

Guidelines for essential trauma care



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Guidelines for essential trauma care

WORLD HEALTH ORGANIZATION



IATSIC

INTERNATIONAL SOCIETY OF SURGERY
SOCIÉTÉ INTERNATIONALE DE CHIRURGIE
and
INTERNATIONAL ASSOCIATION FOR THE SURGERY OF TRAUMA
AND SURGICAL INTENSIVE CARE

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Contents

Preface by Etienne Krug, WHO	v
Foreword by Stephen Deane, IATSIC	vii
Contributors	ix
Acknowledgements	x
1. Executive summary	1
2. Orientation to the Essential Trauma Care Project	3
2.1 Goals of the Essential Trauma Care Project	3
2.2 Disparities in outcome of trauma	4
2.3 Elements of trauma care to reinforce	4
2.4 Foundations on which to build	6
2.5 Evidence of the impact of better organization of trauma services	7
2.6 Development process for essential trauma care	8
2.7 Overlap with other activities	9
3. Essential trauma services: needs of the injured patient	11
4. Inputs needed to achieve essential trauma services	13
4.1 Overview	13
4.2 Resource matrix: introduction	13
4.3 Resource matrix: necessary elements of trauma care	13
4.4 Resource matrix: range of health facilities	14
4.5 Resource matrix: designation of priorities	16
5. Guidelines for essential trauma care	19
5.1 Airway management	19
5.2 Breathing—management of respiratory distress	22
5.3 Circulation—management of shock	24
5.4 Management of head injury	28
5.5 Management of neck injury	31
5.6 Management of chest injury	32

5.7	Management of abdominal injury	34
5.8	Management of extremity injury	36
5.9	Management of spinal injury	39
5.10	Management of burns and wounds	42
5.11	Rehabilitation	45
5.12	Pain control and medicines	48
5.13	Diagnosis and monitoring	53
5.14	Safety for health care personnel	56
5.15	Special considerations for children	57
6.	Methods for promoting essential trauma care services	59
6.1	Training for trauma care	59
6.2	Performance improvement	64
6.3	Trauma team and organization of the initial resuscitation	69
6.4	Hospital inspection	72
6.5	Integration of systems for trauma management	75
6.6	Interaction and coordination of stakeholders	78
6.7	Progress to date	79
	References	81
	Annex 1. Detailed list of equipment and services for airway management	86
	Annex 2. Composition of a typical trauma team	87
	Annex 3. Detailed list of individuals and groups involved in development of <i>Guidelines for essential trauma care</i>	93

Preface

Injury is an increasingly significant health problem throughout the world. Every day, 16 000 people die from injuries, and for every person who dies, several thousand more are injured, many of them with permanent sequelae. Injury accounts for 16% of the global burden of disease. The burden of death and disability from injury is especially notable in low- and middle-income countries. By far the greatest part of the total burden of injury, approximately 90%, occurs in such countries.

Decreasing the burden of injuries is among the main challenges for public health in this century. The World Health Organization is playing an important role in meeting this challenge. In particular, the Department of Injuries and Violence Prevention (VIP) has spearheaded efforts to improve the spectrum of injury control activities. These include improving and standardizing injury surveillance systems; promoting injury control policy initiatives for violence, traffic and other major sources of injury; and promoting low-cost improvements in injury care, in both the pre-hospital and hospital-based arenas. All of these efforts are needed to adequately confront the injury problem.

The Essential Trauma Care (EsTC) Project addresses one of the important points in the spectrum of injury control activities, that of promoting inexpensive improvements in facility-based trauma care. Through this and through the WHO's accompanying guidelines for trauma care before admission to hospital, currently in development, we seek to assure a certain minimum level of care for virtually every injured person worldwide. The potential benefits for such improvements are evidenced by the gross disparities in outcome between low- and middle-income countries on one hand and high-income countries on the other. For example, one of the studies quoted later in this document shows that persons with life-threatening but salvageable injuries are six times more likely to die in a low-income setting (36% mortality) than in a high-income setting (6% mortality).

The *Guidelines for essential trauma care* seek to reduce such disparities by establishing achievable and affordable standards for injury care worldwide. They set forth a list of essential trauma services that the authors feel are achievable in virtually every setting worldwide. The guidelines then lay out the various human

and physical resources that are needed to assure such services. These guidelines have been developed in a collaborative fashion with our main partner in this endeavour, the International Association for the Surgery of Trauma and Surgical Intensive Care (IATSIC). They have also been developed with the input of several other international and national societies, and, most importantly, by many experts actively involved in the care of injured persons worldwide.

All who have been involved with the development of these guideline feel that they have the potential to make significant improvements in the care of injured persons. I look forward to seeing the recommendations set forth in this document put into action in countries around the world.

Etienne Krug, MD, MPH

Director, Injuries and Violence Prevention Department

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Geneva

Foreword

For too long, trauma has been one of the leading health problems of the world. In addition to all that needs to be done to improve road safety and other aspects of injury prevention, efforts to improve care of the injured are essential. Trauma care represents a major challenge to the clinician, no matter what his or her background. The life- and limb-threatening injuries that are daily parts of trauma care present some of the most difficult decisions that any clinician can face. However, many lives can be saved through inexpensive modifications in education, organization and availability of simple pieces of equipment. Such changes greatly simplify decisions and actions.

The International Association for the Surgery of Trauma and Surgical Intensive Care (IATSIC) was founded to confront such difficulties and to improve the care of injured persons around the world. To our knowledge, it is the foremost organization addressing such problems from the vantage point of practising clinicians. Our association of surgeons has been active in many efforts to promote trauma care, including scientific exchanges of information, and the development and promulgation of several training programmes for doctors. We welcome opportunities to work with colleagues in other clinical and non-clinical disciplines.

Our membership is aware of the difficulties that confront trauma care in low- and middle-income countries. Two years ago, we established the Working Group for Essential Trauma Care, which was charged with formulating a plan to address such difficulties on a global scale and was authorized to forge partnerships with other groups that might have similar goals. We are very enthusiastic about the subsequent highly productive partnership with the World Health Organization.

This document, *Guidelines for essential trauma care*, is the result of a tremendous amount of work on the part of many persons from our two organizations, as well as many other contributors. It has taken into account many, often conflicting opinions. We have made a particular effort to involve clinicians who are in the front line of caring for injured persons in the setting of their home countries in Africa, Asia and Latin America.

The guidelines set forth a list of essential trauma services that we feel are achievable in virtually every setting worldwide, and then lay out the various

human and physical resources that are needed to assure that such services are provided.

A central theme of the guidelines is that we can achieve improved outcomes for injured patients through better organization and planning of trauma care services. The benefits of such improvements in organization and planning, in the form of implementation of systems for trauma management in Australia, the United States of America, Canada, the United Kingdom of Great Britain and Northern Ireland and many other high-income countries, are well documented. Many members of IATSIC have led such initiatives. We are very hopeful that similar improvements in organization and planning will result in equally significant improvements in the care of the injured in other countries worldwide. Moreover, the improvements in organization and planning promoted by the *Guidelines for essential trauma care* are felt to be cost-effective, feasible and sustainable, even in those environments with poorest access to resources.

The members of IATSIC are available to assist, as appropriate, in the implementation of these guidelines in support of WHO and in partnership with governments, health authorities and medical colleges and associations.

On behalf of the membership of IATSIC, I look forward to seeing these *Guidelines for essential trauma care* put into action, improving the care of the injured around the world.

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I. Executive summary

Injury¹ has become a major cause of death and disability worldwide. Organized approaches to its prevention and treatment are needed. In terms of treatment, there are many low-cost improvements that could be made to enhance the care of injured persons. The goal of the *Guidelines for essential trauma care* is to promote such low-cost improvements. These guidelines seek to set achievable standards for trauma treatment services which could realistically be made available to almost every injured person in the world. They then seek to define the resources that would be necessary to assure such care. These include human resources (staffing and training) and physical resources (infrastructure, equipment and supplies). By more clearly defining such services and resources, we hope these guidelines will facilitate the strengthening of trauma treatment services worldwide. The basic premise of these guidelines is that improvements in organization and planning can result in improvements in trauma treatment services and hence in the outcome of injured persons, with minimal increases in expenditures.

The authors of the guidelines have developed a series of resource tables for essential trauma care that detail the human and physical resources that should be in place to assure optimal care of the injured patient at the range of health facilities throughout the world, from rural health posts whose staff do not have training as doctors, to small hospitals staffed by general practitioners (known as GP-staffed hospitals), to hospitals staffed by specialists (specialist-staffed hospitals), to tertiary care centres. They also take into account the varying resource availability across the spectrum of low- and middle-income countries.² Finally, a series of recommendations is made on methods to promote such standards including training, performance improvement, trauma team organization and hospital inspection. The resource tables and associated recommendations are

¹ The terms “injury” and “trauma” are used interchangeably throughout these guidelines.

² In these guidelines, mention is made of the categorization of countries by economic level according to the criteria of the World Bank (www.worldbank.org/data/countryclass/countryclass.html), based on 2002 gross national income (GNI) per capita: low-income, US\$735 or less; lower-middle-income, US\$736–2935; upper-middle-income US\$2936–9075; and high-income, US\$9076 or more.

intended to provide a template to assist individual countries in organizing and strengthening their own trauma treatment systems. It is anticipated that the template will be adapted to suit local circumstances.

These recommendations have been drawn up in collaboration between the following parties:

- the Department of Injuries and Violence Prevention (VIP) of the WHO
- members of the Working Group for Essential Trauma Care of the International Association for the Surgery of Trauma and Surgical Intensive Care (IATSIC), which is an integrated society within the broader International Society of Surgery/Société Internationale de Chirurgie (ISS/SIC);
- representatives of other organizations and other departments of WHO, such as the Department of Essential Health Technologies, which are involved in developing training materials on essential surgical care and trauma; and
- trauma care clinicians from Africa, Asia and Latin America.

The guidelines are written in a style oriented primarily towards health care planners and administrators. In many circumstances, these may include clinicians who are involved in the care of injured patients but also have administrative duties. The guidelines are also intended for use by clinicians who might use them to demonstrate to planners and administrators the need to make improvements to the resources that are available for trauma care. Thus, the target audience for these guidelines includes planners in ministries of health, hospital administrators, nursing service directors, medical service directors and clinicians, both individually and collectively, through organizations such as societies of surgery, anaesthesia, traumatology and other disciplines that deal with the injured patient. Broadly construed, these guidelines are of relevance to anyone involved in planning trauma care services or anyone who might wish to promote improvements in the care of the injured in their country.

2. Orientation to the Essential Trauma Care Project

2.1 Goals of the Essential Trauma Care Project

In working towards decreasing the burden of death and disability from injury, a spectrum of activities needs to be considered, ranging from surveillance and basic research to prevention programmes, to trauma management. Large gains are to be made in prevention, and hence a major emphasis should be placed on this approach. There are also major gains to be made by addressing treatment. That is to say, low-cost initiatives can help to reinforce current trauma treatment systems worldwide and by so doing help to reduce the overall burden from injury. The goals of the Essential Trauma Care (EsTC) Project are to identify and promote such inexpensive ways of reinforcing trauma treatment worldwide.

The EsTC Project seeks to accomplish this overall goal by better defining what essential trauma treatment services should realistically be made available to almost every injured person worldwide. The project then seeks to develop ways of assuring the availability of these services by reinforcing inputs of: (1) human resources (training and staffing); and (2) physical resources (supplies and equipment). These inputs are outlined in the form of a template, referred to as the EsTC resource matrix. It is intended that this template and the entire manual should be used as a guide for those planning trauma treatment services for their countries or areas.

The following chapter is intended as an introduction to the concept and development of the EsTC Project. It outlines the current disparities in outcome between persons injured in high-income countries and those injured in low- and middle-income countries. It briefly reviews some of the difficulties facing trauma care in developing countries which may account for existing disparities and which are the focus of efforts to improve organization and reinforce services. It reviews the foundations we have on which to build in our efforts to improve trauma treatment services, including essential health service programmes for other diseases and efforts to improve trauma care in individual countries. It introduces the premise that improvements in the organization of trauma treatment services may represent a cost-effective way of improving the delivery and outcome of such services, and presents evidence to this effect. It then summarizes the process by which this manual was developed and written, and suggests how it should

ultimately be used. Finally, it addresses the overlap between the EsTC Project and other international health activities, including WHO activities.

2.2 Disparities in outcome of trauma

There are notable disparities in mortality rates for injured patients around the world. For example, one study looked at the mortality rates for all seriously injured adults (injury severity score of 9 or more) in three cities, in countries at different economic levels. The mortality rate (including both pre-hospital and in-hospital deaths) rose from 35% in a high-income setting to 55% in a middle-income setting, to 63% in a low-income setting (1). Considering only patients who survive to reach the hospital, a similar study demonstrated a six-fold increase in mortality for patients with injuries of moderate severity (injury severity score of 15–24). Such mortality increased from 6% in a hospital in a high-income country to 36% in a rural area of a low-income country (2).

In addition to an excess mortality, there is a tremendous burden of disability from extremity injuries in many developing countries (2, 3). By comparison, head and spinal cord injuries contribute a greater percentage of disability in high-income countries (4). Much of the disability from extremity injuries in developing countries should be eminently preventable through inexpensive improvements in orthopaedic care and rehabilitation.

In part, the improved survival and functional outcome among injured patients in developed countries comes from high-cost equipment and technology. Unfortunately, much of this may be unaffordable to the average injured person in the world for the foreseeable future. However, much of the improvement in patient outcome in higher-income countries has come from improvements in the organization of trauma care services (5–9). Improvement in the organization of trauma services should be achievable in almost every setting and may represent a cost-effective way of improving patient outcomes. This is the basis of the Essential Trauma Care Project. Before going into further detail about the plans for the project itself, it is useful to briefly examine some of the difficulties facing trauma care in developing countries that might be improved upon in an inexpensive fashion through improvements in organization and planning.

2.3 Elements of trauma care to reinforce

This section provides brief examples of the deficiencies in resources and organization that could be targeted by an Essential Trauma Care Project. These are considered in three broad categories.

Human resources: staffing and training

In most developing countries, little consideration has been given to optimizing the training of medical and nursing staff for the care of injured patients. This applies

to both urban and rural environments. For example, hospitals in rural areas along major roads in Ghana receive large numbers of casualties, yet are often staffed by general practitioners (GPs) and nurses with no specific training in trauma care. Moreover, 30% of the GPs in these hospitals have not had a surgery rotation during their training as house officers (internship) (10). Inexpensive but effective solutions to such problems might include: (i) country-wide plans to encourage those staff with more experience in trauma care to go to such hospitals; and (ii) provision of continuing education courses on trauma care for GPs and nurses in high-volume trauma hospitals. Pilot programmes for such training have demonstrated improvements in trauma care in a variety of environments, including Ghana and Trinidad (10–14).

Physical resources: infrastructure, equipment and supplies

Many hospitals lack important equipment, some of which is inexpensive. For example, in Ghana, it was found that of 11 rural hospitals along major roads, none had chest tubes and only 4 had emergency airway equipment (11). These items are vitally important for the treatment of life-threatening chest injuries and airway obstruction, major preventable causes of death in trauma patients. Such equipment is inexpensive and much of it is reusable. The main reason for the absence of such vital equipment is a lack of organization and planning, rather than resource restrictions (10, 11). In Mexico, a lack of adequate capabilities for the repair of the one CT (computerized tomography) scanner at a major urban trauma centre resulted in prolonged periods of breakdown, which greatly impaired the care of head-injured patients (15). Programmes to assure the supply and maintenance of trauma-related equipment, appropriate to the specific circumstances of the given country, could help to address deficiencies of inexpensive but high-yield resources.

Process: organization and administration

In addition to assuring adequate supplies, improved administration could also assist in appropriate utilization. In a study in Ghana, it was found that, even at an urban teaching hospital, there were significant problems with the process of trauma care. There were prolonged times to emergency surgery, with a mean time of 12 hours between arrival at the casualty ward and start of the procedure. There was also low utilization of chest tubes, even though they were physically available in the hospital. Only 0.6% of all trauma admissions had a chest tube inserted, in comparison with 6.3% at a hospital in a developed country. In addition to addressing such items individually, this study identified the implementation of basic quality improvement programmes (medical audit) as a possible way of addressing many such problems in the process of trauma care simultaneously (16).

The Essential Trauma Care Project is viewed as a way of comprehensively addressing such difficulties and deficiencies. Any such effort must build on existing foundations, which are considered next.

2.4 Foundations on which to build

In initiating the Essential Trauma Care Project, there are two sets of activities upon which the authors seek to build: essential health services and efforts to improve trauma care in individual countries.

Essential health services

The World Health Organization (WHO) and others involved in international health have made considerable progress in improving health in the array of developing countries by advancing the concept of essential services. These are services which are low in cost and high in yield, which target major health problems, and which can realistically be made available to almost everyone in a given population. Programmes for these services have included defining, refining and promoting these services, as well as providing technical input to countries to help improve their capacity to deliver the services. Examples of essential service programmes include: the Essential Drugs Programme, the Expanded Programme on Immunization, the Global Tuberculosis Programme and the Safe Motherhood Initiative.

Efforts to improve trauma care in individual countries

As an example of this, the American College of Surgeons (ACS) Committee on Trauma has significantly advanced the care of the injured in the United States and Canada by creating and promulgating the Advanced Trauma Life Support course (ATLS) and by the publication of *Resources for optimal care of the injured patient* (17). This 100-page book contains guidelines for what hospitals at varying levels should have in place in terms of resources such as staffing, continuing education, supplies, equipment, administrative functions and quality assurance programmes. Basically, it has applied an essential services approach. Equally important to the existence of these standards is the fact that they have been enforced through a programme of trauma centre verification, as described in section 2.5. Similar organized measures have been successfully implemented in many other high-income countries (18–21).

In addition to efforts to improve care at individual hospitals, progress has been made by addressing the entire spectrum of the development of systems for trauma management. This involves political jurisdictions designating hospitals to fill the roles of trauma centres at varying levels of complexity, ranging from large urban centres to small rural hospitals. It also implies planning of emergency medical services, pre-hospital triage, transfer criteria and transfer arrangements between hospitals.

It should also be noted that every country has capable, dedicated individuals working to reduce the burden of injury, both by planning and administration and by the direct provision of clinical services. The Essential Trauma Care Project and this manual are meant to assist and reinforce such work.

The Essential Trauma Care Project seeks to blend the perspectives of the two foundations noted above. The project is based on the premise that improved organization of trauma care services can be a cost-effective way of improving care of the injured worldwide. Before going further, evidence for the effectiveness of such improved organization is presented.

2.5 Evidence of the impact of better organization of trauma services

Almost all of the evidence of the effectiveness of improvements in the organization of trauma care services comes from developed countries. In most cases, the better organization comes in the form of two related activities: (1) verification of trauma services through hospital inspections; and (2) planning of systems for trauma management. Verification applies to a review of individual facilities as regards their provision of a variety of items, including human resources (e.g. availability of personnel with certain qualifications), physical resources (equipment and supplies) and administrative and organizational functions, such as quality improvement. The planning of systems for trauma management implies several integrated functions, including political jurisdictions designating which hospitals are to fill the roles of trauma centres at varying levels of complexity, ranging from large urban trauma centres to small rural hospitals and clinics. It also implies the planning of mobile emergency medical services, pre-hospital triage (to determine which patients should go to which types of designated facilities), transfer criteria and transfer arrangements between hospitals.

There is considerable evidence that political jurisdictions that improve the organization of trauma services benefit from reduced trauma mortality, in comparison with similarly resourced jurisdictions that do not. Such evidence comes from panel reviews of preventable deaths, hospital trauma registry studies and population-based studies (7, 22, 23). Most studies confirm a reduction in mortality with the improved organization provided by a system for trauma management. For example, panel reviews show an average reduction in medically preventable deaths of 50% after the implementation of a system for trauma management. Likewise, population-based studies and trauma registry studies show a fairly consistent 15–20% or greater reduction in mortality for better organized systems, compared with either the same systems prior to improvements in organization or to other less organized systems (6, 7, 23).

In one of the best series of studies done on this topic, Nathens et al. used population-based data to examine the effects of planning of systems for trauma

management in all of the 50 states of the United States. They looked at mortality rates, adjusting for several potential confounding variables, including traffic laws and other safety measures. They demonstrated an 8% reduction in mortality for those states with systems for trauma management. It should be mentioned that this figure represents overall trauma mortality, including persons dead at the scene, before any chance of medical treatment. In comparison, the larger reductions in mortality mentioned above represented changes in mortality for patients surviving to reach the hospital. Especially notable in Nathens' study was the finding that the effect of a system for trauma management was not usually evident until 10 years after its initial enactment and reached a maximum at 16 years (8, 9).

When considering the relevance of these findings to the potential utility of similar organizational efforts in developing countries, it is important to note that the above improvements were mostly witnessed in comparison with environments with the same levels of resources. The enactment of an organized system for trauma management usually required inputs of resources that were fairly small in comparison with the overall cost of the existing system of care itself. The system for trauma management itself did require the funds for increased organization and occasional extra inputs of resources to bring institutions up to standards for verification (6). The Essential Trauma Care Project is based on making similar improvements in organization and planning that are inexpensive in comparison with the cost of the existing treatment system itself.

2.6 Development process for essential trauma care

In developing the *Guidelines for essential trauma care*, the authors sought to define inexpensive, feasible, minimal standards that would be applicable virtually everywhere in the world. They also sought to identify ways of reinforcing existing systems of trauma care in all locations in the world, including the spectrum of conditions found in both low- and middle-income countries.

In this process, the authors developed a list of medical goals that should be feasible for most injured persons everywhere. These can be viewed as the "needs of the injured patient" (chapter 3). In order to assure the achievement of such goals, the inputs of human and physical resources must be utilized in an optimal process. To this end, the authors have developed a template for the resources that are needed. These are described in chapters 4 and 5. These are based conceptually on a similar template developed for the book, *Resources for optimal care of the injured patient* (17). However, they are significantly amended to reflect the realities of low- and middle-income countries.

The authors envision that the template presented in this manual will be used as a guide for those planning trauma treatment services across a wide spectrum of low- and middle-income countries. These guidelines will hopefully be of relevance to planners in ministries of health, to hospital administrators, to nursing

service directors and to clinicians, both individually and collectively, through organizations such as societies of surgery, anaesthesia, traumatology and other disciplines that deal with the injured patient. These groups constitute the target audience for the guidelines.

The use of the template will require adaptation for use in individual countries. The authors envision that this would ideally occur in a collaborative, consensus-driven process, with input from clinicians involved in the care of injured patients, officials in ministries of health, and health service administrators. The category of clinicians would include both those who are primarily devoted to the field of traumatology and generalists such as general surgeons, anaesthetists and emergency physicians. In countries in which a large percentage of rural trauma is handled by general practitioners and non-doctor providers of health care, these groups should be included as well, to assure the feasibility of recommendations for rural areas.

As part of the process of national level adaptation and implementation, there could reasonably be a role for a Needs Assessment of trauma treatment services nationwide. This would involve a survey of the capabilities of the range of facilities caring for injured persons. It would help to identify the potential deficiencies in human resources, physical resources and organization that would be targeted by subsequent improvements.

2.7 Overlap with other activities

The guidelines provided by this manual deal primarily with facility-based trauma care. A very important component of trauma care with which it does not deal is pre-hospital care, or mobile emergency medical services (EMS). The authors acknowledge the great importance of this topic, especially as most trauma deaths in almost all countries occur outside of hospital (1). A WHO publication addressing this area of care is in preparation. Furthermore, there is no hard and fast line between pre-hospital care and hospital-based care, nor between stabilization and definitive care. For example, rural clinics whose staff are not doctors are often the first source of care for injured patients in their communities. These are intermediate between pre-hospital and hospital-based in character, as regards trauma care. Hence, for purposes of these guidelines, the authors have decided not to directly address mobile pre-hospital care, which is usually categorized as EMS. They have decided to consider care at all fixed facilities, whether these be clinics or actual hospitals.

Likewise, the guidelines in this manual deal exclusively with the care of injured patients. It is acknowledged that, except in rare circumstances, the human and physical resources in place will also be utilized for other health problems, including medical, obstetric and other surgical problems. Hence, there is a need to integrate the guidelines with other emergency services. It is hoped that the upgrading

of trauma care resources will have the secondary effect of improving other aspects of emergency medical care as well. To increase the probability of this outcome and to decrease the probability that such recommendations might rather have a detrimental effect on other aspects of health care, the authors have sought the input of other departments of the WHO and other groups that are involved in emergency care and health care in general. In other words, these guidelines are vertically oriented with respect to trauma care. However, the authors have taken measures to assure that they are horizontally integrated into the broader functioning of the health care system. In this regard, the guidelines have been developed with the input of persons involved in the following WHO programmes and departments: Essential Drugs and Medicines Policy, Management of Non-communicable Diseases, Disability and Rehabilitation, Essential Health Technologies, Diagnostic Imaging and Laboratory Technology, and Child and Adolescent Health.

The *Guidelines for essential trauma care* are not clinical algorithms. They represent an attempt to provide sufficient resources that such algorithms can be carried out effectively and safely. For further details of pertinent emergency algorithms, the reader is referred to the *Integrated management of adolescent and adult illness*, which is in preparation by WHO (http://www.who.int/gtb/publications/whodoc/imai/cds_stb_2003_22.pdf).

The guidelines are concerned only with the care of the injured, and hence with secondary and tertiary prevention of injury-related death and disability. Obviously, primary injury prevention is of great importance. Clinicians of all types should be strongly encouraged to become involved in promoting primary injury prevention. For further details, readers are referred to the related activities and publications of the WHO's Injuries and Violence Prevention Department (www.who.int/violence_injury_prevention).

Finally, the ultimate utility of these guidelines consists in their ability to actually enact improvements in the process of trauma care that lead to decreases in mortality and disability due to trauma. In order to monitor the success or failure of such efforts and to be able to make modifications when success has not been achieved, it is necessary to have reliable and timely sources of information on the incidence of injury and its outcome. This implies some form of surveillance. For further information on this, the reader is referred to the WHO publication: *Injury surveillance guidelines* (24).

3. Essential trauma services: needs of the injured patient

This section contains a list of those services which the authors feel are essential to prevent death and disability in injured patients. They might be considered as the “needs of the injured patient.” These can be categorized into three broad sets of needs:

1. Life-threatening injuries are appropriately treated, promptly and in accordance with appropriate priorities, so as to maximize the likelihood of survival.
2. Potentially disabling injuries are treated appropriately, so as to minimize functional impairment and to maximize the return to independence and to participation in community life.
3. Pain and psychological suffering are minimized.

Within these three broad categories, there are several specific medical goals that are eminently achievable within the resources available in most countries.

- Obstructed airways are opened and maintained before hypoxia leads to death or permanent disability.
- Impaired breathing is supported until the injured person is able to breathe adequately without assistance.
- Pneumothorax and haemothorax are promptly recognized and relieved.
- Bleeding (external or internal) is promptly stopped.
- Shock is recognized and treated with intravenous (IV) fluid replacement before irreversible consequences occur.
- The consequences of traumatic brain injury are lessened by timely decompression of space occupying lesions and by prevention of secondary brain injury.
- Intestinal and other abdominal injuries are promptly recognized and repaired.
- Potentially disabling extremity injuries are corrected.
- Potentially unstable spinal cord injuries are recognized and managed appropriately, including early immobilization.
- The consequences to the individual of injuries that result in physical impairment are minimized by appropriate rehabilitative services.

- Medications for the above services and for the minimization of pain are readily available when needed.

The precise procedures that can optimally be applied to achieve these goals, as well as the human and physical resources needed to optimally carry out these procedures, will vary across the spectrum of economic resources of the nations of the world and the geographic location of the facilities concerned. However, these goals should be achievable for most injured patients in most locations.

The provision of these services should not be dependent on ability to pay. Hence, cost recovery schemes, necessary though they may ultimately be, should not preclude the provision of initial emergency care nor of critical elements of definitive care.

4. Inputs needed to achieve essential trauma services

4.1 Overview

The goals outlined in the previous chapter depend on the provision of specific items of physical examination, diagnostic tests, medications and therapeutic procedures. Likewise, the ability of the health system to provide these items depends on the inputs of human resources (training and staffing) and physical resources (infrastructure, equipment and supplies). The following sections of this manual outline those resources which the authors feel are essential to the provision of essential trauma services. These resources are outlined in the form of the resource matrix for essential trauma care (Tables 1–14).

4.2 Resource matrix: introduction

The resource matrix for essential trauma care contains brief descriptions of the resources that need to be available for the provision of specific categories of care at different levels of the health care system. A specific matrix is derived for each of 14 categories of care, such as airway, shock, head injuries, extremity injuries and rehabilitation. These include both initial emergency management and long-term definitive care.

4.3 Resource matrix: necessary elements of trauma care

On the vertical axis of each matrix are listed the specific elements of trauma care that are needed. These are divided into two categories: (1) knowledge & skills and (2) equipment & supplies. See Table 1 as an example.

Knowledge and skills imply that the staff (medical, nursing and others) have the requisite training to perform such diagnostic and therapeutic activities safely and successfully. This implies not only the requisite training in their basic education (school and postgraduate training), but also continuing education to maintain these skills. Training issues are comprehensively addressed in chapter 6 of this manual.

Equipment and supplies imply that these items are available to all who need them, without consideration of ability to pay, especially in true life-threatening emergencies. This implies not only having them physically present in the facility but having them readily available on an ongoing basis; where appropriate, 24 hours

a day, 7 days a week. It thus implies that organizational and administrative mechanisms exist to quickly replace depleted or expired stocks of supplies and medications, and to quickly repair non-functioning equipment. The quality control mechanisms necessary to assure such provision of supplies and to assure the quality of medical care provided are addressed in chapter 6.

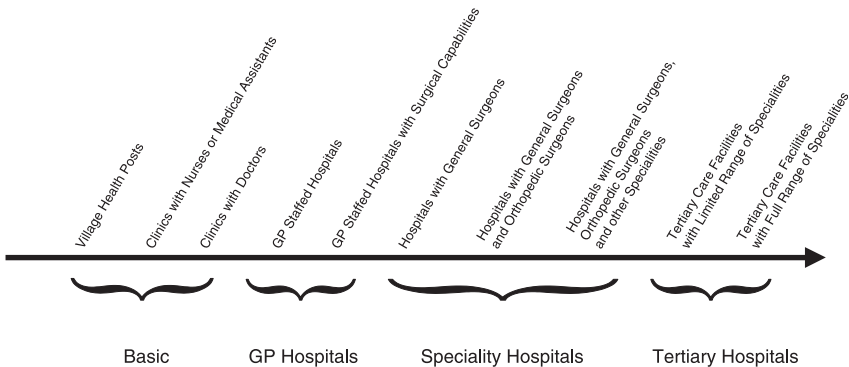
The EsTC resource matrix goes into depth on the simple, vital services and related equipment. This is especially so for the immediately life-threatening injuries to be addressed in the initial evaluation and resuscitation, such as the management of airway, breathing and circulation (sections 5.1–5.3). For more complicated services, such as operative care of head, torso or extremity injuries (sections 5.4–5.14), the EsTC resource matrices go into less detail. For most of these more complicated issues, the elements of care to be provided are listed as a general service (e.g. laparotomy for trauma), with a basic discussion of what broad skills and equipment need to be available, but without a detailed, separate delineation of the specific skills or physical materials needed. Details of operating theatre instruments, equipment, supplies and infrastructure, and of anaesthetic capabilities are beyond the scope of this publication. The availability of a clinical service in these guidelines implies the expertise and physical materials to carry out that service successfully and safely. In this regard, the reader is also referred to WHO publications on broader surgical and anaesthetic issues (25), including the recently released *Surgical care at the district hospital* (26).

4.4 Resource matrix: range of health facilities

On the horizontal axis of each matrix are listed the range of health facilities. It is acknowledged that the division between different levels is somewhat artificial, with actual facilities representing a continuum rather than discrete categories (see Figure 1). It is also acknowledged that the capabilities of each level vary significantly between different countries. Working within these constraints, the authors have devised the following categories.

Basic facilities (outpatient clinics and/or non-medical providers)

This includes the primary health care (PHC) clinics that are the mainstay of health care throughout many of the rural areas of low-income countries. These are almost exclusively staffed by non-doctor providers, such as village health workers, nurses and medical assistants. This category also includes outpatient clinics run by doctors, whether in urban or rural settings. In many cases, such facilities represent the first access for injured patients to the health care system. This is especially true in low-income countries where there are no formal emergency medical services (EMS). These guidelines apply to these fixed facilities and not to mobile EMS. The latter will be addressed in a WHO publication which is currently in preparation. The “basic” category consists of a wide spectrum of capabilities,

FIGURE 1 **Spectrum of health care facilities**

ranging from extremely minimally equipped facilities staffed by village health workers, usually with only a few months of health-related training, up to facilities staffed by trained professionals, such as doctors, nurses or medical assistants, usually having more supplies and equipment to work with (Figure 1).

Hospitals staffed by general practitioners

This includes hospitals without full-time specialist doctors, particularly those without a fully trained general surgeon. Such hospitals may or may not have operating theatre capabilities. These facilities are usually referred to as district hospitals in Africa and primary health centres in India. In some areas, particularly in East Africa, certain medical assistants have been highly trained to act in the capacity of general practitioners, even performing operations such as Caesarean section. The facilities in which they work are more likely to fall into this category, rather than the basic designation above.

Hospitals staffed by specialists

This includes hospitals whose personnel includes at least a general surgeon. Staff at such facilities may also include orthopaedic surgeons and members of other subspecialties (i.e. specialists with responsibility for more narrowly defined fields within each speciality). Such facilities have operating theatres. These facilities are usually referred to as regional hospitals in Africa, community health centres or district hospitals in India, or general hospitals in Latin America.

Tertiary care hospitals

This includes hospitals with a broad range of subspecialties. Such facilities are usually, but not exclusively, teaching or university hospitals. They usually repre-

sent the highest level of care in a country or large political division within a country. There are notable differences in the capabilities of tertiary care hospitals worldwide. In some countries, surgical staff may be quite extensive in their range of subspecialties, and in others, more limited (Figure 1).

The manual does not make any recommendations regarding the optimum population served by each level of facility. However, this is of great relevance to the accessibility of trauma care by the population of a country. These issues are addressed by broader planning activities and should be considered by those planning trauma services for their country or area. Likewise, it is recognized that the different levels of facility will play differing roles within overall trauma treatment in different countries. For example, facilities staffed by non-doctors and hospitals staffed by general practitioners are likely to care for a greater percentage of all injured patients in low-income countries, whereas specialist-staffed hospitals and tertiary care hospitals are likely to care for a greater percentage of all injured patients in middle-income countries.

4.5 Resource matrix: designation of priorities

For each cell within the matrix, the authors recommend those resources (vertical axis) that should be available at a specific level of the health care system (horizontal axis). The priority of each item was given a designation according to the following criteria.

“Essential” (E) resources

The designated item should be assured at the stated level of the health care system in all cases. As this Essential Trauma Care Project covers the spectrum of facilities across the world, the E designation represents the “least common denominator” of trauma care common to all regions, including even those where access to resources is most severely restricted. It is felt that these services could and should be provided to injured patients at the level of health facility concerned, even in countries whose ministries of health have a total budget of only \$3–4 per capita per year. Moreover, the authors feel that the essential items could be provided primarily through improvements in organization and planning, with a minimal increase in expenditure.

“Desirable” (D) resources

The designated item represents a capability that increases the probability of a successful outcome of trauma care. It also adds cost. Such items are not likely to be cost-effective for all facilities of a given level in environments with the poorest access to resources. Hence, they are not listed as essential. However, for countries with greater resource availability, such items may ultimately be designated essential in their own national plans. Likewise, there are some services for which

only low-cost physical resources would be required and for which training of health care personnel at the level in question would be feasible. However, in order for this training to be considered essential, mechanisms would need to be in place to ensure that it is provided for all health care workers at the level in question, within the time constraints of all else for which they must be trained. In cases where it did not seem reasonable to assure such training nationwide, such services have been designated as desirable. Individual countries may wish to upgrade these to essential, either at all such facilities or at a subset of those with high trauma volume.

“Possibly required” (PR) resources

In environments with poorer access to resources, some trauma treatment capabilities might need to be shifted to lower levels of the health care system in order to increase their availability. Such services usually represent only minimal increased cost, relative to the provision of such services only at higher levels of the health care system. Shifting to a lower level in the health care system would usually imply that a provider with less advanced trauma-related training and skills would be performing procedures that might otherwise be performed by more highly trained personnel. Hence, it is to be emphasized that the “PR” designation is different from the “desirable” designation. PR represents a potential necessity to increase availability of trauma care services in environments with poorer access to resources. It is anticipated that the PR designation will apply primarily to low-income countries, but not to middle-income.

“Irrelevant” (I) resources

This implies that one would not ordinarily expect this capability at the given level of the health care system, even with full availability of resources.

Application of priorities

In the development of national trauma plans, the authors anticipate that many countries may very appropriately decide to convert some of the items in the desirable category to essential. The converse is not true. Items designated as essential should remain so designated except in extreme or very unusual circumstances, as changing these may result in trauma care falling below the EsTC standard.

Throughout these guidelines, more detail is provided on the elements of care that are deemed essential. *However, it should be emphasized that items designated as desirable are also an integral part of these guidelines.* They are considered somewhat less important or cost-effective than essential items, but are not to be ignored. Items designated as essential are those which should be able to be assured to all injured patients arriving at all facilities of a given level in all countries, even those of lowest income. *Hence, the essential items are applicable to all*

health facilities, including the most basic of facilities of a given level in the countries of lowest income: e.g. village health posts at the basic level; small hospitals without surgical capabilities for the GP hospital level; specialist hospitals with only a general surgeon; and tertiary care facilities with a limited range of subspecialties. Hence, many of the items that are designated as desirable may indeed be applicable to many of these facilities, such as those in middle-income countries or those with high numbers of trauma patients in all countries. This is particularly an issue in the case of basic-level facilities, for which there is tremendous variation worldwide (Figure 1). Using the “least common denominator” of a village health post in a low-income country, the major emphasis at basic-level facilities in these guidelines is on rapid, basic first aid. Many other therapeutic items are listed as desirable (e.g. oxygen, most medications, and IV fluids), as these are not applicable to village health posts. In national plans that address the basic level, many such items might reasonably be upgraded to essential for higher-level basic facilities, such as those staffed by nurses or medical assistants.

By way of an example of how the terms “essential” and “desirable” are actually applied in the recommendations, we look at airway management (Table 1). At all levels of the health care system, it is deemed essential that health care personnel know the signs of airway obstruction and are skilled in manual manoeuvres to keep an airway patent. The probability of success in airway management is increased by the provision of specific equipment and the skills to utilize it properly and safely. This includes equipment and skills for basic airway management, including oral airway, suction and bag–valve–mask. These are deemed essential at hospital-level facilities. The probability of success of airway management is increased even further by the provision of equipment and skills for advanced airway management, including endotracheal intubation and cricothyroidotomy. These are deemed essential at specialist-staffed hospitals. At each level, the probability of success of airway management is increased. However, both the need for resources (both equipment and training) and the potential for harm are increased. In environments in which more resources are available, and/or in which specific facilities handle a greater than average volume of trauma, it may be appropriate to change the “desirable” designation to “essential” at some or all facilities of a given level.

Note on terminology:

The entire Essential Trauma Care Project represents wider efforts on the part of both the WHO and IATISIC to improve trauma services. This particular document is the *Guidelines for essential trauma care*, which is a component of the overall project. The EsTC resource matrix constitutes a summary and a main component of the guidelines.

5. Guidelines for essential trauma care

For each of the following 14 categories of trauma care, a summary resource matrix is provided, preceded by a brief explanation of the rationale used in determining which elements of care are to be considered essential or desirable. An explanation of the organization of the resource matrices is provided in section 4. The final category (section 5.15) deals with special considerations for the care of injured children.

5.1 Airway management

Airway management is one of the key components of emergency care. Its primary objective is to diagnose an obstructed or potentially obstructed airway, to clear the obstruction and keep the airway patent. No medical emergency, short of a complete cardiopulmonary arrest, is more immediately life-threatening than the loss of an adequate airway. Failure to adequately manage airway patency and ventilation has been identified as a major cause of preventable death in trauma (27–30).

In the initial assessment and management of any critically ill patient, the airway, breathing and circulation (ABC) are the first steps. The response to any acutely ill or injured patient must be met using a systematic approach, with the airway being the first priority. If any abnormalities are detected, measures to intervene are instituted immediately. The skills to assess a patient for obstruction of the airway, to establish and maintain a patent airway, and to ensure adequate ventilation and oxygenation of the patient, are therefore essential.

At all levels of the health care system, it is deemed essential that health care personnel know the signs of airway obstruction and are skilled in manual manoeuvres to keep an airway patent while maintaining cervical spine protection. The probability of success of airway management is increased by the provision of specific equipment and the skills to utilize it properly and safely. This includes equipment and skills for basic airway management, including oral or nasal airway, suction and bag–valve–mask. These are deemed essential at hospital-level facilities. The probability of success in airway management is further increased by the provision of equipment and skills for advanced airway

management, including endotracheal intubation and cricothyroidotomy. These are deemed essential at specialist-staffed hospitals. At each level, the probability of success in airway management is increased. However, both the need for resources (both equipment and training) and the potential for harm are increased. Environments in which more resources are available, and/or in which there is a greater than average trauma volume in specific facilities, may wish to change the “desirable” designation to essential at some or all facilities of a given level.

At whatever level of the health care system it is decided to provide advanced airway capabilities (e.g. endotracheal intubation with or without cricothyroidotomy, with or without tracheostomy—see end of section 5.1),¹ several safety assurances should be in place. This includes the provision that the equipment is readily available in whatever area receives the injured patient (casualty ward or emergency department). This is aided by having the necessary equipment in pre-assembled packs (where appropriate and feasible), stocked in the emergency area. Safety assurance also mandates that staff performing the various procedures be adequately trained to perform them successfully, with an acceptable rate of complications. This includes both the training received in basic education (e.g. medical or nursing or other professional school) and whatever continuing education might be required to maintain the skills. Given the potential for harm (in the form of oesophageal intubation) with advanced airway management, inexpensive materials to assist in the clinical assessment of endotracheal tube placement should be provided whenever endotracheal intubation is performed. This includes principally an oesophageal detector device (either bulb or syringe). Finally, given this potential for harm associated with advanced airway manoeuvres, a quality assurance mechanism should be in place to track adverse events such as oesophageal intubations. Further details can be found in the chapter on quality assurance.

By way of further explanation of some of the equipment listed in the table, suction is an extremely important component of airway management. It can be provided at a low cost by manual and foot pump devices. These should be considered essential in any hospital. Likewise, a stiff suction tip (Yankauer or equivalent) is an essential component of an adequate suction set up. The term “basic trauma pack” implies a kit with a few basic instruments and supplies, including a scalpel, clamps, scissors, gauze, suture, syringe and needles. These represent a component of the minimum of physical resources needed to perform certain smaller procedures in the casualty ward/emergency department setting. Such pro-

¹ Cricothyroidotomy is generally considered to be the surgical airway of choice in emergency situations and can be performed in several seconds. If needed for a prolonged period, it is usually converted to a tracheostomy after a few days.

cedures include cricothyroidotomy in Table 1. They also include some procedures mentioned later, such as chest tube insertion in Table 2. The basic trauma pack is considered essential at all hospital levels.

These guidelines indicate the use of cricothyroidotomy when a surgical airway is indicated. In general, this is performed more quickly and safely than a tracheostomy, especially by non-specialists (31).

Further details of airway equipment are included in Annex 1.

TABLE 1 **Airway management**

Airway: knowledge & skills	Facility level ¹			
	Basic	GP	Specialist	Tertiary
Assessment of airway compromise	E ²	E	E	E
Manual manoeuvres (chin lift, jaw thrust, recovery position, etc.)	E	E	E	E
Insertion of oral or nasal airway	D	E	E	E
Use of suction	D	E	E	E
Assisted ventilation using bag–valve–mask	D	E	E	E
Endotracheal intubation	D	D	E	E
Cricothyroidotomy (with or without tracheostomy)	D	D	E	E
Airway: equipment & supplies				
Oral or nasal airway	D	E	E	E
Suction device: at least manual (bulb) or foot pump	D	E	E	E
Suction device: powered: electric/pneumatic	D	D	D	D
Suction tubing	D	E	E	E
Yankauer or other stiff suction tip	D	E	E	E
Laryngoscope	D	D	E	E
Endotracheal tube	D	D	E	E
Oesophageal detector device	D	D	E	E
Bag–valve–mask	D	E	E	E
Basic trauma pack	D	E	E	E
Magill forceps	D	D	E	E
Capnography	I	D	D	D
Other advanced airway equipment (Annex 1)	I	D	D	D

¹ In this and subsequent resource matrices, the following key is used to indicate different levels of facilities: Basic: outpatient clinics, often staffed by non-doctors; GP: hospitals staffed by general practitioners; Specialist: hospitals staffed by specialists, usually including a general surgeon; Tertiary: tertiary care hospitals, often university hospitals, with a wide range of specialists.

² Items in the resource matrices are designated as follows:

E: essential; D: desirable; PR: possibly required; I: irrelevant (not usually to be considered at the level in question, even with full resource availability).

5.2 Breathing—Management of respiratory distress

The ability to assess a patient for respiratory distress and adequacy of ventilation is essential at all levels of the health care system. This applies both to those initially evaluating the patient and to those who are providing definitive care. The only resources required for this function are training and a stethoscope. If no other resources are available at the level in question, it is anticipated that respiratory distress would usually constitute grounds for referral to the next highest level of the system.

Capabilities for the administration of oxygen to trauma patients in respiratory distress are essential at all hospital facilities. This would be useful at all levels of the health system. It is recognized that this is currently beyond the realm of feasibility for most primary health care clinics with non-medical staff in low-income countries. However, facilities that receive a moderate volume of seriously injured patients (e.g. those located along busier roadways), especially in middle-income settings, might realistically be supplied with oxygen. The capability for administration of oxygen implies both health care providers capable of understanding the indications for its use and equipment and supplies to administer it in a timely fashion to trauma patients in respiratory distress. In most cases, this implies that the physical resources are present in the area where acute trauma patients are initially received. WHO's Department of Essential Health Technologies (EHT) is developing guidelines for the use of oxygen and related training and equipment (<http://www.who.int/ehd>).

The recognition of tension pneumothorax, its primary treatment by needle thoracostomy and definitive treatment by tube thoracostomy are essential at all hospital-level facilities that handle trauma. This implies sufficient training of the principal caregiver in the diagnosis of tension pneumothorax and in the safe performance of the relevant procedures. It also implies the ready availability of the needed materials, including a basic trauma pack, chest tubes and underwater seal drainage bottles.

At the basic health care level, capabilities for the recognition of tension pneumothorax and temporary relief with a needle thoracostomy could be considered desirable in settings with the possibility of rapid evacuation to a site of definitive treatment. This would usually imply the existence of an EMS system.

Recognition of the presence of a sucking chest wound and the ability to apply a three-way dressing for immediate treatment is deemed essential at all levels.

Assessment of the adequacy of supplemental oxygen is based primarily on clinical examination. Supplemental laboratory measurements (arterial blood gas concentration) and monitoring (oxygen saturation through pulse oximetry) provide further useful information. However, their cost prevents them from being deemed

essential for all environments. They are listed as desirable and might especially be considered in environments with better access to resources.

When ventilation is inadequate, it can be supported manually (e.g. self-inflating bag–valve–mask) or mechanically (e.g. ventilator). The preceding section on the airway has outlined the requirements for the bag–valve–mask. Mechanical ventilators have considerable utility for the physiological support of seriously injured patients. They are listed as desirable at the upper three levels of the health system. However, their cost prevents them from being considered essential for countries at all economic levels. The use of mechanical ventilators implies not only that they are physically present, but also that mechanisms exist to assure continual functioning by rapid repair, and that personnel are trained in their use. This would include respiratory therapists or nursing or other staff with adequate training in the use and routine maintenance of ventilators. The use of ventilators also implies doctors and nurses with sufficient training to care for mechanically ventilated patients. The latter implies the assessment of oxygenation status, the ability to recognize and correct problems (e.g. endotracheal tube obstruction), and skills in routine maintenance of ventilated patients, such as sterile suctioning, physiotherapy and postural drainage to reduce the risk of pneumonia.

TABLE 2 **Breathing—Management of respiratory distress**

Breathing: knowledge & skills	Facility level			
	Basic	GP	Specialist	Tertiary
Assessment of respiratory distress and adequacy of ventilation	E	E	E	E
Administration of oxygen	D	E	E	E
Needle thoracostomy	D	E	E	E
Chest tube insertion	I	E	E	E
Three-way dressing	E	E	E	E
Breathing: equipment & supplies				
Stethoscope	E	E	E	E
Oxygen supply (cylinder, concentrator or other source)	D	E	E	E
Nasal prongs, face mask, associated tubing	D	E	E	E
Needle & syringe	D	E	E	E
Chest tubes	I	E	E	E
Underwater seal bottle (or equivalent)	I	E	E	E
Pulse oximetry	I	D	D	D
Arterial blood gas measurements	I	D	D	D
Bag–valve–mask	D	E	E	E
Mechanical ventilator	I	I	D	D

5.3 Circulation—Management of shock

Assessment of shock and control of external haemorrhage

The ability to assess a patient for the presence of shock is essential at all levels of the health care system. The only resources required for this function are a clock or watch with second hand, a stethoscope and blood pressure (BP) cuff, and the relevant training. Training should include visual/manual assessment of circulation, including pulse, venous filling and skin temperature. If no other resources are available at the level in question, it is anticipated that shock would usually constitute grounds for referral to the next highest level of the system.

Control of external haemorrhage through manual pressure and through the application of a pressure dressing is essential at all levels of the health care system. The only resources required are training and sufficient gauze bandages. These should be sterile whenever possible. Given the limited facilities for sterilization at most basic facilities, clean bandages should be considered essential at this level. Sterile bandages are considered essential at all hospital levels. Training regarding indications for the use of arterial tourniquets in extreme situations, as well as understanding the potential complications and the need for removal under controlled circumstances within several hours, is essential at all levels. Splinting of fractured extremities as a means of decreasing internal haemorrhage is essential at all levels.

More advanced, externally applied haemorrhage control measures include wrapping for potential pelvic fractures and deep interfascial packing for complicated wounds, such as landmine and machete wounds. These are deemed desirable at the basic level and essential at all hospital levels.

Fluid resuscitation

Capabilities for fluid resuscitation include the equipment, the fluids themselves and the skills to administer them, monitor the response (including accurately monitoring fluid intake and output) and treat potential complications. The insertion of peripheral intravenous (IV) lines, percutaneously and by cutdown, and the use of crystalloid are deemed essential at all hospital levels. These are desirable at even the most basic levels at which seriously injured patients are seen. This is especially the case in locations where the basic level is at such a distance that evacuation to a higher level of care will entail a delay of several hours or more. The insertion of central lines (including the lines themselves and the expertise to insert them safely) is deemed essential at the upper two hospital levels and desirable at GP-level hospitals. However, in the setting of GP hospitals, given the potential for complications, the insertion of central lines should really only be considered for emergency situations in which access cannot be achieved by any other means.

The use of colloid is deemed desirable at higher hospital levels and should comply with existing WHO Essential Drug Programme guidelines. Intraosseous lines for children, especially for those under 5 years, are deemed essential at all hospital levels. Formal intraosseous needles would be ideal, but the ability to establish intraosseous access using any suitable large-bore metal needle (e.g. spinal needle) is acceptable.

Capabilities for blood transfusion are deemed essential at all hospital levels. A formal blood bank is best. However, if not available, capabilities for immediate donation and administration of fresh whole blood are acceptable. Such capabilities are also needed for the treatment of obstetric haemorrhage and severe anaemia. Most GP-level hospitals need to provide transfusions for these indications as well as for trauma. A small minority of GP-level hospitals might not be expected to have such capabilities. These would include smaller facilities in less remote areas, with easy access to referral centres. Such facilities might be considered to more closely represent the basic level than the GP-level hospitals considered in these guidelines.

Any time that blood is administered, there should be capabilities to assure its safety, including screening for HIV, hepatitis B and C, and other blood borne diseases, depending on the geographic area. Use of blood should follow existing WHO Blood Transfusion Safety guidelines and associated national policies (http://www.who.int/eht/Main_areas_of_work/BTS/BTS.htm). The use of blood also implies that it is being ordered by a clinician who knows the indications for transfusion in a trauma patient and is capable of recognizing and treating the potential complications of transfusion, monitoring the patient's response to transfusion and other fluid resuscitation, and assessing the patient for continued bleeding and the need for surgical intervention.

Monitoring

The capability for monitoring a patient in shock for response to fluid therapy is deemed essential at all hospital levels. This includes an understanding of the stages of haemorrhagic shock. It also includes the following basic equipment: clock or watch with second hand, stethoscope, blood pressure cuff and urinary catheter with collection bag (or improvised equivalent). The following monitoring devices add utility, but also cost, and hence are deemed desirable, depending on the hospital level (see table): electronic cardiac monitoring, monitoring of central venous pressure and right-heart catheterization with monitoring of pulmonary capillary wedge pressure.

Laboratory tests assist in the assessment of the presence of shock, the degree of bleeding and response to resuscitation. Haematocrit or haemoglobin monitoring is deemed essential at all hospital levels. Measurements of electrolytes (sodium, potassium, chloride, bicarbonate), blood urea nitrogen, creatinine,

glucose, lactate and arterial blood gases are all considered desirable, depending on the hospital level. All of these add considerable utility to the management of a patient in shock. However, they also add considerable cost and hence cannot be considered essential.

Other considerations

Most of the above pertains to the most common cause of shock in a trauma patient, haemorrhagic shock. Other causes include cardiogenic shock, neurogenic

TABLE 3 **Circulation and shock**

Circulation: knowledge & skills	Facility level			
	Basic	GP	Specialist	Tertiary
Assessment and external control of haemorrhage				
Assessment of shock	E	E	E	E
Compression for control of haemorrhage	E	E	E	E
Arterial tourniquet in extreme situations	E	E	E	E
Splinting of fractures for haemorrhage control	E	E	E	E
Deep interfascial packing for severe wounds (e.g. landmine)	D	E	E	E
Pelvic wrap for haemorrhage control	D	E	E	E
Fluid resuscitation				
Knowledge of fluid resuscitation	D	E	E	E
Peripheral percutaneous intravenous access	D	E	E	E
Peripheral cutdown access	D	E	E	E
Central venous access for fluid administration	I	D	E	E
Intraosseous access for children under 5 years	D	D	E	E
Transfusion knowledge and skills	I	E	E	E
Monitoring				
Knowledge of resuscitation parameters	D	E	E	E
More advanced monitoring (central venous pressure)	I	D	D	D
More advanced monitoring (right heart)	I	I	D	D
Other				
Differential diagnosis of causes of shock	D	E	E	E
Use of pressors in neurogenic (spinal) shock	I	D	D	D
Use of fluids and antibiotics for septic shock	I	E	E	E
Recognition of hypothermia	E	E	E	E
External rewarming in hypothermia	E	E	E	E
Use of warmed fluids	I	D	E	E
Knowledge of core rewarming	I	D	E	E

TABLE 3 *Continued*

Circulation: equipment & supplies	Facility level			
	Basic	GP	Specialist	Tertiary
Assessment and external control of haemorrhage				
Clock or watch with second hand	E	E	E	E
Stethoscope	E	E	E	E
Blood pressure (BP) cuff	E	E	E	E
Gauze and bandages	E	E	E	E
Arterial tourniquet in extreme situations	E	E	E	E
Fluid resuscitation				
Crystalloid	D	E	E	E
Colloids	D	D	D	D
Blood transfusion capabilities	I	E	E	E
Intravenous infusion set (lines and cannulas)	D	E	E	E
Intraosseous needle or equivalent	D	D	E	E
Central venous lines	I	D	E	E
Monitoring				
Stethoscope	E	E	E	E
Blood pressure (BP) cuff	E	E	E	E
Urinary catheter	D	E	E	E
Electronic cardiac monitoring	I	D	D	D
Monitoring of central venous pressure	I	D	D	D
Right-heart catheterization	I	I	D	D
Laboratory facilities for haemoglobin or haematocrit	D	E	E	E
Laboratory facilities for electrolytes, lactate and arterial blood gases	I	D	D	D
Other				
Pressors (for neurogenic/spinal shock)	I	D	D	D
Nasogastric (NG) tube	D	E	E	E
Thermometer	E	E	E	E
Fluid warmers	I	D	D	D
Weighing scale for children	D	E	E	E

(or spinal) shock and septic shock. The ability to recognize these other causes of shock is deemed essential at all hospital levels. Cardiogenic shock is covered further under chest injuries. The ability to treat neurogenic shock appropriately with fluid resuscitation and pressors is deemed desirable at all hospital levels. It is not deemed essential because of the infrequency of neurological/spinal injury

and because of the cost needed to adequately train both medical and nursing staff in the safe administration of pressors by continuous IV drip. The ability to treat septic shock with antibiotics, fluid resuscitation and other supportive care is deemed essential at all hospital levels. Appropriate treatment of source of infection and underlying injury is covered further in several of the following sections.

Many patients in shock develop an ileus and are at risk of vomiting and aspiration of gastric contents. Hence, the availability of nasogastric (NG) tubes and the skills to insert them are deemed essential at all hospital levels.

Hypothermia is a frequent complication of shock. The ability to recognize this and to treat it with external rewarming is deemed essential at all levels. Capabilities to provide warmed fluids and gases, as well as other means of rewarming the body core, such as lavage via urinary catheters, nasogastric tube or intraperitoneal catheter, are considered desirable at all hospital levels.

Weighing scales for children, in order to more accurately calculate fluid requirements, are considered essential at all hospital levels and desirable at the basic level.

5.4 Management of head injury

Sections 5.1–5.3 described in detail the specific skills, equipment and supplies needed to treat the immediately life-threatening injuries addressed in the initial evaluation and management. For more complicated issues, these guidelines provide less specific detail. Details of operating theatre equipment and supplies are beyond the scope of this publication. Hence, only a few exceptionally critical items are mentioned. Instead, the guidelines state the services that should be provided, with the implication that the training, equipment and supplies needed to provide these services successfully and safely are present. Hence, the following sections 5.4–5.14 of the guidelines list clinical services without division into skills and knowledge versus supplies and equipment.

Head injury is one of the major causes of trauma-related death and disability worldwide. The American Association of Neurological Surgeons (AANS) has developed a set of Guidelines for the management of severe traumatic brain injury (32). These have been shown to improve survival and functional outcome after severe head injury in high-income countries (33, 34). Unfortunately, optimal treatment of head injuries by these protocols requires some of the most expensive resources in the modern therapeutic armamentarium. It is unlikely that low- or even middle-income countries will be able to meet these guidelines fully. In the current guidelines, we have attempted to delineate the most effective diagnostic and therapeutic capabilities that are likely to be achievable at a reasonable and sustainable cost in low- and middle-income countries. It is acknowledged that full compliance with the AANS guidelines would be the most desirable.

Within the resource limitations of developing countries, the assessment of neurological status, including determination of level of consciousness using the Glasgow coma scale, recognition of lateralizing signs, and determination of pupillary size and reflexes, are considered essential at all levels of the health care system, in all countries. This requires only training and perhaps a source of artificial light such as a pocket torch. One of the most significant therapeutic modalities that needs to be applied broadly worldwide is the minimization of secondary brain injury through the maintenance of cerebral perfusion and oxygenation. Most (65%) of the mortality from head injury is associated with secondary brain injury resulting from hypoxia and hypotension (35). This reinforces the primary importance of the ABC outlined in sections 5.1–5.3 above. Recognition of the importance of these factors in patients with head injuries is deemed essential at all hospital levels.

A refinement on the above is to offset the propensity towards raised intracranial pressure (ICP) by avoiding overhydration, principally in haemodynamically stable patients. This knowledge and the understanding that head-injured patients with hypovolemia also require appropriate hydration to prevent hypotension is deemed essential at all hospital levels.

Intracranial pressure (ICP) monitoring for appropriate indications (e.g. Glasgow coma scale less than 9 and abnormal CT scan of the head) and the ability to treat raised ICP through such means as sedation, osmotic diuresis (with mannitol), paralysis, cerebrospinal fluid (CSF) drainage and hyperventilation are deemed desirable at the tertiary care level. They are also desirable at the specialist-level hospital if a neurosurgeon is present. They are also desirable at the specialist-level hospital if a general surgeon with considerable neurosurgical expertise is available, in a setting in which facilities for referral to a tertiary centre are limited.

Intracranial mass lesions with pressure effect account for only around 10–20% of comatose patients. However, timely decompression of these lesions significantly improves outcome. Treatment of these lesions is greatly facilitated by the availability of computerized tomography (CT). This is deemed desirable at all hospital levels. However, its high cost prevents it from being considered essential at any level. CT scans are indeed available in many locations, including low-income countries, but many factors preclude their ready availability to all patients with suspected intracranial mass lesions. These include cost, and in some cases associated mandatory fees, as well as prolonged periods of breakdown (15). Some countries may decide to make CT scanning essential in their own plans. This requires not only the physical presence of the machine, but also timely 24-hour availability to all severely head-injured patients, without regard to ability to pay. It also includes facilities for maintenance and rapid repair within 24 hours. In addition, basic quality improvement programmes should assure that all patients

warranting CT scan of the head (generally Glasgow coma scale of 8 or less) are promptly scanned (generally within 2 hours of arrival to the hospital).

Surgical treatment of intracranial mass lesions is classified as basic (burr hole) or advanced (including craniotomy, craniectomy, treatment of intracerebral haematoma, etc.). CT scans facilitate such treatment, but they are not mandatory. It should be noted that increased survival with drainage of intracranial haematoma was widely documented in the era before CT scans (36). Relief of raised ICP from intracranial mass lesions by burr hole alone implies the skill to perform the operation and the drills or other suitable equipment needed. Some GP-staffed hospitals are situated in isolated places with minimal facilities for timely referral. In these locations, burr holes may reasonably be considered to be “possibly required”. This would imply that a GP with suitable surgical experience would be authorized to perform them. Specialist-level hospitals in most low-income countries would not usually be expected to have a neurosurgeon. In these cases, especially if referral time to tertiary care facilities is prolonged, the ability to perform burr holes by general surgeons is deemed desirable. Moreover, many tertiary care hospitals in low-income countries do not have neurosurgeons. At these facilities, the capability to perform burr holes should be essential. More advanced neurosurgical procedures are deemed “possibly required” at specialist-level hospitals. These would certainly be required if a neurosurgeon were present. However, they would also be reasonably performed by general surgeons in cases where referral to tertiary hospitals was significantly restricted. They would be desirable in any tertiary care environment. However, the dearth of neurosurgical expertise in low-income countries prevents them being deemed essential, even at the tertiary level.

A particular subset of neurosurgical procedures, elevation of open depressed skull fractures, is considered as possibly required at some very isolated GP hospitals, desirable at specialist facilities and essential at tertiary hospitals. Elevation of closed depressed skull fractures is less urgent and hence deemed possibly required at specialist-level hospitals (unless a neurosurgeon is present) and desirable at tertiary hospitals.

The AANS guidelines indicate that steroids are of no proven benefit in the treatment of traumatic head injury. Hence, they are not promoted in the *Guidelines for essential trauma care*.

Finally, malnutrition in head trauma patients has been associated with worsened outcome (32). Maintenance of at least baseline caloric and protein requirements should be assured, including NG feeding if the patient is comatose. This is deemed essential for all head-injured patients with altered neurological status at all hospital levels. This also applies to patients with a prolonged inability to eat, whether for head injury or other forms of trauma.

TABLE 4 **Head injury**

Resources	Facility level			
	Basic	GP	Specialist	Tertiary
Recognize altered consciousness; lateralizing signs, pupils	E	E	E	E
Full compliance with AANS ¹ guidelines for head injury	I	I	D	D
Maintain normotension and oxygenation to prevent secondary brain injury	D	E	E	E
Avoid overhydration in the presence of raised ICP ² (with normal BP)	D	E	E	E
Monitoring and treatment of raised ICP	I	I	D	D
CT ³ scans	I	D	D	D
Burr holes (skill plus drill or other suitable equipment)	I	PR	D	E
More advanced neurosurgical procedures	I	I	PR	D
Surgical treatment of open depressed skull fractures	I	PR	D	E
Surgical treatment of closed depressed skull fractures	I	I	PR	D
Maintenance of requirements for protein and calories	I	E	E	E

¹ AANS: American Association of Neurological Surgeons.² ICP: Intracranial pressure.³ CT: Computerized axial tomography.

5.5 Management of neck injury

This section will deal primarily with penetrating neck trauma. Blunt trauma causing spinal injury is included in the section on the spine. All forms and causes of airway obstruction are covered in section 5.1.

The ability to recognize platysmal penetration is deemed essential at all hospital levels. This implies the ability to recognize the physical finding, understand its significance and either treat the patient accordingly or refer to the next level of the health care system. Such skills are desirable for the basic level, especially in areas with high rates of penetrating trauma.

The ability to perform external control of haemorrhage is essential at all levels of the health care system. More advanced initial manoeuvres include packing and balloon catheter tamponade. These are deemed desirable at all levels of the health care system. All of these imply the requisite skills in airway management (section 5.1), especially as compression of neck wounds may exacerbate airway compromise. Such packing, with or without balloon tamponade, implies a level of skill that would not be expected, and hence would be irrelevant, at most basic units. However, it might be useful even at basic facilities in areas with high levels of penetrating trauma.

TABLE 5 **Neck injury**

Resources	Facility level			
	Basic	GP	Specialist	Tertiary
Recognize platysmal penetration	D	E	E	E
External pressure for bleeding	E	E	E	E
Packing, balloon tamponade for bleeding	D	D	D	D
Contrast radiography, endoscopy	I	I	D	E
Angiography	I	I	D	D
Surgical skills to explore neck	I	PR	E	E

Ancillary diagnostic tests include contrast radiography (oesophagography), endoscopy (laryngoscopy, bronchoscopy) and angiography. The high cost of the latter prevents it from being considered essential.

Surgical exploration of penetrating neck trauma is the definitive diagnostic test and the definitive mode of treatment. It is deemed essential at specialist and tertiary hospitals. In more remote, rural low-income areas, it is possibly required at GP hospitals, primarily in those locations where facilities for referral are limited. In such cases, appropriate training in exploration, repair of oesophageal injuries and primary suturing of vascular injuries should be assured for any GP expected to undertake such work.

5.6 Management of chest injury

Essential items for the care of immediately life-threatening chest injuries have been addressed in section 5.2. These include capabilities for the emergency insertion of a chest tube, oxygenation and respiratory support. An extension of such issues is the ability to collect blood from chest tube output for autotransfusion. This is desirable at all hospital levels. The cost of the resources needed to provide this service in a sterile fashion prevents it from being considered essential.

Most chest injuries, whether blunt or penetrating, are managed without surgical operation. Major preventable complications are atelectasis and pneumonia. The prevention of these is contingent on adequate pulmonary toilet, which is in turn contingent on adequate pain control. These are all low-cost capabilities and should be essential at all hospital levels. Pain control implies an adequate supply of analgesics, which is addressed in section 5.12. In addition to the physical availability of the medications, adequate pain control implies the skills needed to understand the importance of pain control in a patient with a chest injury, the ability to assess a patient for such pain and its effect on their respiratory status,

and the ability to assess adequate response to analgesia. Such skills are deemed essential at all hospital levels.

Useful adjuncts include regional anaesthesia, such as rib blocks (e.g. intercostal nerve blocks) and epidural analgesia. These would imply the availability of long-lasting local anaesthetics (e.g. bupivacaine). They also imply training to be able to perform the blocks satisfactorily and safely, and to recognize and treat potential complications. Capabilities for rib blocks are essential at specialist and tertiary level. They are possibly required at GP-level hospitals, if these are in more remote locations with limited capabilities for referral. Epidural analgesia would usually only be available where a fully trained physician anaesthetist is available. Due to this restriction and the cost of the special catheters needed, this capability is deemed desirable only for the upper two hospital levels.

Surgery for chest injuries can be classified as intermediate (including ligation of chest wall bleeding, pulmonary tractotomy and pulmonary resection) or advanced (including aortic repair with prosthetic graft). Intermediate thoracotomy capabilities are deemed desirable at the specialist level and essential at the tertiary level. Given the level of skill needed for such procedures, they would not be deemed desirable or even possibly required in GP-staffed hospitals, except under the most extreme circumstances. Performance of these procedures at specialist-level hospitals would imply the presence of a surgeon with the requisite skill, and adequate operative and postoperative facilities. The balance between these capabilities and the capability for rapid transfer to tertiary facilities needs to be determined on a local basis. Advanced thoracic surgical capabilities are deemed desirable at the tertiary care level, because of the high cost and hence low availability of more advanced materials, such as aortic grafts.

Any hospital performing thoracic surgical procedures should have basic quality improvement mechanisms in place to track the outcomes of such procedures.

TABLE 6 **Chest injury**

Resources	Facility level			
	Basic	GP	Specialist	Tertiary
Autotransfusion from chest tubes	I	D	D	D
Adequate pain control for chest injuries/rib fractures	D	E	E	E
Respiratory therapy for chest injuries/rib fractures	I	E	E	E
Rib block or intrapleural block	I	PR	E	E
Epidural analgesia	I	I	D	D
Skills and equipment for intermediate thoracotomy	I	I	D	E
Skills and equipment for advanced thoracotomy	I	I	I	D

5.7 Management of abdominal injury

The capability to utilize basic physical examination to assess an injured patient for the possibility of intra-abdominal injury requiring surgical treatment is deemed essential at all levels of the health care system. Also needed are the skills and equipment (BP cuff and stethoscope) to assess the patient for shock.

Such physical examination needs supplementation with ancillary diagnostic tests in equivocal cases and when the patient's abdominal examination is unreliable due to altered mental status. This is usually fulfilled by diagnostic peritoneal lavage (DPL), ultrasound or CT scan. The capability to perform DPL implies provision of the fluid and the inexpensive equipment involved, as well as the skills needed to perform the procedure safely. Such capability is deemed essential at hospitals at specialist and tertiary care levels. It is desirable at the GP-level hospital. This is especially the case for those GP-level hospitals with high trauma volumes. The need to assure adequate and safe performance of the procedure will often mandate continuing education and periodic practice, especially in circumstances of low trauma volumes, where the procedure is only infrequently utilized. The cost of this prevents DPL from being considered essential at all GP-level hospitals. In many countries, abdominal tap (without lavage) is the principal ancillary test used for abdominal evaluation. It is reasonable to continue this, especially in circumstances where the practitioner (usually a GP) is unskilled in the safe performance of DPL; where facilities are very basic and hence where a DPL would constitute an operating theatre case, with consequent delays; and where capabilities for urgent referral are limited. In such cases, knowledge of the limitations of abdominal tap without lavage is a necessary component of the skills needed to perform the procedure. It must be recognized that the DPL is a more sensitive test and is preferable if expertise and facilities permit it to be performed safely and efficiently. It must also be recognized that the degree to which abdominal tap (without lavage) increases the ability to detect haemoperitoneum, above and beyond physical examination alone, has not been well determined.

Ultrasound (US) shows considerable promise in the diagnosis of haemoperitoneum. It is deemed desirable at all hospital levels. However, its cost prevents it from being considered essential. When utilized, it should be recognized that the skills needed to perform US examination for haemoperitoneum are different and somewhat more advanced than those needed to perform basic obstetric evaluation, which is available in many low- and middle-income environments. When designated essential for the evaluation of abdominal trauma in a national plan, the following need to be assured: 24-hour availability of the equipment (which implies timely repair of any malfunctioning equipment); 24-hour availability of staff skilled in the performance of the procedure; and ongoing monitoring of the accuracy of the results of the scans.

CT scanning adds some utility in the evaluation of the injured abdomen, especially as regards the retroperitoneal structures. It is desirable at the upper two hospital levels. Its cost prevents it from being deemed essential. When designated essential for the evaluation of abdominal trauma in a national plan, the same caveats apply as for the use of CT for head trauma: prompt availability without regard to ability to pay; maintenance and timely repair; and quality assurance monitoring.

The capability to perform a trauma laparotomy and to deal with the wide range of potential injuries to the intraperitoneal and retroperitoneal structures is one of the mainstays of definitive care of the seriously injured patient and is deemed essential for the specialist and tertiary care hospitals. This is primarily wherever fully trained general surgeons are available. As with neurosurgical and thoracic trauma operations, abdominal trauma operations can be roughly categorized into intermediate and advanced. Intermediate implies procedures such as exploration, recognition of injured structures, haemostasis through packing, splenectomy, hepatic packing and suturing, repair of perforated bowel, and bowel resection and anastomosis. Advanced implies procedures in the retroperitoneum, hepatic resection and other more difficult procedures.

The capability to perform intermediate trauma laparotomy is possibly required at GP hospitals. This is especially the case in rural, low-income settings, where general practitioners are called upon to perform a wide range of basic- to intermediate-level abdominal surgical procedures, such as Caesarean section, salpingectomy for ruptured ectopic pregnancy, plication of typhoid ileal perforation, and bowel resection for strangulated hernia. In such circumstances, trauma-related procedures that are often required include those intermediate-level procedures listed above. In some circumstances, they may include damage-control laparotomy prior to transfer to higher-level hospitals. Whenever GPs are called upon to perform aspects of trauma laparotomy, the skills needed to perform such

TABLE 7 **Abdominal injury**

Resources	Facility level			
	Basic	GP	Specialist	Tertiary
Clinical assessment	E	E	E	E
Diagnostic peritoneal lavage (DPL)	I	D	E	E
Ultrasonography	I	D	D	D
CT ¹ scan	I	I	D	D
Skills and equipment for intermediate laparotomy	I	PR	E	E
Skills and equipment for advanced laparotomy	I	I	E	E

¹ CT: Computerized axial tomography.

procedures effectively and safely should be assured during basic medical school education and by continuing education courses.

At whatever facility trauma laparotomy of either intermediate or advanced level is performed on a routine basis, the quality of the procedures should be monitored and assured by some form of quality improvement programme. This would look at such aspects of care as missed injuries, delays in performance of emergency laparotomy and reoperation rates.

5.8 Management of extremity injury

Injuries to the extremities are the primary cause of injury-related disability in many countries. These disabilities can be greatly reduced if promptly recognized and corrected. Functional disabilities due to neglected or late treatment of these injuries continue to constitute a major burden on the developing world. The ability of individuals to return to work may be compromised and they may thus become a burden on their families and communities.

The recognition of major limb injuries and associated neurovascular compromise (including compartment syndrome) are essential at all health care levels. The skills and resources required to immobilize limb injuries are considered essential at all levels, including the basic level, as appropriate immobilization can reduce or stop haemorrhage, provide pain relief, correct deformities and ensure safe transport. In unstable injuries, particularly those involving the cervical and thoracolumbar spine, immobilization may also limit secondary neurological damage, as discussed in section 5.9 (Management of spinal injury).

It is recognized that there will be great variation in types of immobilization devices used across various countries. There will be indigenous material and designs for devices and various types of splints used to immobilize the injured extremity. Any improvisation that is inexpensive and based on scientific principles should be encouraged. Individual countries may seek professional expertise as they standardize their immobilization devices to ensure patient safety. Quite often, such devices are used as a part of definitive treatment in many conditions. All health workers are expected to have the skills to provide suitable immobilization to the injured patient, as transportation may be necessary for definitive care. It is essential that necessary immobilization devices for major extremity injuries, including hand injuries, be made available at the basic level.

Spine boards (see section 5.9 for further details), which can be produced at low cost, are considered to be desirable equipment at the basic level but will be essential at higher levels of care. Immobilization technique and resources for wrapping pelvic fractures are deemed essential even at the basic level of care as this can be performed with a piece of cloth and may save many lives by minimizing blood loss in unstable fractures of the pelvis. Similarly, splinting fractures

of the femoral shaft will be helpful in reducing blood loss and providing pain relief, particularly in settings where transportation times are long.

A spectrum of procedures is required for definitive management of fractures, both those presenting acutely and those with delayed presentation. These include closed manipulation and casting, skeletal traction, external fixation (and its functional equivalent, pins and plaster), internal fixation, and irrigation and debridement (toiletting) of complex extremity wounds, including open fractures. All of these are essential at tertiary hospitals, which in general have orthopaedic surgeons. All of these are essential at specialist hospitals. Depending on the country or area involved and its resources, specialist hospitals may have orthopaedic surgeons. If they do, all of the above are pertinent. If they do not, general surgeons with appropriate training and experience may be required to perform the above-mentioned procedures, especially in circumstances where capabilities for referral to tertiary facilities are limited. The increased infection potential with more aggressive procedures, such as internal fixation, must be kept in mind. Hence, in addition to the physical presence of the implants and equipment, and to the skills necessary to conduct the procedures, a sufficiently sterile operating theatre environment is essential whenever internal fixation itself is considered essential.

In some rural, low-income circumstances, the above spectrum of capabilities might be possibly required for GP-level hospitals. This would include some procedures carried out for definitive care. It might also include procedures such as irrigation and debridement of open fractures in circumstances where transfer to higher levels is possible but often delayed for several days.

A variety of other procedures need to be considered in the armamentarium of care of extremity injuries. These include management of injured hands, tendon lacerations and compartment syndrome. They also include an understanding of the indications for amputation and the capabilities to perform this safely. The same considerations of capabilities for care by orthopaedic surgeons, general surgeons and GPs pertain.

In all cases in which practitioners are routinely called upon to provide a level of care that is above and beyond what they would ordinarily be considered to be trained for, their training should be maximized as part of planning for essential trauma care. This would include training in medical school and postgraduate programmes, as well as continuing education. It would include training for GPs and general surgeons in the above-mentioned spectrum of skills. In the case of general surgeons, it might also include training in the higher-level orthopaedic care, such as internal fixation.

As with other topics considered in previous sections, the availability of a service implies the skills needed to provide it effectively and safely, as well as the needed equipment. The relevant equipment must not only be physically present,

but also promptly available to all who urgently need it, without regard to ability to pay, and worn-out or broken equipment must be repaired or replaced. As regards such physical resources, the care of injured extremities entails diagnostic (e.g. radiographic) equipment, implants and operative equipment, the latter of which will not be dealt with further in these guidelines.

X-ray facilities are generally designated essential for the diagnosis, treatment and successful outcome of skeletal injuries. It is essential that such facilities be available at appropriate levels in the system, particularly where orthopaedic surgical expertise is available. It is desirable to have X-ray facilities at a lower level (e.g. GP-level hospital or even basic facilities) to facilitate primary diagnosis and decisions regarding transfer of the patient. Portable X-rays assist in the management of patients in traction and during operative procedures. Capabilities for portable X-rays should be essential at the tertiary care level and are desirable at lower-level hospitals. C-arm image intensifier (fluoroscopy) is considered an integral part of the orthopaedic armamentarium in many settings these days as it offers accuracy, reduces operative time, decreases radiation exposure, allows closed procedures and hence saves blood loss and reduces infection rate (37, 38). It is considered a desirable resource in facilities with a trained orthopaedic surgeon. Cost constraints prevent this from being deemed essential. However, it is important to note the image intensifiers manufactured in India cost approximately \$15 000, which is considerably less than comparable units manufactured in high-income countries. Better resourced environments and especially high-volume facilities may want to convert this particular item of equipment to essential in their own plans.

It is noted that in countries with poor access to resources, non-operative treatment is often offered for fractures, despite the fact that operative repair would result in a better functional outcome. The reasons for this include the unavailability of implants, equipment and imaging capability, lack of surgical training, lack of a good operative environment or simply inability on the part of the patient to pay for such treatment. It is hoped that the benefits of early mobility through stabilization of fractures will eventually be passed on to every injured patient in whom internal/external fixation would be helpful to prevent disability.

The range of implants and equipment used for external and internal fixation varies greatly between countries and between hospitals in the same country. The choice of implants will depend primarily on the training and capability of the surgeons, and on the availability of implants and other resources. No attempt has been made to list the hardware required for fixation of fractures, but it is expected that a country will be able to standardize its own requirements (implants and equipment sets) with local professional expertise. Inexpensive metal implants are used in many countries, with varying degrees of success. Countries may

TABLE 8 **Extremity injury**

Resources	Facility level			
	Basic	GP	Specialist	Tertiary
Recognition of neurovascular compromise; disability-prone injuries	E	E	E	E
Basic immobilization (sling, splint)	E	E	E	E
Spine board	D	E	E	E
Wrapping of pelvic fractures for haemorrhage control	E	E	E	E
Skin traction	I	PR	E	E
Closed reduction	PR	PR	E	E
Skeletal traction	I	PR	E	E
Operative wound management	I	PR	E	E
External fixation (or its functional equivalent: pins & plaster)	I	PR	E	E
Internal fixation	I	I	E	E
Tendon repair	I	PR	E	E
Hand injury: assessment and basic splinting	E	E	E	E
Hands: debride, fix	I	PR	E	E
Measurement of compartment pressures	I	D	D	E
Fasciotomy for compartment syndrome	I	PR	D	E
Amputation	I	PR	E	E
X-ray	D	D	E	E
Portable X-ray	I	D	D	E
Image intensification	I	I	D	D
Proper management of immobilized patient to prevent complications	D	E	E	E

address the quality assurance of metal implants through appropriate mechanisms, in due course.

Complications such as pressure sores may arise from prolonged immobilization. Hence, proper management of immobilized patients (e.g. log rolling, frequent turning and early removal of spine boards) is essential at all hospital levels.

5.9 Management of spinal injury

Recognition of the presence or risk of spinal injury is essential at all levels of the health care system. The only resource needed for this is training. Included in this is the necessity to monitor neurological function at regular intervals, such as hourly, in the acute phase of injury, and this should be considered essential for all levels of care.

It is increasingly recognized that patients with spinal cord injury, especially acute cervical spinal cord injury, may experience severe hypotension and severe

problems in maintaining an airway and adequate ventilation. The risk of further neurological deterioration is increased when the ABC's of trauma management are neglected. Therefore, as with prevention of secondary brain injury, recognition of the importance of these factors in patients with spinal injury is deemed essential at all hospital levels.

A holistic approach to the prevention of complications should be considered essential at all hospital levels of care and during all phases of management, from the acute phase to the rehabilitation phase (39). The most common complications, which increase morbidity and mortality, are pressure sores, urinary retention, urinary infection and deep venous thrombosis. To prevent pressure sores, patients should be log-rolled every two hours. These items are also desirable at basic levels.

For several years, there has been an international movement towards a uniform methodology for the classification and scoring of acute spinal cord injury. A convention among specialists has established the International Classification System, which is the successor to the American Spinal Injury Association (ASIA) system (40). Although basic facilities and general practitioners would not be expected to use this system, it should be essential for all specialists caring for patients with injuries of the spinal cord in tertiary care centres to use this system.

It is anticipated that patients with spinal injuries or suspicion thereof would be rapidly referred to the next highest level in the health care system, where they could be more adequately managed, in terms of diagnosis and treatment. Ideally, patients should arrive at tertiary care centres within two hours of injury. Appropriate handling of patients, with the use of simple techniques such as log-rolling and the avoidance of undue movement during transport, is likewise essential at all levels of the health care system. Devices for immobilization, such as a spinal backboard, collar for cervical spine injuries and sandbags or head blocks to prevent movement of the head and spine, are essential at all hospitals and should also be utilized appropriately, not only during stays in these hospitals, but during inter-hospital transfer as well. These would be considered desirable, even at basic facilities. However, if the volume of blunt trauma at such a facility is low, the cost of such formal immobilization materials will prevent them from being designated essential. Countries in which such basic facilities have greater trauma volumes might reasonably consider designating these materials as essential at such facilities as well.

With respect to diagnosis, plain X-rays of the spine are still used by most specialists and tertiary centres. The simple X-ray is addressed in more detail in sections 5.8 (Management of extremity injury) and 5.13 (Diagnosis and monitoring). Computerized tomography (CT) and magnetic resonance imaging (MRI) have great utility in the management of patients with spinal injury. However, their high cost prevents them from being designated essential. When they are deemed

essential as part of a national plan, their continual functioning and availability on an emergency basis (24 hours a day, 7 days a week) should be considered as an integral part of essential status.

Recently, the American Association of Neurological Surgeons (AANS) and the Congress of Neurological Surgeons have disseminated Guidelines for management of acute cervical spinal injuries (41), which cover many of the issues related to acute spinal cord injury including surgical management. It would be highly desirable for specialists caring for spinal cord injuries (e.g. neurosurgeons and orthopaedic surgeons) to be aware of these. As with similar guidelines for the management of head injury (section 5.4), full compliance with these guidelines is deemed desirable at specialist and tertiary facilities. The cost of the infrastructure needed for full compliance prevent these from being deemed essential.

A variety of spinal injuries may be managed non-operatively. These include stable fractures with or without neurological injury. They also include some unstable bony and ligamentous injuries for which either surgical fixation or non-operative management could be used. Adjuncts to such non-operative therapy include bed rest, cervical spine braces, halo devices and cervical spine traction.

TABLE 9 **Spinal injury**

Resources	Facility level			
	Basic	GP	Specialist	Tertiary
Assessment—recognition of presence or risk of spinal injury	E	E	E	E
Immobilization: C-collar, backboard	D	E	E	E
Monitoring of neurological function	E	E	E	E
Assessment by International Classification System	I	I	D	E
Maintain normotension and oxygenation to prevent secondary neurological injury	D	E	E	E
Holistic approach to prevention of complications—especially pressure sores and urinary retention/infection	D	E	E	E
CT ¹ scan	I	D	D	D
MRI ²	I	I	D	D
Full compliance with AANS ³ guidelines	I	I	D	D
Non-surgical management of spinal injury (as indicated)	I	PR	E	E
Surgical treatment of spinal injury	I	I	PR	E
Surgical treatment of neurological deterioration in the presence of spinal cord compression	I	I	PR	E

¹ CT: Computerized axial tomography

² MRI: Magnetic resonance imaging

³ AANS: American Association of Neurological Surgeons

Halo devices are especially useful in centres with limited surgical capability. The ability to manage selected spinal injuries non-operatively includes the training to recognize which injuries are appropriate for such management, and the equipment to provide non-operative management. Such capabilities are deemed essential in specialist and tertiary care hospitals. In more remote rural low-income areas, such capabilities might be possibly required at GP-level hospitals.

Management of complicated spinal cord injuries as appropriate by surgical means should be essential at tertiary care facilities. This would imply the presence of an orthopaedic or neurological surgeon with appropriate training. In some cases, it would be possibly required at specialist level hospitals, if the availability of tertiary care facilities was limited and if the personnel with the necessary expertise were available.

5.10 Management of burns and wounds

Burns patients are especially prone to compromise of the airway and respiratory tract, and to fluid loss and hypovolemic shock. These issues are covered in detail in sections 5.1–5.3 and are not reiterated in section 5.10, which focuses on care of the burn wound itself.

The capability to assess the depth and extent of a burn wound is deemed essential at all levels of the health care system. These issues bear upon subsequent fluid requirements. The only resource needed for such assessment is training.

The capability for clean or sterile dressing of a burn wound, at least as an adjunct to transfer, is considered essential at all levels of the health care system. This implies training and basic clean or sterile dressing materials. As noted in section 5.3 (Circulation—Management of shock), sterile dressings would be ideal. These are essential at all hospital levels. Limited capabilities for sterilization prevent them from being considered essential at basic levels, where, instead, clean dressing material is deemed essential.

Many burn wounds can be treated definitively with topical antibiotics. The capability for this is deemed essential at all hospital levels. This capability is desirable at basic levels, but cost prevents it from being considered essential. Higher-level basic facilities, such as those run by formally trained nurses or medical assistants (as opposed to village health workers) might reasonably designate such items as essential. A variety of topical preparations are available for the treatment of burn wounds, including silver nitrate, mafenide acetate and silver sulfadiazine. Silver sulfadiazine is the most widely used worldwide. However, the *Guidelines for essential trauma care* do not make an endorsement of any specific preparation.

Debridement of necrotic tissue or external debris from burn wounds is considered essential at specialist and tertiary care hospitals, as is escharotomy (the removal or incision of dead skin in areas of third-degree burns). Capabilities for

this imply the training of the clinician and the provision of basic surgical equipment to perform the procedures. These capabilities are possibly required in some GP-staffed hospitals in rural, low-income areas.

Skin grafting of non-healing burn wounds is considered essential at specialist and tertiary care hospitals. This implies the training of the clinician. It also implies the availability of a dermatome to harvest the graft. This capability is possibly required in some GP-staffed hospitals in rural, low-income areas.

Third-degree (full-thickness) burns are associated with the greatest mortality and most disappointing functional results. Early excision and grafting of these wounds has been shown to reduce mortality and improve functional outcome (42). Such early, aggressive therapy has the possible side-effect of increasing blood loss and hence mortality if not performed with adequate safeguards for haemostasis and adequate capabilities for fluid and blood resuscitation. The capability for early excision and grafting is deemed desirable at specialist and tertiary care hospitals. This would imply not only surgeons who are trained in the safe performance of the procedure, but also sufficient anaesthetic capability to adequately resuscitate patients during and after the procedure.

Burn wound contractures of the extremities are a frequent cause of disability in many countries. Most are eminently preventable through improved attention to splinting and physiotherapy during the period of wound healing. Further details of physiotherapy and rehabilitation are provided in section 5.11. However, as regards burns, at least basic expertise in splinting and physiotherapy are deemed essential at all hospital levels. The primary resource for this is training. Even if fully trained physiotherapists are not available, the needed expertise could be provided by other hospital staff (nurses, doctors, or other personnel) with supplemental training in physiotherapy. The only physical resources required are low-cost splints that could be fashioned from locally available materials, if need be.

Reconstructive surgery to correct burn wound contractures of extremities or other body parts, as well as for repair of poor cosmetic results of facial burns, are deemed to be desirable at specialist level hospitals and essential at tertiary care hospitals.

The general topic of management of wounds is partially considered in section 5.8 (Management of extremity injury). For the sake of completeness, it is covered more fully here. The capability to assess a wound for its potential for mortality and disability is considered essential at all levels of the health care system. Referral to the next highest level of the health care system would ordinarily be expected if a better outcome (both survival and functional status) would be likely to be achieved. Potential for disability includes both damage to underlying nerves, vessels and components of the locomotive system, as well as the extent and location of soft-tissue defects. Non-surgical management of uncomplicated wounds

consists of cleaning and dressing. The capability for such is deemed essential at all levels of the health care system. Minor surgical management of wounds includes minor debridement and suturing. This implies the availability of expertise as well as basic surgical supplies, including anaesthetics (primarily local), antiseptics, surgical instruments and suture. These are considered essential at all hospital levels. They are possibly required at the basic level. It has been shown that a very high percentage of open wounds in rural low-income areas are cared for solely at basic facilities (43, 44). In such environments, assuring the capability of basic facilities to care for wounds would be very useful in assuring overall care of injured patients.

Major surgical management of complicated wounds includes extensive debridement and repair of injured structures, as indicated. It often implies repeat procedures and skin grafting. This capability is deemed essential at specialist and tertiary care hospitals. It is possibly required at GP hospitals. As indicated in the section on open fractures, the initial management of such complicated wounds is

TABLE 10 **Burns and wounds**

Resources	Facility level			
	Basic	GP	Specialist	Tertiary
Burns				
Assessment of depth and extent	E	E	E	E
Sterile dressings	D	E	E	E
Clean dressings	E	I*	I*	I*
Topical antibiotic dressings	D	E	E	E
Debridement	I	PR	E	E
Escharotomy	I	PR	E	E
Skin graft	I	PR	E	E
Early excision and grafting	I	I	D	D
Physiotherapy and splints to prevent contractures in burn wounds	I	E	E	E
Reconstructive surgery	I	I	D	E
Wounds				
Assess wounds for potential mortality and disability	E	E	E	E
Non-surgical management: clean and dress	E	E	E	E
Minor surgical: clean, suture	PR	E	E	E
Major surgical debridement and repair	I	PR	E	E
Tetanus prophylaxis (toxoid, antiserum)	D ¹	E	E	E

* Irrelevant, as clean dressings are superseded by sterile dressings at all hospital levels.

¹ Tetanus prophylaxis should be essential at any basic facility at which there is refrigeration.

often undertaken at GP-level hospitals for a period of hours to days before transport for referral can be arranged. Under these circumstances, assuring adequate early management of complicated wounds, with or without underlying open fractures, would be very useful in assuring adequate care of severely injured patients. The spectrum of training for management of such wounds includes a knowledge of when not to suture wounds in cases where they are too severely contaminated to be closed safely.

The capability for tetanus prophylaxis implies the training to categorize a wound by its tetanus risk (31) and to know the required tetanus prophylaxis based on local epidemiology (e.g. status of immunization of the population). This capability also implies the availability of both tetanus toxoid and tetanus antiserum. These are deemed essential at all hospital levels, and desirable at the basic level. Due to the fact that electricity and refrigeration are not always available at such facilities, the availability of medications for tetanus prophylaxis cannot be deemed essential. However, given its importance, tetanus prophylaxis should be considered essential at any basic facility that does have refrigeration.

5.11 Rehabilitation

As noted in the introductory sections of these guidelines, there is a vast amount of preventable injury-related disability, especially due to fractures and burns of the extremities. Efforts to prevent such disabilities are needed in acute care, as covered in the preceding sections 5.8 (Management of extremity injury) and 5.10 (Management of burns and wounds). Efforts are also needed in the rehabilitation of people with injuries after the acute treatment phase is over, to maximize recovery of independent function. Rehabilitative services have been considered briefly in some of the preceding sections. The current section covers these more comprehensively for all types of injuries.

The following recommendations concentrate on injuries to the extremities, the anatomic pattern of injury-related disability that is most common and most likely to be improved through low-cost modifications to rehabilitation services. Hence, basic physiotherapy/occupational therapy for those recovering from extremity injuries (especially fractures and burns) is deemed essential at all hospital levels. This includes such activities as the proper use of splints to prevent burn wound contractures, and range-of-motion and strengthening exercises for recovery from all types of extremity injuries. In the light of the fact that many injured patients receive follow-up care at basic facilities after hospital discharge, such capabilities are desirable at this level of facilities. Obviously, it would be ideal to have fully trained physiotherapists and occupational therapists providing such care at all levels. However, given limitations of cost, appropriate elements of training in physiotherapy/occupational therapy might reasonably be provided to key personnel. This might involve a specifically designated nurse (or other appropri-

ate person) who would take on the role of providing physiotherapy at a GP-level hospital.

The fields of physiotherapy and occupational therapy overlap somewhat and vary between countries. For the purposes of these guidelines, physiotherapy refers to those services needed to improve range of motion, strength and mobility. Occupational therapy refers to those services needed to improve range of motion and strength, specifically for the upper extremities, and to assist patients in regaining independent function for tasks such as self-care (e.g. dressing, feeding). The latter includes the provision of adaptive devices and training in their use.

The full spectrum of physiotherapy, including that appropriate for patients with injuries of the head and spinal cord, is deemed desirable at specialist and tertiary care hospitals. The full spectrum of occupational therapy is deemed desirable at specialist and tertiary care hospitals. As indicated above, the provision of fully trained professionals in each field is ideal. However, given limitations of cost, appropriate elements of training in these fields might reasonably be provided to key personnel at each facility as a way of maximizing the availability of such rehabilitation services. The key elements of such care that might be promoted in the face of a lack of fully trained personnel still remain to be defined.

Prosthetic services are deemed essential at the tertiary-care-level and desirable at the specialist-level hospital. These services include the provision of the prostheses themselves, as well as personnel with suitable expertise to fit patients with the prostheses properly and to handle problems that may arise in their use.

Given the mental distress of severe injury and the resulting high incidence of post-injury psychological problems, psychological counselling in some form is deemed essential at all hospital levels. This includes capabilities for both screening of injured persons for incipient psychological problems and appropriate treatment. It also includes assisting patients in psychological adjustment to their disabilities. The provision of fully trained mental health workers and psychologists would be ideal. However, given the shortages of such trained personnel, appropriate elements of training in psychological counselling might reasonably be provided to a number of key personnel, such as nursing and medical staff (or other persons with suitable qualifications).

Two additional specialized rehabilitative services include neuropsychology for the diagnosis and treatment of cognitive dysfunction, and speech pathology for the diagnosis and treatment of disorders of communication and swallowing. Both are especially useful in the recovery of head-injured patients. These are both deemed desirable at specialist and tertiary care levels. Fully trained professionals for each field would be ideal. However, given the shortages of such personnel, appropriate elements of training in speech therapy and therapy for cognitive dysfunction might reasonably be provided to a number of key personnel, such as medical and nursing staff (or other suitable persons).

The functional recovery of severely injured or ill patients often involves complicated rehabilitation issues, coordination of the input of multiple professionals, and treatment of ongoing medical problems. The field of physical medicine and rehabilitation has arisen in response to this need. Fully trained specialists in this field would be desirable at hospitals that care for severely injured patients and hence discharge severely disabled survivors. This would primarily involve specialist and tertiary care facilities. The low level of availability of physical medicine and rehabilitation specialists worldwide prevents this recommendation from being deemed essential. Similar considerations apply to specialized rehabilitation nurses. These personnel have specialized training in the management of severely disabled persons, including neurogenic bladder management, bowel programmes, prevention of pressure ulcers and monitoring for nosocomial infections. Such expertise is deemed desirable at specialist and tertiary care facilities. Low availability of such expertise prevents this recommendation from being considered essential.

A useful adjunct to the work of physical medicine and rehabilitation specialists is electromyography (EMG), which is of benefit in the evaluation and treatment of peripheral nerve injuries. This is deemed desirable at specialist and tertiary facilities.

Finally, many injured persons will never regain the functional status they enjoyed before they were injured. Enabling them to function optimally in society is one of the goals of rehabilitation. The Disability and Rehabilitation (DAR) department of the WHO has been addressing the needs of such individuals through its work in community-based rehabilitation (45). This has involved collaboration between different sectors, including ministries of health, ministries of

TABLE 11 **Rehabilitation**

Rehabilitation	Facility level			
	Basic	GP	Specialist	Tertiary
PT/OT ¹ for recovery of extremity injuries	D	E	E	E
Full spectrum of physiotherapy	I	I	D	D
Full spectrum of occupational therapy	I	I	D	D
Prosthetics	I	I	D	E
Psychological counselling	D	E	E	E
Neuropsychology for cognitive dysfunction	I	I	D	D
Speech pathology	I	I	D	D
Physical medicine and rehabilitation specialist-level care	I	I	D	D
Electromyography	I	I	D	D
Specialized rehabilitative nursing	I	I	D	D
Discharge planning	I	E	E	E

¹ PT/OT: physiotherapy/occupational therapy

education, and ministries concerned with social services, as well as nongovernmental organizations and local government. The *Guidelines for essential trauma care* recognize the importance of such efforts. As the guidelines focus on facility-based trauma care, further details of the elements of community-based rehabilitation will not be addressed here. However, a knowledge of existing community services and the capability to assist disabled patients in accessing and utilizing such services after discharge (e.g. discharge planning) are considered essential at all hospital levels.

5.12 Pain control and medicines

Through its Department of Essential Drugs and Medicines Policy (EDM), the WHO has developed a model list of medicines which have been selected to address major public health problems, for which there is documented evidence of efficacy and safety, and which are cost-effective (46). This model list contains 325 medicines that the WHO recommends should be available within a functioning health system at all times in adequate amounts, in appropriate dosage forms, with assured quality and at an affordable price. As with the current guidelines, the *Model list of essential medicines* is intended to be adapted on a national basis. Currently, 156 countries have national essential medicines lists.

Almost all of the medications that would be needed for essential trauma care are already included in the WHO *Model list of essential medicines*. However, the availability of such essential medicines is still far from complete, especially in rural areas of low-income countries (47). Hence, the *Guidelines for essential trauma care* lay out some of the most critical drugs needed for the care of the injured. The EsTC list is drawn from the *Model list of essential medicines*. It is intended to promote greater availability of the trauma-related essential medicines. It also adds further definition as to levels of the health care system at which the various medicines should be considered essential, with respect to the care of injured patients.

In the accompanying table, medicines are grouped by the categories in the *Model list of essential medicines*. Not all of the 27 categories of the Model List are applicable. Only those which are applicable are listed in the *Guidelines for essential trauma care*. Within each category, the guidelines address only those medicines which are trauma-related.

In some cases, the *Model list of essential medicines* indicates a therapeutic group, in which various drugs could serve as alternatives. When this has been done, the *Guidelines for essential trauma care* indicate the drug followed by the term “or equivalent.” In the Model List, drugs may be included in several categories. For example, diazepam is listed under both anaesthetics and anticonvulsants. For brevity, in Table 5.12, each medicine is listed only once.

By way of further explanation on Table 5.12, the *Model list of essential medicines* is divided into a core list and a complementary list. The core list contains medi-

cines that are efficacious, safe and cost-effective for major health problems. The complementary list contains medicines that are also efficacious and safe, but not necessarily as affordable as those on the core list. In the *Guidelines for essential trauma care*, almost any drug on the complementary list is listed as desirable rather than essential.

Likewise, many of the medicines listed might indeed be useful at the basic health care level. However, the great variations in what this level constitutes around the world prevent most of these medicines from being designated as essential. For example, in many locations, basic health care facilities do not provide injections or antibiotics. Hence, these guidelines do not list any of the antibiotics or any medication requiring injection as essential at this level. Depending on the capabilities of such basic health care facilities, some countries may wish to designate some of the medicines as essential at these facilities in their national plans.

The EsTC's list of medicines is not intended to be an exhaustive list of the medicines that might conceivably be needed by trauma patients. For example, in malaria endemic areas, postoperative fever is often due to recurrence of malaria. Antimalarial agents are covered extensively by the *Model list of essential medicines*, but not by the *Guidelines for essential trauma care*.

The *Model list of essential medicines* explains that the selection of these medicines is only one step, which needs to be followed by the appropriate use of these medicines. This implies that individuals who need them “receive the right medicine, in an adequate dose for an adequate duration, with appropriate information, planning of treatment follow up, and at an affordable cost” (46). This depends on factors such as regulatory decisions, procurement, training and information. As part of its Essential Drugs and Medicines programme, the WHO provides consultation to countries on these various factors as a means of increasing their capacity to provide essential medicines. Similar items might need to be addressed as part of the development of essential trauma care development. In particular, it is to be emphasized that, whatever pharmaceutical agent is being considered, the health care providers utilizing this agent should have sufficient training and skill to administer or prescribe it effectively and safely.

With respect to regulations and procurement, many of the medications in section 2 (Pain, fever and inflammation) of the *Model list* are subject to international control under the United Nations Convention against Illicit Traffic in Narcotic Drugs and Psychotropic Substances (1988) and related conventions. In some cases, otherwise reasonably stringent international controls prevent the most effective analgesics from reaching those who need them, especially in rural, low-income areas (48). Trauma patients represent one of the largest groups of people in severe pain, and hence one of the largest groups in need of effective, affordable analgesics. Hence, suitably amending existing regulations or otherwise

finding ways to assure the availability of inexpensive, effective, narcotic-level pain-relieving medications would be a key element in a plan for essential trauma care plan.

Most of the medicines in the accompanying table are self-explanatory or have been addressed in further detail in the *Model list of essential medicines*. A few points need to be mentioned. Medications from sections 3 (Anaphylaxis) and 4 (Poisonings) of the *Model list* are included here because of the possible need to treat complications of medicines elsewhere on the list, including allergic reactions to antibiotics and respiratory depression from narcotics. Under section 6 (Infections), only those antibiotics which generally pertain to care of the injured are included. Anti-tuberculosis medications and antimalarial agents (see above) are not included here, although they are in the *Model list of essential medicines*.

Blood products and plasma expanders (section 11 of the *Model list*), Cardiovascular disorders (section 12), and Fluid and electrolyte balance (section 26) are further explained in section 5.3 of these guidelines, on the topic of Circulation. The isotonic crystalloid solutions constitute the mainstay of resuscitation of hypotensive trauma patients, and their availability and appropriate use should be assured in every hospital where severely injured patients are treated. Although dopamine is considered to be an essential medicine in the *Model list*, the *Guidelines for essential trauma care* list it as desirable, because of the cost involved in adequately training both medical and nursing staff in the safe administration of pressors by continuous IV infusion.

Gastrointestinal medicines (section 17 of the *Model list*) are included primarily because of the need for peptic ulcer prophylaxis in severely injured patients. Insulin (section 18) is included in the light of increasing evidence of improved outcome for severely injured patients with tighter blood glucose control.

Finally, an important mode of pain control in patients with extremity injuries consists of splinting and immobilization. These have been addressed in section 5.8 (Management of extremity injury) and section 5.9 (Management of spinal injury) of these guidelines.

TABLE 12 **Pain control and medicines**

Anaesthesia (WHO EML ¹ section I)	Facility level			
	Basic	GP	Specialist	Tertiary
bupivacaine (or equivalent)	I	D	E	E
general anaesthetic (ether, halothane or equivalent)	I	D	E	E
ketamine	I	D	E	E
lidocaine (or equivalent)	D	E	E	E
nitrous oxide	I	D	E	E

TABLE 12 *Continued*

	Facility level			
	Basic	GP	Specialist	Tertiary
oxygen	D	E	E	E
thiopental (or equivalent)	I	D	E	E
diazepam (or equivalent)	D	E	E	E
atropine	D	D	E	E
Pain, fever, inflammation (WHO EML section 2)				
morphine (or equivalent)	D	E	E	E
codeine (or equivalent)	D	E	E	E
acetylsalicylic acid	E	E	E	E
ibuprofen (or equivalent)	D	D	E	E
paracetamol (acetaminophen)	E	E	E	E
Anaphylaxis (WHO EML section 3)				
dexamethasone, hydrocortisone (or other equivalent steroid)	D	E	E	E
epinephrine	D	E	E	E
Poisoning (WHO EML section 4)				
naloxone	D	E	E	E
Anticonvulsants (WHO EML section 5)				
phenobarbital	D	E	E	E
phenytoin	D	E	E	E
magnesium sulphate	D	E	E	E
Infections (WHO EML section 6)				
amoxicillin/ampicillin	D	E	E	E
amoxicillin & clavulanic acid (C) ²	D	D	D	D
amphotericin	I	D	E	E
benzylpenicillin	D	E	E	E
ceftazidime (C)	I	D	D	D
ceftriaxone (C)	I	D	D	D
chloramphenicol	D	E	E	E
ciprofloxacin (or equivalent)	D	D	E	E
clindamycin (C)	I	D	D	D
cloxacillin (or equivalent)	D	E	E	E
fluconazole (or equivalent)	I	D	E	E
gentamicin (or equivalent)	D	E	E	E
imipenem & cilastin (C)	I	D	D	D

TABLE 12 *Continued*

	Facility level			
	Basic	GP	Specialist	Tertiary
levofloxacin (C)	I	D	D	D
metronidazole	D	E	E	E
sulfamethoxazole & trimethoprim (or equivalent)	D	E	E	E
Medicines affecting the blood (section 10)				
heparin	I	D	E	E
warfarin (or equivalent)	I	D	E	E
Blood products and plasma expanders (WHO EML section 11)				
dextran 70, polygeline (or equivalent)	D	D	D	D
factor IX concentrate (C)	I	D	D	D
factor VIII concentrate (C)	I	D	D	D
Cardiovascular disorders (WHO EML section 12)				
dopamine	I	D	D	D
epinephrine (C)	I	D	D	D
Skin diseases: topical applications (WHO EML section 13)				
sulfadiazine	D	E	E	E
Antiseptics and disinfectants (WHO EML section 15)				
antiseptics: chlorhexidine, ethanol, polyvidone or equivalent	E	E	E	E
disinfectants: chlorine base compound, chloroxylenol, glutaral or equivalent	D	E	E	E
Diuretics (WHO EML section 16)				
furosemide (or equivalent)	D	E	E	E
mannitol (C)	D	D	D	D
Gastrointestinal disorders (WHO EML section 17)				
aluminium hydroxide	I	E	E	E
cimetidine (or equivalent)	I	D	E	E
magnesium hydroxide	I	E	E	E
Hormone disorders (WHO EML section 18)				
insulin	I	E	E	E
Muscle relaxants (WHO EML section 20)				
alcuronium, suxamethonium or equivalent	I	D	E	E

TABLE 12 *Continued*

	Facility level			
	Basic	GP	Specialist	Tertiary
neostigmine (or equivalent)	I	D	E	E
vecuronium (C)	I	D	D	D
Fluid and electrolyte balance (WHO EML section 26)				
glucose solution (5%, 50%)	D	E	E	E
normal saline solution (0.9% isotonic)	D	E	E	E
glucose with sodium chloride (4% glucose, 0.18% NaCl)	D	D	D	D
compound solution of sodium lactate (Ringer's lactate or equivalent)	D	E	E	E
potassium chloride solution	D	D	E	E
Vitamins and minerals (WHO EML section 27)				
calcium chloride/gluconate (C)	I	D	D	D

¹ EML: WHO's *Model list of essential medicines* (WHO, 2002)

² C: WHO's *Complementary model list*

5.13 Diagnosis and monitoring

Equipment and associated expertise for the diagnosis and monitoring of injured patients have been addressed in each of the preceding sections. Because of the overlapping requirements for many of these, all are repeated in this section, along with several that have not previously been discussed. The rationale for most of these items has been discussed above and will not be repeated in full here.

The foundation for the diagnosis and monitoring of injured patients is in adequate clinical examination skills. Basic equipment for the diagnosis of life-threatening injuries and the monitoring of vital signs include stethoscope, blood pressure (BP) cuff, pocket torch and thermometer, all of which are considered essential at all levels of the health care system. Foetal stethoscope and urinary catheter with collection bag for the measurement of urinary output are essential at all hospital levels. Various forms of electronic monitoring and invasive monitoring, such as central venous pressure (CVP), right heart catheters and ICP, add value to the management of severely injured patients and hence are deemed desirable. However, at this time, their costs prevent them from being considered essential. For more details on the preceding items, the reader is referred to a related WHO publication, *Surgical care at the district hospital* (26).

Plain-film radiography is essential at the upper two hospital levels and is highly desirable at GP-level hospitals. National plans may wish to designate it essential

TABLE 13 **Diagnosis and monitoring**

Resources	Facility level			
	Basic	GP	Specialist	Tertiary
Monitoring				
Stethoscope	E	E	E	E
Blood pressure cuff	E	E	E	E
Torch (flashlight)	E	E	E	E
Thermometer	E	E	E	E
Foetal stethoscope	D	E	E	E
Urinary catheter with collection bag	D	E	E	E
Electronic cardiac monitoring	I	D	D	D
Pulse oximetry	I	D	D	D
Central venous pressure monitoring	I	D	D	D
Right heart catheterization	I	I	D	D
Intracranial pressure monitoring	I	I	D	D
Radiological investigations				
Plain films	D	D	E	E
Portable plain films	I	D	D	E
Contrast radiography (barium, gastrograffin)	I	I	D	D
Ultrasound for trauma (haemoperitoneum)	I	D	D	D
CT ¹	I	D	D	D
Angiography	I	I	D	D
Image intensification/fluoroscopy	I	I	D	D
MRI ²	I	I	D	D
Nuclear medicine	I	I	D	D
Laboratory tests				
Haemoglobin/haematocrit	D	E	E	E
Glucose	I	E	E	E
Gram stain	I	D	E	E
Bacterial cultures	I	D	D	E
Electrolytes (Na, K, Cl, CO ₂ , BUN ³ , creatinine)	I	D	D	D
Arterial blood gas measurements	I	D	D	D
Serum lactate	I	I	D	D
Other				
Paediatric length-based tape (Broselow tape)	D	D	D	D
Otoscope	D	E	E	E
Ophthalmoscope	D	D	E	E
Compartment pressure measurement	I	D	D	E

¹ CT: Computerized axial tomography.² MRI: Magnetic resonance imaging.³ BUN: blood urea nitrogen.

at GP hospitals that care for a specified minimum number of trauma cases. Given the importance of basic X-ray, the reader is referred to existing guidelines on the WHO Basic Radiology System (BRS) (49). The BRS describes the minimum equipment needed for basic X-ray services, oriented towards small hospitals.

The capability for portable plain X-rays (mobile radiography units) is deemed essential at tertiary care hospitals and desirable at all other hospitals. Other imaging capabilities, including CT scans, angiography, fluoroscopy, image intensification, MRI and nuclear medicine exams, add value to the management of injured patients. They are listed as desirable at various levels, as indicated in the table. Their costs prevent them from being designated essential at any level at this time.

Basic, general-purpose ultrasound is of great utility for non-trauma purposes, especially obstetrics. Hence, one might reasonably wish to assure its availability at all specialist and tertiary hospitals, as well as many GP hospitals, for general purposes. However, ultrasound for trauma requires more advanced skills in both performance and interpretation, primarily for the diagnosis of haemoperitoneum. It is this skill and capability that are considered desirable (rather than essential) at all hospital levels. See also section 5.7 (Management of abdominal injury) for more details.

The measurement of haemoglobin concentration or haematocrit by any suitable, reliable technique is deemed essential at all hospital levels, as is the measurement of serum glucose concentration. Gram stains are essential at specialist and tertiary hospitals. Bacterial cultures are essential at tertiary facilities. Measurements of electrolytes, arterial blood gases (ABG) and serum lactate are deemed desirable. Their costs prevent them from being deemed essential at any level at this time.

The use of a paediatric length-based tape (Broselow tape) is of benefit in the calculation of doses of fluids and medications for children. This is inexpensive and desirable at all institutions that care for injured children. Ophthalmoscopes and otoscopes are useful adjuncts for the physical diagnosis of injured patients and are deemed essential or desirable as indicated in the table. Equipment for the measurement of compartment pressures can be purchased as a ready-made set or can be constructed using tubing and the gauge from a blood pressure cuff. Expertise to use either one is deemed essential at tertiary care facilities.

Any capabilities for monitoring, radiology or laboratory services that are deemed essential or that are converted from desirable to essential in a national plan should meet certain criteria, in addition to mere physical availability of the relevant equipment. These include prompt availability (24 hours a day, 7 days a week, if indicated), sufficient personnel skilled in performing the procedures or tests safely and accurately and in interpreting the results, and, where relevant, sufficient quality assurance mechanisms to monitor the application of the test or procedures. Diagnostic imaging and laboratory facilities should follow WHO

guidelines, including those for internal quality control and external quality assessment (http://www.who.int/eht/Main_areas_of_work/DIL/About_DIL.htm).

Equipment should be maintained so as to assure the availability of the related services without interruption due to malfunction. This point is to be emphasized, as the ability to manage and maintain medical equipment has often lagged behind acquisition of the equipment (49).

5.14 Safety for health care personnel

Give the high rates of HIV and other bloodborne pathogens worldwide, it is imperative that health workers be provided with adequate protection. This is generally true, but especially so in trauma care, where blood and other body secretions are abundant and where the hectic nature of resuscitation may lead to an increased propensity to contact. Capabilities for universal precautions are deemed essential at all levels of the health care system. This includes the training necessary to apply these. It also implies provision of the necessary materials, including gloves and goggles, as well as capabilities for the safe disposal of sharps and biological materials. All of these are considered essential at all levels of the health care system. In the course of trauma resuscitation, large volumes of fluids may sometimes come into contact with health workers' skin. In such cases, adequate water-resistant clothing/gowns should be available. These are essential at all hospital levels. They are listed as desirable at the basic level, as some such facilities may not care for severely injured patients under such scenarios. Finally, capabilities for anti-HIV, post-exposure prophylaxis with anti-retroviral medications is deemed desirable at all levels.

Throughout these guidelines, numerous invasive procedures have been discussed. Implicit in all of these is that they be conducted under appropriate sterile conditions. The capability to achieve sterility is likewise implicit whenever these procedures are mentioned.

TABLE 14 **Safety for health care personnel**

Safety for health care personnel	Facility level			
	Basic	GP	Specialist	Tertiary
Training in universal precautions	E	E	E	E
Gloves	E	E	E	E
Goggles	E	E	E	E
Sharps disposal	E	E	E	E
Biological waste disposal	E	E	E	E
Gowns	D	E	E	E
Post-exposure prophylaxis for HIV	D	D	D	D

5.15 Special considerations for children

Almost all of the preceding sections require some amendment for children. These amendments concern particular skills in handling injured children, equipment in paediatric sizes, and adjustment of doses of medications. A brief summary of these issues follows, emphasizing items that might need to be amended to further optimize care of the injured child. These apply to items that have already been designated as either essential or desirable.

Airway management (see also section 5.1)

Skills:

- recognition of the differences in airway anatomy in children
- somewhat different techniques needed, particularly for endotracheal intubation

Equipment:

- paediatric sizes for nasal and oral airways, bag–valve–masks, laryngoscopes and endotracheal tubes

Management of respiratory distress (see also section 5.2)

Equipment:

- paediatric-size equipment for oxygen face masks and for chest tubes

Management of shock (see also section 5.3)

Skills:

- knowledge of different baseline vital signs by age
- knowledge of varying physiological responses to blood loss and varying manifestations of shock in children of different ages
- knowledge of paediatric doses for fluids, both for baseline requirements and for treatment of shock
- knowledge of paediatric doses for blood transfusion for treatment of haemorrhagic shock
- skills in the insertion of paediatric intravenous cannulas, in peripheral cutdown access and in insertion of intraosseous lines

Equipment in paediatric sizes:

- intravenous cannulas
- blood pressure cuff
- urinary catheters
- nasogastric tubes
- intraosseous needle or equivalent
- weighing scale

Laboratory facilities:

- ability to perform laboratory tests on small samples of blood from paediatric patients

Head injury (see also section 5.4)

Skills:

- ability to calculate modified Glasgow coma scale for young children

Extremity injury (see also section 5.8)

Skills:

- understanding of specific paediatric orthopaedic injuries which are highly prone to disability
- management of fractures specific to the paediatric age group (e.g. epiphyseal fractures)

Spinal injury (see also section 5.9)

Skills:

- knowledge of the varying anatomy of the childhood spine
- interpretation of spinal X-ray films (required for both non-surgical and surgical management)

Equipment:

- C-collars in paediatric sizes

Burns and wounds (see also section 5.10)

Skills:

- assessment of percentage body surface area of burn wounds in young children

Rehabilitation (see also section 5.11)

Skills:

- monitoring of growth and development to assure that the normal milestones are met as closely as possible, despite the injury and any related physical impairment.

Pain control and medicines (see also section 5.12)

Skills:

- knowledge of paediatric doses

Equipment:

- appropriate references or charts to calculate paediatric doses

Diagnosis and monitoring (see also section 5.13)

Equipment:

- urinary catheters in paediatric sizes
- laboratory capabilities for paediatric volumes (as noted above)
- paediatric length-based tape (Broselow tape) for estimating paediatric doses

6. Methods for promoting essential trauma care services

This section will review some of the methods that could be utilized to promote the implementation of services for essential trauma care. These are methods that have been utilized to promote improvements in medical care generally worldwide. With specific reference to trauma care, they have primarily been used in developed countries. This experience is briefly reviewed. Where information exists on the applications of these methods to trauma care in the setting of developing countries, this is likewise indicated, with thoughts on how such methods might be expanded.

6.1 Training for trauma care

All of the components of these guidelines require skill on the part of the practitioners. Some of these are skills at all levels of the health system and by all levels of providers, such as the skills for initial evaluation and resuscitation. Some are only for hospital workers and some are highly specialized, such as those for operative management. In this manual, we have concentrated on skills for the main care providers, including doctors and nurses. However, it must be recognized that a variety of other professionals are involved in the care of the injured patient. Their skills and training must be considered, including laboratory technicians, X-ray technicians, operating theatre personnel and village health workers. Optimizing the trauma-related skills outlined in these guidelines is a major way in which the EsTC standards can be assured in a cost-effective manner.

Greater attention is needed worldwide to define and optimize the training of doctors and nurses in trauma care. This pertains to both trauma-related skills imparted in basic education and those acquired during postgraduate training, such as house-officer posts and specialist training for doctors. The tables in this manual outline the core set of trauma-related skills that are needed. It is hoped that by so doing this manual will provide guidance for curriculum development in schools of medicine and schools of nursing.

Higher-level skills for operative care require specific training. In rural, low-income environments, most notably in Africa, there is often a need for general practitioners to perform a variety of surgical procedures. In such environments,

it would be useful to comprehensively address the appropriate elements of operative care that should be worked into basic medical school curriculum and house-officer training. This would assure that all graduates going to work in rural hospitals would have the skills needed to perform the procedures safely. In all environments worldwide, there is a need to consider the trauma-related skills that are imparted to surgeons in training during their residency. This applies to general surgeons, orthopaedic surgeons and others. Greater standardization of such curricula would assure increased availability of trauma-related services worldwide. In some environments, trauma services might be advanced by promoting an increased number of trauma fellowships after the completion of formal residency training. This would especially be the case for large urban trauma centres in middle-income countries.

In addition, continuing education for all practitioners involved must be promoted to prevent decay of cognitive knowledge and skills, especially among those who are not seeing large numbers of trauma patients. Such continuing education also provides updates to all practitioners, no matter what volume of trauma care they are handling. Finally, continuing education courses offer the opportunity to better define the core essential elements of trauma care for a given environment. By so doing, they can influence the trauma-related knowledge and skills imparted in undergraduate and postgraduate training. Continuing education courses have been documented to improve the process and outcome of trauma care. For example, Ali et al. (13, 14) evaluated the effect of regular provision of the two-day continuing education course, Advanced Trauma Life Support (see below for further details), at the largest hospital in Trinidad. Most of the doctors providing care for injured patients at that hospital had taken this course by the late 1980s. Compared to the period before such widespread trauma training, the authors noted an increase in appropriate use of several therapeutic modalities, including early (in the emergency department) endotracheal intubation of patients with severe injuries, early insertion of chest tubes in patients with severe chest injuries, and the use of urinary and nasogastric catheters. These improvements in the process of care were associated with a substantial decrease in the mortality rate of severely injured patients (injury severity score of 16 or higher) treated at that hospital. The mortality declined from 67% to 34% after most of the doctors had been ATLS-certified.

A variety of different courses have been utilized worldwide. We provide here brief descriptions of a selection of these. These guidelines do not formally endorse any one more than another. One or more may be optimal for a given environment.

- **Advanced Trauma Life Support (ATLS):** This is a proprietary course provided by the American College of Surgeons (31). It is the longest standing and most widely utilized continuing education course in trauma care world-

wide; since its inception in the late 1970s, over 350 000 doctors have taken this course. The course lasts two to three days and covers the breadth of trauma care, oriented primarily towards the first hour of care in an emergency department. It includes didactic lectures and skill stations, where key technical skills can be demonstrated and practised using mannequins and anaesthetized animals. It is oriented towards the circumstances of developed countries. However, it has been found to be useful in some middle-income countries, as described above for Trinidad (13, 14). It has been formally established in 42 countries, including 23 high-income countries, 17 middle-income countries and 2 low-income countries. Formal promulgation to low-income countries has been hindered by start-up costs of around \$80 000 per country (50).

- **National Trauma Management Course (NTMC):** This course has been developed and implemented by IATSIC. It has been established principally in India, in partnership with the Academy of Traumatology (India). It has been running since 2000 and has trained over 1500 doctors in India. It is a two-day course oriented towards care of the severely injured during the initial emergency period. It is specifically oriented towards circumstances in India and other low-income countries. The curriculum contains lectures and teaching of life-saving skills on mannequins and animals. NTMC was introduced with faculty from IATSIC, but is now offered jointly with local instructors trained through an instructor programme, aimed at making it self-sustaining in the long term. There were no start-up costs involved, so the introductory expenses could be contained, and the course fees are subsidized to make it affordable in the local context.
- **Definitive Surgical Trauma Course (DSTC):** This is another course developed and promoted by IATSIC. It is oriented towards surgeons and is focused on operative management of some of the more difficult life-threatening injuries. The course emphasizes decision-making, using short lectures and discussion of case scenarios, and provides practical training in operative skills and strategies, such as thoracotomy incisions and access, laparotomy strategies, neck exploration strategies, management of solid and hollow visceral injuries, injuries to retroperitoneal structures, cardiac injuries and vascular injuries of the neck and chest. This two-day course includes lectures and surgery on cadavers and/or anaesthetized animals. It has been taken by over 500 surgeons, in 11 countries, since its inception in the early 1990s.
- **Essential Surgical Skills (ESS):** This course has been run by the Canadian Network for International Surgery (CNIS) in partnership with departments of surgery in several African countries, including Ethiopia, Malawi, Mozambique

and Uganda. The curriculum content and implementation are managed by the Africa Canadian Committee for ESS, which includes representatives from each surgical department. It is designed to train primary care practitioners in the management of surgical problems commonly handled at rural hospitals. It includes two introductory lectures, 25 case studies and 40 technical procedures using mannequins and animal material. It lasts five days and covers the breadth of emergency surgery. Two of its five modules address trauma (e.g. anaesthesia & life support and orthopaedics & traumatology). It has been taken by over 3000 persons in the above countries since its inception in 1994 (for further information, see <http://www.cnis.ca>).

- **Primary Trauma Care (PTC):** This course is administered by the PTC Foundation. It has been funded, in part, by the World Federation of Societies of Anaesthesiologists (WFSA). It is designed to train doctors, nurses and other health professionals in the early management of severe trauma at rural, GP-staffed hospitals. It lasts two days, with lectures, skill stations and moulage scenarios. It also covers disaster management and issues pertaining to the prevention of injury. It has been held in 23 countries in Africa, Asia and South America. In each country, local institutions adapt the template from the WFSA as needed to address the local environment. It has been running since 1996 and has trained several thousand practitioners. The manual has also been adapted for a WHO publication, *Surgical care at the district hospital* (26, 51).
- **Kwame Nkrumah University of Science and Technology (KNUST) Trauma Course:** This course was developed in response to the particular needs of rural hospitals in Ghana, which are almost exclusively staffed by general practitioners. It is oriented not only towards initial emergency care, but also towards definitive care appropriate to rural African hospitals. 150 doctors have undergone training on this week-long course since its inception in the mid-1990s. This is considerably less than the above-mentioned international courses, but nevertheless, this course demonstrates a model national trauma course developed to meet the specific needs of rural areas in a low-income country (12). The course covers the breadth of trauma care, including knowledge and skills in:
 - initial emergency management that should be applicable under any circumstances;
 - definitive management which can reasonably be carried out in a rural African hospitals;
 - diagnosis of more complicated injuries that would ordinarily be considered as warranting referral to a higher level facility; and

— reasonable management of such injuries when referral is delayed or impossible.

- **Trauma Nursing Core Course (TNCC):** This course is run by the Emergency Nurses Association and is oriented towards nurses working in emergency departments in developed countries. It runs for 16 hours and covers principles of acute management in the emergency department setting. It includes lectures and skill stations, including trauma nursing process, airway and ventilation interventions, and spinal immobilization. The course provides core-level knowledge and psychomotor skills associated with implementing the trauma nursing process (www.ena.org).
- **Trauma Team Training (TTT):** This course is run collaboratively by the Injury Control Centre in Kampala, Uganda, and the Canadian Network for International Surgery. This course is designed to create trauma teams that can function with the personnel found in under-resourced health centres in rural Africa. The instructional target is the team, which consists of a clinical officer, an anaesthetic officer, an orthopaedic technician, a registered nurse and an aid. It lasts three days and consists of lectures, skill stations and team exercises. The purpose of the lectures is to assure that all team members have a common understanding of key issues in clinical trauma care, and of the importance of the trauma team. The skill stations assure that all participants can proficiently perform their role in the skills necessary for the initial care of the injured patient and the preparation of the patient for definitive care. At the end of the course, the institution gains a cohesive team. TTT has trained around 200 people from 10 hospitals in Uganda since 1998, and plans are in place for its translation into Portuguese for use in Mozambique.

Much could be achieved towards assuring the services outlined in the *Guidelines for essential trauma care* by promulgating some or all of these courses, depending on the context. It is the feeling of the authors of this manual that part of the EsTC process would involve countries defining which of the continuing education courses best suit their particular needs. This might include a definition of which courses suit their needs at a national level. It might also include which courses best suit a particular subset of providers, or geographic area, or level of institution. In some cases, this might imply developing their own courses, as in the example of Ghana mentioned above.

In some cases, this might also imply establishing plans to facilitate and promulgate the particular continuing trauma training selected. For example, in some middle-income countries in which the ATLS programme has already been formally established, its availability has been impaired by high cost relative to local salaries

and by a low number of courses relative to those who would benefit from this type of training (15). Nationwide plans to remove these barriers and thus facilitate increased utilization of such training constitute one means to be considered in efforts to promulgate the *Guidelines for essential trauma care*. As mentioned above, this might not necessarily imply all trauma care providers. Depending on resources to be deployed, it might imply special efforts to subsidize, reduce the cost or otherwise increase availability to certain critical providers. These might include the lead trauma care providers in emergency departments in hospitals who have no one with such certification. Other possibilities might include increased availability to doctors in rural hospitals with limited access to specialists. Finally, it might also imply widespread certification for all doctors providing care in busy urban trauma centres. Similar considerations would apply for a nursing staff training course such as the TNCC.

Another example of the utilization of continuing education to promote the *Guidelines for essential trauma care* in low-income countries comes from Ghana. It has been suggested to the Ministry of Health that a low-cost means of promoting improvements in trauma care in the country would include providing the KNUST trauma course regularly for general practitioners in hospitals located along busy roads.

In addition to the considerations noted above, the *Guidelines for essential trauma care* could be promoted by several other educational means. These include developing and promoting educational resources for trauma care in hospitals. Prior surveys from some countries have indicated a dearth of such educational materials (12). Larger institutions might reasonably develop their own continuing education plans, including not only doctors and nurses but also ancillary personnel. Finally, countries with heavy burdens of trauma care could consider making trauma care rotations mandatory, either in medical schools or postgraduate programmes, in the same way in which rotations in Obstetrics & Gynaecology are required in some countries.

Finally, these guidelines are written as a planning tool, oriented primarily towards planners and administrators (see Executive summary). As part of plans to implement the guidelines on a national basis, it would not be unreasonable to consider developing training courses or other training materials for planners and administrators. These courses would address the topic of the critical elements of personnel, staffing, equipment, supplies and organization, of which planners/administrators need to be aware and whose provision they need to help to assure.

6.2 Performance improvement

Performance improvement is a method of improving medical care by monitoring the elements of diagnosis, treatment and outcome. It evaluates the performance

of both individual providers and the system in which they work. The concepts of such a process have evolved over time. Medical audit is a concept originating in the 19th and early 20th century. It consisted of a system of counting procedures, complications and deaths. Quality assurance was built upon audit by reviewing medical records for documentation of predetermined criteria, which were felt to reflect an acceptable quality of delivery of medical care. This was utilized typically to look for providers who did not live up to expected standards. This approach evolved into the process of performance improvement, also known as continuous quality improvement (CQI), which looked at the effect of factors in the system as well as individual practitioners' actions (52).

Performance improvement for trauma care has followed the same evolution. A variety of techniques have been used specifically in this field.

- **Morbidity and mortality conferences:** These involve a discussion of deaths and complications in search of preventable factors, primarily in the actions of individual practitioners. Such conferences are utilized in surgery departments around the world, and the peer review process involved in these is the foundation for improvements in medical care through more formal programmes for performance improvement. Typically, all types of cases are discussed at these. Busier trauma centres may have specific morbidity and mortality conferences on trauma alone.
- **Preventable death studies:** These employ reviews of deaths, either at an individual hospital or within a given system, looking for deaths which are considered, by consensus, preventable. This may include deaths due to airway obstruction or isolated splenic injuries.
- **Audit filters:** A number of quality-of-care criteria are established. Particular cases that do not meet these criteria are then reviewed on a systematic basis to see whether, indeed, there was a problem with the quality of medical care delivered. These include such factors as patients with abdominal injuries and hypotension who do not undergo laparotomy within one hour of arrival at the emergency department; patients with epidural or subdural haematoma who do not undergo craniotomy within four hours of arrival at an emergency department; and open fractures which are not debrided within eight hours of arrival. Among the audit filters are evaluations of unexpected trauma deaths, such as those occurring with low injury severity scores (53).
- **Complications:** A long list of potential complications may also be tracked as indicators of the quality of care. This process looks for a rate of complications that is higher than would normally be expected. This includes complications

such as pneumonia, wound infections, venous thrombosis and urinary tract infections.

- **Risk-adjusted mortality:** Through this statistical process, hospitals evaluate the percentage of deaths occurring in patients with low injury severity scores or a low probability of death based on a combination of injury severity scores and trauma scores (TRISS methodology). This allows the hospitals to compare themselves against predetermined national norms. Hospitals with higher risk-adjusted death rates may warrant evaluation of the individual unexpected deaths along with evaluation of their systems of care, to identify elements that might be contributing to such higher risk-adjusted mortality.

For all of the methods noted above, the primary principle is to identify the problems that are arising due to correctable factors. Corrective action is taken to ameliorate these problems. Finally, the effect of these changes is evaluated to assess whether they have been successful in correcting the problem. The last step is known as “closing the loop”.

Most of these methods of performance improvement in trauma care depend on reliable, ongoing sources of information about trauma patients. This is typically provided by trauma registries, which are generally considered an integral part of any quality improvement programme (17, 52). In the previously noted process of trauma centre verification, professional societies look closely at the existence and functioning of programmes for performance improvement in trauma care. The publication *Resources for optimal care of the injured patient* lays out guidelines for what should be in place for a trauma performance improvement programme. These are required at all hospitals that care for injured patients. Likewise, in developing standards to improve trauma care in the United Kingdom, the British Trauma Society mandated that all hospitals caring for major trauma patients should have an audit programme to maintain quality standards in trauma care (54).

There has been some experience with programmes for performance improvement for general medical care in developing countries. In Malawi, audit of antibiotic usage revealed large-scale inappropriate use, which led to the implementation of treatment guidelines (55). In Nigeria, the implementation of a quality-assurance programme in a network of primary health care clinics improved the management of diarrhoea (56).

Some of the best reported use of programmes for performance improvement in low- and middle-income countries relates to the Safe Motherhood Initiative. A specific type of performance improvement for obstetric care is the medical audit of maternal death. This has proved instrumental in improving obstetric care globally (57–61). Pathak et al. demonstrated that most facility-based maternal deaths

in Nepal were due to correctable factors, such as delays in treatment at the facilities, inappropriate treatment and lack of blood (57). In Zaria, Nigeria, Ifenne et al. demonstrated that such performance improvement monitoring assisted in reducing the time interval between admission and treatment from 3.7 to 1.6 hours. Similar performance improvement-related improvements in the process of care led to a decrease in the case fatality for obstetric complications from 12.6 percent to 3.6 percent in Kigoma, Tanzania (60).

Looking at nationwide improvements in maternal care, Koblinsky et al. point out an interesting contrast which is of some relevance to the Essential Trauma Care Project (62). Some countries (Malaysia, Sri Lanka) have reduced the maternal mortality rate to well below 100 deaths per 100 000 live births through fairly simple measures. These have included an increased use of midwives for home delivery, and an increased use of hospitals with basic (non-surgical) obstetric care. Accompanying these increases in resources were improvements in organization of the system for emergency obstetric care through a process of tiered oversight. This included programmes for performance improvement and reviews of maternal deaths. In contrast, a study in urban Mexico City in the 1980s revealed that almost all births in the city took place in hospitals. The maternal mortality rate was relatively high, at 114 deaths per 100 000 live births. Eighty five percent of these deaths were deemed preventable and were associated with a lack of quality assurance, a lack of organization and suboptimal use of resources (62, 63).

Several articles have specifically addressed quality improvement programmes in surgery departments in developing countries. In Saudi Arabia, Ashoor et al. reported on the development of a quality assurance programme for an otolaryngology unit. They reported that this programme helped with their resource utilization, including minimizing cancelled cases (64). In Pakistan, Noorani et al. reported on the implementation on a locally designed, inexpensive surgical audit system. They demonstrated improved reporting of chest and wound infections, which led to development of protocols for improved antibiotic prophylaxis (65).

Many of the preceding authors report on the problems of implementing a quality improvement programme in a developing country. These included the lack of an organized data collection system and computers for analysis, failure by governments to provide the necessary initial resources, resistance to the introduction of such a programme by clinicians, for fear of reprisal, and difficulty with definitions of "quality of care" within different societies. However, none of these problems was insurmountable and all of the studies indicated successful implementation of programmes that did lead to improvements in the quality of medical care provided. Moreover, the implementation of a more formal performance improvement process was generally felt to improve upon the existing system of periodic case review meetings (55, 56, 64, 65).

One of the few and best reports on the implementation and effectiveness of a performance improvement programme for trauma care in a developing country comes from the Khon Kaen region of Thailand. At the major hospital in this region, a trauma registry was established in the mid-1990s. This indicated a very high rate of potentially preventable deaths. A trauma audit committee reviewed the process of care on expired cases. A variety of problems were identified, both in the actions of individual practitioners and in the system. This included difficulties in the referral system, the emergency department, the operating theatres and the intensive care unit. One of the difficulties that was noted was inadequate resuscitation for patients in shock, both during referral and in the emergency department. In addition, there was a high incidence of delay in operations for head injuries. Throughout all of this, there were felt to be difficulties with record-keeping and communication among hospital personnel. Corrective action included improving communication by introducing walkie-talkies within the hospital, stationing fully trained surgeons in the emergency department during peak periods, improved orientation about trauma care for new junior doctors joining the surgery team, and improved reporting on trauma care through hospital meetings. Using the trauma registry, they were able to demonstrate that these improvements increased compliance with medical audit filters. These improvements in process were associated with a decline in mortality. Overall mortality among admitted trauma cases decreased from 6.1% to 4.4% (66).

Experience from other countries indicates that such successes should be eminently reproducible. As previously described, a review of trauma admissions at the main hospital in Kumasi, Ghana, revealed notable deficiencies in the process of care, despite availability of resources. These included low use of chest tubes, low use of crystalloid and blood for resuscitation, and prolonged times to emergency surgery. All such items should be readily amenable to improvement through the improved organization provided by programmes for performance improvement (16).

In conclusion, it remains to be determined what types of programmes for performance improvement might play a role in promoting the *Guidelines for essential trauma care*. Formal programmes for performance improvement are especially likely to play a role at larger hospitals with high trauma volumes. Progress might come in the form of improved record-keeping and establishing basic trauma registries (67), and augmenting existing morbidity and mortality conferences by tracking unexpected and preventable deaths. Elements of performance improvement that might be instituted at smaller general practitioner (GP) hospitals still need to be defined. Formal programmes for performance improvement in trauma care are less likely to be indicated. Rather, broader systems for processing management information that address both efficiency and quality assurance for a broad range of issues are likely to be found appropriate (49). However, there is

almost certainly a role for monitoring the process of trauma care as a means of assuring the provision of standards for essential trauma care at all levels of care.

6.3 Trauma team and organization of the initial resuscitation

The resuscitation of severely injured patients usually involves many personnel, and too often takes place in an environment of anxiety and confusion. A well-planned and organized approach to such patients is fundamental to optimal management. Resuscitation implies a coordinated group of actions performed to secure the airway, support breathing and restore circulation. Survival after severe injury depends on promptly re-establishing adequate tissue oxygenation. Hence, critical time limitations apply to the successful performance of the elements of resuscitation. There is thus a need to assure that the personnel and equipment needed for resuscitation are present and utilized in an optimal fashion. Achieving this goal is assisted by appropriate pre-planning and coordination among personnel caring for the injured patient in the field, in the emergency department and elsewhere in the hospital. Such pre-planning and coordination involve equipment and supplies in the emergency area. However, more than anything else, they involve the organization of personnel as addressed by the concept of the trauma team.

Both the American College of Surgeons' Committee on Trauma and the British Trauma Society have emphasized the functioning of the trauma team as a critical element in assuring the quality of trauma treatment in their countries (17, 54). The exact composition of the trauma team varies with local rules, conditions and staffing. However, a key element is organization, with pre-assigned roles for members of the trauma team and protocols to assure rapid assembly and efficient operation of the trauma team.

At hospitals in high-income countries, members of a trauma team typically include the following personnel (17, 68):

- team leader (command doctor);
- airway control (may be a surgeon, anaesthetist, emergency physician or other);
- assistant doctor (as needed);
- primary nurse;
- recorder (usually a nurse; the recorder sometimes takes on some of the duties of the above-mentioned primary nurse);
- airway assistant (respiratory therapist, nurse or other suitable person with the skills needed);
- X-ray technician;
- laboratory technician.

Further details on the roles of each of these team members are presented in Annex 2.

In the above scenario, if there is an abundance of personnel, another doctor may assume the role of primary resuscitator. This person then undertakes the primary and secondary survey, while the team leader has less direct hands-on involvement, but still takes on the duties of coordination, review of data, and formulation of definitive plan. In cases where there is an abundance of nurses, one nurse may take the role of primary nurse. This nurse performs procedures and obtains vital signs as mentioned above, while a second nurse undertakes the documentation and assists the primary nurse as needed.

Some authors from middle-income countries have reported modifications of trauma team set-up to suit local staffing. For example, in South Africa there are no respiratory therapists. Hence, the tasks of the airway assistant in the schema above are handled by nurses with the necessary training in ventilator management. Likewise, in Mexico, the lack of respiratory therapists and shortages of laboratory technicians have led to modifications in the trauma team whereby additional nurses are utilized to perform these functions. In particular, the nurse performing the recorder function is also in charge of making calls and processing orders for laboratory work, X-rays and other services. This person also maintains order in the resuscitation room and is in charge of not permitting the presence of any more people than necessary. One of the extra nurses also assists with airway procedures, locating all the equipment needed and administering whatever medications might be needed as an adjunct to intubation. Finally, paramedics/emergency medical technicians (EMTs) are routinely stationed in the emergency department as a way of promoting their training and experience. One or more such paramedics/EMTs take part in the trauma team. They assist with a variety of the above duties, and in particular assist with the transport of patients to other hospital departments (69).

Almost all of the above experience has been gained either in high-income or middle-income countries, and usually from larger urban trauma centres. There is a need to address the adaptation of the trauma team concept to smaller hospitals, especially those primarily staffed by general practitioners. At these hospitals, there are smaller numbers of professional staff of all types. Typically, there is only one nurse present in the emergency department at night; a doctor on call from home; limited telecommunications with pre-hospital care facilities (if any element of pre-hospital care even exists); limited telecommunications within the hospital; minimal equipment and supplies; and often limited capabilities for emergency referral. None the less, improvements in planning for trauma resuscitation are expected to be beneficial.

In this regard, the experience from the Trauma Team Training course in Uganda (TTT, described in section 6.1) is interesting. This course emphasized effective teamwork in the setting of rural, GP-staffed African hospitals. In a qualitative assessment of the effectiveness of this course, key informant interviews were con-

ducted with course participants, casualty department staff with whom the course participants subsequently worked, hospital administrators and patients. The trauma team training appeared to have improved practical skills and led to more systematic trauma team functioning. It was not yet possible to evaluate an effect on actual outcome (personal communication, Olive Kobusingye, Ronald Lett). Given the promising results from this approach, further expansion and evaluation of the possible role of trauma team organization in rural, GP hospitals is warranted.

Organized trauma teams have been shown to improve the process and outcome of trauma care, primarily in high-income countries. Driscoll et al. examined trauma resuscitations (70). In the presence of an organized trauma team, resuscitation time was reduced by 54%. This was felt to be due to precise task allocation, larger trauma teams and the adoption of simultaneous rather than sequential resuscitation. The involvement of an experienced senior trauma team leader, who was not actively involved in the physical aspects of resuscitation, was found to help to shorten resuscitation times. Likewise, consistent positioning of all trauma team members promoted smooth personnel interaction and efficient completion of assigned tasks. Vernon et al. looked at the effectiveness of improvements in a multidisciplinary paediatric trauma team (71). The improved organization resulted in shorter times to CT scanning for head-injured patients, shorter times to the operating theatre for emergency procedures, and decreased total times in the emergency department. Another British study reported that the new establishment of trauma teams at a district hospital had resulted in a reduction in preventable deaths. This study emphasized that such establishment of new trauma teams could be accomplished at virtually no cost, included ATLS training (see section 6.1) as a necessary component and relied on adequate recording of information to allow ongoing audit of trauma team function (72).

Several other studies have looked at specific elements of the functioning of the trauma team. Hoff et al. (68) showed that an identified team leader (command-physician) improved trauma resuscitation. Compared with trauma resuscitations without a designated team leader, those resuscitations which had a team leader had an increased proportion of completed secondary surveys and formulated definitive plans. Likewise, the presence of a designated team leader improved the orderliness of resuscitations and adherence to ATLS guidelines. A similar study from Australia reviewed fifty trauma resuscitations. In this, the function of the team leader was analyzed using a team leader score. This demonstrated that the major shortcomings in trauma resuscitations in their hospital related to interpersonal communications with other members of the team and adequacy of documentation (73).

There has been some preliminary evidence for the utility of the organization of trauma teams in several developing countries (66, 74, 75). For example, in the

aforementioned development of the system for trauma management in the region of Khon Kaen, Thailand, improvements in the trauma team in the emergency department constituted a critical component of efforts to improve trauma care at that hospital. These improvements included increasing senior surgical involvement in the emergency department during peak hours, and increased communications between the trauma team in the emergency department and other personnel elsewhere in the hospital. As previously noted, such changes, along with other changes in the functioning of the hospital, were associated with improved process and decreased mortality of trauma patients (66).

Likewise, in Turkey, the new establishment of a trauma team at an urban trauma centre improved on previously haphazard care. The mortality of patients with injuries severe enough to warrant admission to the general surgery service decreased from 33% to 23%. There was a decrease in unexpected deaths. These improvements were felt to be particularly due to improved resuscitation of patients in shock and improved airway management, especially advanced airway management including endotracheal intubation (76).

The above examples indicate that improvements in trauma team organization can be a cost-effective way of facilitating the implementation of the *Guidelines for essential trauma care*. Finally, physical resources for improved trauma resuscitation also need to be addressed. These include such issues as the configuration of the trauma resuscitation area and the immediate availability of equipment. The physical space should be sufficient to hold a patient, the necessary personnel and the equipment. It should be well lit and access should be limited, in order to prevent non-essential personnel from disrupting resuscitation activities. Instruments and equipment should be available to perform emergency procedures such as endotracheal intubation, cricothyroidotomy, chest tube insertion and peritoneal lavage. Pre-assembled materials for these procedures should be kept immediately available in the resuscitation area. Likewise, emergency medications should be immediately available. These include drugs needed for paralysis and intubation, analgesics, medications for cardiac resuscitation and antibiotics. To the extent that infrastructure permits, the resuscitation area should include telephones or other means of communication with personnel in the rest of the hospital, such as staff who are on call but not stationed in the emergency area (17).

6.4 Hospital inspection

All countries have some mechanism, however rudimentary, for monitoring the functioning of their hospitals. This is especially true in locations in which a significant portion of health care is provided by government-run hospitals. It also comes in the form of accreditation of hospitals, whether they be private or public.

Hospital inspection and related accreditation has proven to be an important part of the development of systems for trauma management in high-income coun-

tries. A brief review of this process is instructive. However, any process of hospital inspection and review related to the implementation of the *Guidelines for essential trauma care* in low- and middle-income countries would be quite different in both form and substance. Usually, some political jurisdiction is responsible for designating which hospitals should play what roles in an organized system for trauma management, varying from large urban trauma centres to small rural hospitals. For example, a choice may have to be made between several large urban hospitals as to which one should be the level-I (highest level) trauma centre for a given city. This would imply that it would receive the necessary resources to function at this level. It would also include the establishment of pre-hospital triage guidelines so that the most seriously injured patients in that particular city are taken by preference to this hospital. Similar considerations would apply to choosing among several potential medium-sized hospitals in suburban areas or larger towns.

In terms of rural hospitals, such planning of systems for trauma management would also imply choosing between potential alternatives in widely dispersed rural areas, as well as assuring that smaller hospitals that do provide a certain minimal level of trauma care are brought up to an expected minimum standard. Such “designation” is accompanied by a process of inspection and verification or accreditation. This may be performed by a governmental body. However, it is usually performed by an independent, qualified, professional organization. For example, in the United States, the individual states designate the level of capability at which hospitals are to function in a system for trauma management. However, it is the American College of Surgeons (ACS) that performs the actual hospital inspection and verification. The criteria that hospitals must meet to be designated at various levels of trauma care are laid out in detail in the publication *Resources for optimal care of the patient*, to which we have alluded in the earlier parts of these *Guidelines for essential trauma care*. Similar situations exist in Canada and Australia, where the Trauma Association of Canada (22) and the Royal Australasian College of Surgeons (RACS), respectively, provide such inspection.

One note on terminology is warranted here. The term “trauma centre” verification is often used. However, it is really the trauma service of a given hospital that is inspected and verified. This is true no matter the size of the hospital. Hence, the concept of inspection and verification should not be construed as pertaining only to large urban hospitals providing primarily trauma care. It pertains to hospitals of all sizes that provide trauma care among other services.

Typically, a verification review of a hospital lasts two days. It is usually carried out by a team consisting of two general surgeons or one general surgeon with an emergency physician, neurosurgeon, orthopaedic surgeon, anaesthesiologist, hospital administrator or trauma nurse coordinator. Before the visit, a questionnaire has been administered to the hospital administrator and/or chief of the

trauma service. This is reviewed by the team with key personnel from the hospital. The actual site visit occurs the following day and usually takes six hours. The team makes a one- to two-hour tour of the whole hospital, emphasizing the emergency department (casualty ward or wherever else trauma patients are first seen and evaluated), trauma resuscitation areas, radiology department, laboratory, blood bank, operating theatre and intensive care units. Following this, a review lasting three to four hours is made of randomly selected patient records, as well as all trauma deaths from the preceding year. This is utilized to make an assessment of the quality of care rendered and the functioning of quality improvement programmes for trauma. Specific cases are tracked through the quality improvement programmes to see how potential problems are identified and dealt with. During the review, approximately 100 criteria are used. Most apply to all levels of hospitals. However, there are several criteria, such as sub-specialized clinical services and research, which apply only to level-one trauma centres (77, 78).

A review of verification visits of 179 hospitals showed that the leading factor associated with unsuccessful review was absence or deficiencies in programmes for performance improvement. The second leading item was lack of an organized trauma service, including a trauma service director. The third most common deficiency was lack of documentation for the presence of a general surgeon in the emergency department for the resuscitation of critically injured patients (77, 78).

The authors of the summary of verification reviews felt that programmes for performance improvement were not well understood and that more emphasis on these was needed in the development of systems for trauma management. Examples of deficiencies in performance improvement included failure to correct problems that had been identified, lack of documentation of physician response times in particular, failure to adhere to protocols, failure to attend a regular multidisciplinary performance improvement conference and failure to utilize an existing trauma registry to support a performance improvement programme. The next major criterion associated with unsuccessful reviews was the lack of an organized trauma service. In most such cases, there were groups of surgeons caring for trauma patients independently, without any oversight by a trauma director, nor any coordination between the surgeons (77, 78).

The third most common deficiency was the lack of documentation of a trauma surgeon's presence in the emergency department at the time of arrival of a critically injured patient. This was felt to arise most often from inadequate trauma alert protocols, with a lack of coordination between surgical services and doctors in the emergency department. It was also felt to reflect a general lack of commitment by the surgical staff to trauma care.

It was interesting to note that actual deficiencies in hospital facilities, such as personnel, equipment and supplies, were rarely identified (at least in the higher-

income setting) and were rarely the cause of unsuccessful verification reviews. It was rather organization, performance and appropriate utilization of the resources that constituted the problem.

The accreditation process itself has been shown to improve the functioning of a trauma centre. This has been demonstrated through an improved process of medical care, with fewer deficiencies being noted after completion of a review process. It has also been shown by a decrease in mortality of seriously injured patients (79). Such verification of trauma centres has been identified as an integral part of the overall development of systems for trauma management (22).

It would be reasonable to adapt the trauma centre verification process, as described above, to efforts to promote the *Guidelines for essential trauma care*. This would be conceptually similar to the trauma centre verification process in high-income countries. However, it would need to be significantly amended to suit the system of accreditation, management and supervision of hospitals and health facilities already existing in a given country. For example, EsTC criteria, especially those of high importance and impact, might be added to existing review processes. On the other hand, specific review of trauma treatment facilities might be reasonable for hospitals with large numbers of trauma patients.

6.5 Integration of systems for trauma management

These guidelines have focused on specific facilities. As mentioned elsewhere, assuring the resources available at given facilities is part of an overall system for trauma management (section 2.4: Efforts to improve trauma care in individual countries). This also involves political jurisdictions designating hospitals to fill roles of varying levels of complexity of trauma care (section 6.4). It also implies planning for pre-hospital emergency medical services (EMS), pre-hospital triage, transfer criteria and transfer arrangements between hospitals. To put the role of these guidelines more clearly into perspective, each of these will be briefly considered.

Pre-hospital triage

In locations with well-organized EMS and with several alternative hospitals at varying levels of trauma capabilities, a refinement on the organization of systems for trauma management is to establish pre-hospital triage criteria. This implies that the more severely injured patients would be taken to the nearest suitable hospital and not necessarily the geographically nearest hospital. Hence, this involves bypassing nearby, but less well-equipped hospitals with the more severely injured patients, assuming that the transport time to the better equipped hospital is not inordinate. This is based on training EMS personnel in various triage criteria, including the use of scoring algorithms such as the trauma score and the pre-hospital index. This also implies detailed, pre-existing arrangements with the EMS and the hospitals in a given city or area.

Designation of trauma centres

The above also implies that a given political jurisdiction has worked out such arrangements with the hospitals. This is usually accompanied by the process of trauma centre designation, which is slightly different from the concept of verification mentioned earlier. Designation implies that the political jurisdiction has made a selection among various alternative hospitals as to which ones should be expected to meet varying criteria of trauma capability (ranging from small rural hospitals up to large urban trauma centres).

Referrals and inter-hospital transfer

As another part of planning of systems for trauma management, the relationship between hospitals is often considered. This includes transfer criteria specifying which types of injuries or levels of severity of injury should be transferred from smaller hospitals to larger ones. It also includes inter-hospital transfer agreements and protocols to facilitate such transfer. The goals of such transfer agreements and protocols are to decrease the time needed to carry out the transfer of a critically injured patient; to assure that the transfer is carried out in such a way as to diminish the probability of problems during transport; and to optimize care at each end of the transfer by assuring the necessary communication between medical providers at each end. These types of formal arrangements have hitherto primarily pertained to high-income countries. However, in almost every environment an informal system has arisen to assess which types of problems cannot be handled at smaller hospitals and hence are referred to larger facilities. This also considers which larger facilities are willing and able to take these patients, as well as the manner in which transport of such patients is arranged and paid for. Some of the same principles apply as discussed above, though in different formats, depending on local political considerations. However, the basic principle of knowing the capacity of each institution remains. Some progress might be made, even in greatly varying contexts, through a clearer definition of which specific injuries or level of injury severity might particularly benefit from referral in a given environment (10).

Communication

Necessary components of planning of systems for trauma management include communication and transport. Communication takes into account the radio communication between EMS units and receiving hospitals. Prior notification by such radio communication allows trauma team activation and preparation for immediate care of severely injured patients upon arrival. Communication also takes into account designated telephone numbers and assigned tasks for transfer of patients between hospitals. Pre-existing transfer agreements can help to streamline such processes.

Transport

As mentioned earlier, transport in the pre-hospital setting by mobile EMS units is considered in a related WHO document. Also to be considered in the planning of systems for trauma management are arrangements for transport for inter-facility transfers, as mentioned above. This can be streamlined by including it in transfer protocols. There are, of course, several barriers to the transfer of injured patients to higher levels of the health care system. One of these may be a preference on the part of the injured person or the family to stay in the local area. Other such barriers include cost and logistical limitations (2, 10). For example, in many low-income settings, such transport must be arranged by relatives who hire a private vehicle, taxi or other means of commercial transport for this purpose. Economic barriers to formal EMS for such transport are obviously a huge consideration. Nevertheless, facilitating such transfer might reasonably be a component of an overall plan of systems for trauma management. Similar issues have been addressed by the Safe Motherhood Initiative, which has looked at how to assure emergency transport for patients with obstetric complications in more remote rural areas. Some potential solutions have included pre-existing arrangements with owners of private or commercial vehicles to provide emergency transport for reasonable prices.

Settings with no formal EMS

Most of the above issues of pre-hospital triage and radio communication pertain to systems for trauma management as organized in high-income countries. Many of these issues may also pertain to some middle-income environments in which EMS and a better telecommunications infrastructure exist. Nevertheless, some of the above principles apply to organization of trauma care systems even in low-income countries. This may apply even in settings where there is no formal EMS. For example, in Ghana a pilot programme assessed the potential utility of basic first-aid training for commercial drivers. These commercial drivers were already the ones transporting most of the severely injured patients who did make it to a hospital. The pilot programme demonstrated an improvement in basic first-aid manoeuvres performed by these drivers. Among these was the use of triage. Such triage was not related to the concept of bypass of facilities as mentioned above, but rather to identifying which of many casualties (e.g. in bus crashes) might benefit most from being transported first to nearby hospitals (80, 81).

Siting of facilities

The concept of trauma centre designation may also play a role in terms of siting of trauma care facilities according to geographic distribution and need. It would be of potential benefit to consider which hospitals of given levels might reasonably be targeted for improvements to reach specific criteria for essential trauma

care. For example, GP-staffed hospitals located on major roadways with high trauma volumes may be reasonably targeted to assure that they meet the minimum criteria laid down in these guidelines.

Data and injury surveillance

Finally, any efforts to improve systems for trauma management need to include provisions for ongoing evaluation. For this purpose, there is a need for accurate data on the occurrence of injuries and related deaths. Improvements in systems for trauma management in most locations will of necessity include efforts to augment existing sources of data about injury and to assure the quality and timely availability of the data (24).

All of the above factors are elements that might reasonably be addressed on national levels as ways to improve the care of injured patients. The recommendations in these *Guidelines for essential trauma care* address one specific component of this broader planning of systems for trauma management: that of capabilities of fixed facilities.

6.6 Interaction and coordination of stakeholders

As previously indicated, EsTC builds on two foundations: the essential services approach of international health and the development of systems for trauma management of individual countries. Each of these involves a variety of political modes of implementation:

- central planning through ministries of health;
- promotion through professional societies and networks (such as the Prevention of Maternal Mortality Network in West Africa);
- technical assistance from WHO headquarters, regional offices and country offices;
- laypeople in grass-roots lobbying, as involved in promoting essential drugs programmes.

It is envisioned that the EsTC process in individual countries might involve similar interplays. This might involve such activities as professional societies involved with trauma care in individual countries meeting with members of the Ministry of Health. One or both might draw up a preliminary plan for what needs to be promoted on the basis of a local adaptation of the *Guidelines for essential trauma care*. This might result in widespread and, hopefully, low-cost improvements in trauma services. It might also result in pilot projects in limited geographic areas with appropriate research into operations and assessment of outcomes to decide how best to scale up such activities nationwide.

Throughout all of this, there could be a role for lay groups, including survivors or relatives of people killed or disabled by trauma. Such concerned citizens might

help to exert the needed influence to help promote implementation of these guidelines. Unfortunately, there is a growing number of such individuals worldwide.

When efforts to improve trauma services according to the *Guidelines for essential trauma care* are undertaken, we must consider how these will ultimately be provided and how they are to be integrated into existing governmental administrative structures. The current guidelines focus on facility-based trauma care. However, the trauma care delivery system in a country, a province or a given geographical area encompasses all phases of care, from pre-hospital care to acute care and rehabilitation. It is important that good coordination be ensured between all components of trauma care. In addition, the success of a programme for essential trauma care in a given country will depend on its implementation and dissemination at the grass-roots level, enactment of the guidelines in national policies, and constant monitoring and evaluation of the programme. To facilitate the above-mentioned tasks, it is recommended that appropriate institutional mandates be created at national, provincial and local levels, where such authority does not already exist. National governments need enhanced capacity to be able to focus upon and act to upgrade their trauma services.

In many countries, emergency services, including those for trauma care, are monitored collectively by an EMS authority. Diverse arrangements are operational in some health systems in some countries, and even provinces within a country. Local circumstances may require an existing apex agency to adopt EsTC as an additional responsibility.

An EsTC programme in a country should preferably be led by a national agency, which should build broad consensus about the *Guidelines for essential trauma care* nationally and allow accommodation of local ideas and innovations. The Guidelines constitute a flexible template. Innovative ideas to augment physical or human resources with local input will ensure a sense of ownership among local stakeholders. Such an agency should represent all stakeholders in the delivery of trauma care, including representatives with political, administrative, professional and technical backgrounds. Donor agencies, voluntary organizations and community groups may be included. Larger countries and provinces may wish to organize an appropriate hierarchy for EsTC in smaller geopolitical areas to maintain smooth functioning and coordination.

6.7 Progress to date

A basic premise behind the Essential Trauma Care Project is that improved planning and organization will improve the process and outcome of trauma care. As mentioned throughout this document, these guidelines are intended to serve as a flexible template to assist with such planning. It is also intended to serve as a catalyst to promote improvements in systems for trauma management in individual countries.

In this regard, some progress has taken place, even as the guidelines have been going through the finalization process. The EsTC criteria have served as the basis for needs assessments made in the Hanoi area of Vietnam, in Ghana (nationwide) and in Mexico (nationwide). These needs assessments have been arranged by concerned individuals interacting with their own ministries of health. In the case of Mexico, the needs assessments have involved the participation of a professional society, the Asociación Mexicana de Medicina y Cirugía del Trauma (Mexican Association for the Medicine and Surgery of Trauma—AMMCT). The *Guidelines for essential trauma care* have been endorsed by the AMMCT and the Ghana Medical Association.

In one case, a group of stakeholders has come together, as outlined in section 6.6 (Interaction and coordination of stakeholders). In the state of Gujarat, India, the following groups have been working together to adapt and implement the EsTC criteria: state government (ministry of health), the Gujarat sub-country office of the WHO, representatives of IATSI/ISS, local professional groups (including the Indian Academy of Traumatology and the Indian Orthopaedic Association) and several nongovernmental organizations. These groups have: (a) adapted the *Guidelines for essential trauma care* to local circumstances, which has involved changing the status of some of the items designated as desirable to essential, in keeping with the availability of resources in the area; and (b) creating working groups of representatives of the above stakeholders to develop plans for implementation.

The above-mentioned assessments of needs, local adaptations and interactions of stakeholders provide examples of the use of the *Guidelines for essential trauma care* in the manner in which the document is intended to be used. The authors hope such activities will continue and expand.

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ANNEX I

Detailed list of equipment and services for the management of airway and breathing (both essential and desirable items)

Airway

Level of management	Service	Equipment
Basic	Jaw thrust, chin lift, and other basic manoeuvres	Tongue depressor Oropharyngeal airway (range #000 to 4) Nasopharyngeal airway
	Suction	Manual (bulb syringe, foot pump or hand-powered suction device) Pneumatic (wall) Electric Yankauer tips Suction catheters Suction tubing (range #10–16)
Advanced	Endotracheal intubation	ET tubes with ET tube connector (range #3.0 to 8.5 mm internal diameter) Laryngoscope (with sufficient range of sizes of blades) Introducing stylet/bougie
	Other advanced	Laryngeal mask airway (LMA) Oesophageal obturator airway/oesophageal gastric obturator airway Oesophageal–tracheal airway (combitube) Fibre-optic endoscope Transilluminator Magill forceps
	Surgical airway	Needle cricothyroidotomy Surgical cricothyroidotomy

Breathing

	Face shield Pocket mask Self-inflating bag–valve–mask (paediatric and adult) with reservoir Mask Ventilator Oxygen supply: Wall (with flow meter) Tank (with regulator and flow meter) Nasal cannula Nebulization masks Venturi masks
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ANNEX 2

Composition of a typical trauma team (as organized in a high-income country: American College of Surgeons Committee on Trauma (17); Hoff et al. (68))

Team leader (command physician)

Responsibilities:

- initial assessment and survey
- coordinates all team activities
- performs or assists with procedures
- review of all data
- coordination of diagnostic interventions
- formulation of definitive plans.

This team member usually stands at the right side of the bed, near the patient's head. In cases in which there is an abundance of personnel and another team member is actually undertaking initial assessment and survey and performing the procedures, the team leader may stand at the foot of the bed.

Airway control

(may be a surgeon, anaesthetist, emergency physician or other)

Responsibilities:

- establishes clear airway
- intubates
- performs or assists with procedures
- insertion of nasogastric tubes
- administers medications as directed by team leader.

This person typically stands at the head of the bed.

Assistant doctor (as needed)

Responsibilities:

- assists team leader
- exposes patient
- performs surgical procedures.

Typically stands on the left side of the bed.

Primary nurse

Responsibilities:

- calls alert
- prepares area
- records vital information
- takes vital signs

- intravenous access and phlebotomy
- supervises placement of monitors
- passes equipment
- assists with surgical procedures.

Typically stands on the left side of the bed.

Recorder

(usually a nurse, sometimes takes on some of the duties of the above-mentioned primary nurse.)

Responsibilities:

- documents resuscitation

assists primary nurse as necessary.

Typically stands towards the foot of the bed, slightly removed from the bed unless actively involved in procedures.

Airway assistant

(respiratory therapist, nurse or other suitable person with needed skills)

Responsibilities:

- assists with airway control
- sets up mechanical ventilator
- places monitoring devices.

Typically stands slightly behind and beside the person administering airway control.

X-Ray technician

Responsibilities:

- performs X-rays as directed by team leader.

Typically stands away from the patient and the rest of trauma team, except as needed for the performance of X-rays.

Laboratory technician

Responsibilities:

- assists with phlebotomy
- transport and processing of specimens.

Typically stands away from the patient and trauma team, except as needed to perform procedures.

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