based trauma system development: key barriers and facilitating factors. *Journal of Trauma*, 1999, 47(Suppl. 3):S22–S24.
6. Bossaert LL. The complexity of comparing different EMS systems: a survey of EMS systems in Europe. *Annals of Emergency Medicine*, 1993, 22:99–102.
7. Campbell JE. *Basic trauma life support for paramedics and other advanced providers*, 4th ed. Upper Saddle River, NJ, Brady/Prentice Hall Health, 2000.
8. Carney CJ. Prehospital care – a UK perspective. *British Medical Bulletin*, 1999, 55:757–66.
9. Chawla R. Need for trauma care programmes in developing countries. *Bulletin of the World Health Organization*, 1999, 77: 948–49.
10. Coats TJ, Davies G. Prehospital care for road traffic casualties. *British Medical Journal*, 2002, 324:1135–41.
11. European Transport Safety Council. *Reducing the severity of road injuries through post impact care*. Brussels, European Transport Safety Council, 1999 Brussels (<http://www.etsc.be/documents/care.pdf>, accessed 18 May 2005).
12. Feero S et al. Does out-of-hospital time affect trauma survival? *American Journal of Emergency Medicine*, 1995, 13:133–35.
13. Fiander S. *Anyone can save a life: road accidents and first aid*. London, British Red Cross, 2001 (<http://www.i-connect.ch/grsp/grspdev/pdfs/BRCreport2000.pdf>, accessed 18 May 2005).
14. Greengross P. Effects of helicopter service on survival after trauma: service is a part of continuum of care. *British Medical Journal*, 1995, 311:1164–65.

15. Husum H. Effects of early prehospital life support to war injured: the battle of Jalalabad, Afghanistan. *Prehospital Disaster Medicine*, 1999, 14:75–80.
16. Jiang C et al. Trauma care in China: challenge and development. *Injury*, 1996, 27:471–75.
17. Joshipura MK et al. Trauma care systems in India. *Injury*, 2003, 34:686–92.
18. Kerr WA, Kerns TJ, Bissell RA. Differences in mortality rates among trauma patients transported by helicopter and ambulance in Maryland. *Prehospital Disaster Medicine*, 1999, 14:159–61.
19. Kirsch TD. Emergency medicine around the world. *Annals of Emergency Medicine*, 1998, 32:237–38.
20. Kobusingye O, Guwarudde D, Lett R. Injury patterns in rural and urban Uganda. *Injury Prevention*, 2001, 7:46–50.
21. Kuehl A. *Prehospital systems and medical oversight*, 3rd ed. St. Louis, MO, Kendall-Hunt Publishing, 2002.
22. Lenworth MJ et al. Prehospital advanced life support: benefits in trauma. *Journal of Trauma*, 1984, 24:8–13.
23. London JA et al. Priorities for improving hospital-based trauma care in an African City. *Journal of Trauma*, 2001, 51:747–53.
24. MacFarlane C. The advances and evidence base for prehospital care. *Emergency Medicine Journal*, 2003, 20:114–15.
25. MacFarlane C, Benn CA. Evaluation of emergency medical services systems: a classification to assist in determination of indicators. *Emergency Medicine Journal*, 2003, 20:188–91.
26. Maheshwari A et al. Prehospital ACLS – does it work? *Emergency Medicine Clinics of North America*, 2002, 20:759–70.
27. Mock C, nii-Amon Kotei D, Maier RV. Low utilization of formal medical services by injured persons in a developing nation: health service data underestimate the importance of trauma. *Journal of Trauma*, 1997, 42:504–13.
28. Mock CN. Trauma system development in Ghana. *Ghana Medical Journal*, 2001, 35: 1–3.
29. Mock C, Arreola-Risa C, Quansah R. Strengthening care for injured persons in less developed countries: a case study of Ghana and Mexico. *Injury Control and Safety Promotion*, 2003, 10:45–51.
30. Nicholl J. Prehospital deaths from accidental injury. *British Medical Journal*, 1994, 309:57.
31. Nicholl J, Brazier JE, Snooks HA. Effects of London helicopter emergency medical service on survival after trauma. *British Medical Journal*, 1995, 311:217–22.
32. Nicholl J et al. The cost and benefits of paramedic skills in prehospital trauma care. *Health Technology Assessment*, 1998; 2(17):1–72.
33. Runge JW. The cost of injury. *Emergency Medicine Clinics of North America*, 1993, 11:241–53.
34. Tamburlini G et al. Evaluation of guidelines for emergency triage assessment and treatment in developing countries. *Archives of Disease in Childhood*, 1999, 81:478–82.

