Chapter **68**

Emergency Medical Services

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INTRODUCTION

Emergency medical conditions typically occur through a sudden insult to the body or mind, often through injury, infection, obstetric complications, or chemical imbalance; they may occur as the result of persistent neglect of chronic conditions. Emergency medical services (EMS) to treat these conditions include rapid assessment, timely provision of appropriate interventions, and prompt transportation to the nearest appropriate health facility by the best possible means to enhance survival, control morbidity, and prevent disability (see table 68.1). The goal of effective EMS is to provide emergency medical care to all who need it. Advances in medical care and technology in recent decades have expanded the parameters of what had been the traditional domain of emergency services. These services, no longer limited to actual in-hospital treatment from arrival to stabilization, now include prehospital care and transportation.

Despite the best efforts of primary care providers and public health planners, not every emergency is preventable. Emergency medical care is needed in diverse circumstances: prospective patients range from rural farmers or fishers whose most common mode of transportation may be canoes or animal-drawn carts, to factory workers living in densely populated urban slums, to residents of high-income cities and suburbs. Actual provision of emergency care may range from delivery using trained emergency professionals to delivery by laypeople and taxi drivers. Developing strategies to meet the range of needs posed by such diverse circumstances will require innovation and a reorientation of public health planning.

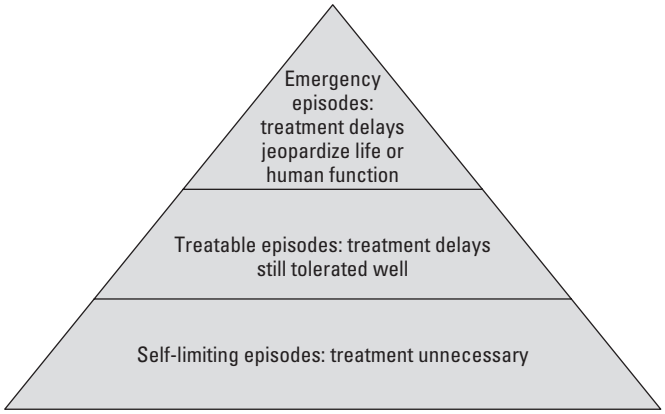
A number of misconceptions about emergency care are often used as a rationale for giving it low priority in the health sector, especially in low-income countries. These ideas include equating emergency care with ambulance transportation, neglecting the role of the community and facility care provided, and assuming that emergency departments and physicians are the only acute care resources. Such a narrow view ignores the important contributions of other disciplines, skills, and personnel. Perhaps the most common misperception is that emergency medical care is inherently expensive and requires high-technology interventions as opposed to simple and effective strategies.

Emergency care, which may be delivered in crisis situations with poor planning and ineffective use of resources, may be inefficient**.** In many countries, few resources are set aside for possible emergencies, and when situations that demand emergency care arise, they precipitate hurried and costly resource deployment. Efforts to improve emergency care, however, do not necessarily increase costs. This chapter shows that improved organization and planning for emergency care can be done at a reasonable cost and lead to more appropriate use of resources, improved care, and better outcomes (White, Williams, and Greenberg 1996). This chapter does not address nonacute conditions, even though emergency care is often the only recourse for people with nonemergency conditions because of the failure of these other components of the system (see figure 68.1).

Table 68.1 Overview of Emergency Medical Services

	Acute event	On-site management	Transportation	Health facility care
Role of EMS	Recognition	Triage, stabilization, or both	Safe and efficient transportation	Prompt, appropriate, and quality care
Key issues	Surveillance and identification	Trained personnel, equipment	Safe transportation, equipment, referral system	Personnel, equipment, organization of services

Source: Authors.



Source: Authors.

Figure 68.1 The Emergency Medical Care Pyramid

Definitions

The current literature is often inconsistent in the use and interpretation of terminology. Accordingly, the specific terms used in this chapter are defined as follows**:**

- *Emergency care.* Emergency medical care is that care delivered in the first few hours after the onset of an acute medical or obstetric problem or the occurrence of an injury, including care delivered inside a fixed facility.
- *Paramedical personnel.* Paramedical personnel refers to all persons with medical training who are involved in the care and transportation of patients in need of emergency medical care. The length and quality of training vary, from highly specialized personnel with capabilities for advanced life support to those with simple first-aid training and limited field experience.
- *Hospital.* A hospital is a geographically fixed facility in which personnel with some acceptable level of training deliver emergency medical care. The distinctions between a clinic, health center, and hospital are unclear, and the presence or absence of a doctor is not a determining factor in this distinction. A range of facilities from small, basic units up to tertiary care hospitals provides an increasing level of capability for emergency and other care.
- *Triage.* Triage is the screening of patients in the field or in the receiving area of a fixed facility to determine their relative priority for treatment. Triage, which is usually necessary in the occurrence of mass casualties, may be necessary whenever a large number of patients requiring emergency care present at the same time. It typically entails categorizing patients into three groups: those very unlikely to survive, even with treatment; those whose conditions are minor and who will recover without emergency care; and those with potentially lethal conditions who are likely to survive if they receive timely emergency care. Patients in the last category form the highest priority for emergency care.
- *Stabilization.* A distinction is often made between initial emergency care and stabilization on one hand and definitive medical care on the other. Initial emergency care and stabilization are usually considered the domain of mobile EMS; lower levels of the health care system (for example, clinics and smaller hospitals); and the emergency departments of any fixed facility. Definitive care is usually considered the domain of the hospital and of larger facilities and implies the resolution of the condition needing treatment. However, the distinction is somewhat arbitrary; a more accurate approach is to view care as a continuum. Many of the elements of early care delivered in the course of emergency treatment, whether in the field or in fixed facilities, can be considered definitive (McCord and Chowdhury 2003; McCord and others 2001).

Burden of Disease

Investing in emergency medical care should become a priority. Emergency medical systems address a diverse set of diseases that span the spectrum of communicable infections, noncommunicable conditions, obstetrics, and injuries. All of these conditions may present to the EMS in their acute stages (for example, diabetic hypoglycemia, septicemia, premature labor, or asthma), or they are acute in their natural presentation (for example, myocardial infarction, acute hemorrhage, or injuries). Accordingly, defining the burden of disease addressed by EMS can be problematic.

Malaria causes 300 to 500 million acute episodes worldwide annually and results in an estimated 1 million deaths, mostly in Sub-Saharan Africa. Effective emergency care can avert these deaths, as well as those from acute respiratory and diarrheal diseases in children and from noncommunicable diseases such as diabetes, hypertension, and other cardiovascular diseases. In addition to the acute presentation of chronic conditions, the

lack of access to medical care and lack of sustained effective treatment means that subacute episodes and flare-ups may be life threatening. Early recognition can prevent the emergency precipitated by infectious disease and many other medical conditions or can limit the effects.

More than 500,000 maternal deaths occur each year; 95 percent of these deaths are in low-income countries where emergency care is often lacking. It is estimated that 15 percent of all pregnant women experience a potentially life-threatening condition and will need emergency care. Prenatal screening methods alone may not be effective in reducing this risk ratio. Although identifying risk factors for acute complications is easy, identifying which of the at-risk women will actually develop a life-threatening condition is not possible (Graham 1997). The only way to prevent the deaths is by ensuring access to emergency obstetric care for all pregnant women.

Injuries were responsible for 21.7 percent of global deaths and 31.1 percent of disability-adjusted life years (DALYs) lost in 2001 (WHO 2002). Because both unintentional injuries (chapter 39) and injuries caused by interpersonal violence (chapter 40) are by definition acute events, nearly all require emergency care (see table 68.2). In 2001, more than 80 percent of all deaths attributable to injury were in low-income countries. Most injuries attributable to violence involve a predominantly young and productive population (WHO 2002) that is resilient and can respond well to appropriate emergency care.

The conditions listed in table 68.2 represent 45 percent of all deaths and 36 percent of the disease burden (including disability) that occur in low-income countries. The numbers represent a conservative estimate of the potential burden, because they do not include all the conditions that could benefit from emergency care and they do not include data from high-income countries.

INTERVENTIONS FOR EMERGENCY CARE: SYSTEMS, STRUCTURES, AND ORGANIZATION

Emergency care must be appreciated as an entire system with interdependent components. These components include prehospital care, transportation, and hospital care. Each component is important, but all of them must work together to make a lasting effect on the health of a population. The organization and operation of the prehospital care system will vary by country, but it should be linked to the local hospitals or facilities where patients are taken. When prehospital transportation is poor or absent, deaths occur that could have been prevented even by inexpensive procedures (Mock and others 1998). For example, the majority of maternal deaths may fall into this category. Poor quality of care at the hospitals will lead to in-hospital deaths and may eventually discourage communities that might have the capacity to promptly transfer patients to such facilities (Leigh and others 1997; Prevention of Maternal Mortality Network 1995). Skilled and motivated personnel, appropriate supplies, pharmaceuticals, equipment, coordination, and management oriented to the needs of the critically ill

Table 68.2 Burden of Diseases Potentially Addressed by EMS in Low- and Middle-Income Countries *(2001, all ages, both sexes)*

Group	Disease	Deaths (thousands)	DALYs (thousands)	DALY rates/1,000 population	YLL (thousands)	YLD (thousands)
I: Communicable	Diarrheal diseases	1,777	58,697	11.25	50,883	7,835
	Childhood cluster[a]	1,362	43,131	8.26	40,506	2,624
	Maternal conditions	507	26,383	5.05	13,363	13,020
	Meningitis	169	5,475	1.05	4,343	1,131
	Malaria	1,207	39,961	7.66	35,461	4,438
II: Chronic	Diabetes	757	15,804	3.03	10,140	5,661
	Hypertensive heart	760	9,969	1.91	9,077	888
	Ischemic heart	5,699	71,882	13.77	67,925	3,921
	Cerebrovascular	4,608	62,669	12.01	51,539	11,100
	Asthma	205	11,514	2.21	3,799	7,714
III: Injuries	Unintentional	3,214	113,235	21.70	73,140	40,104
	Intentional	1,501	42,615	8.16	34,374	8,242
	Total EMS related	**21,766**	**501,335**	**96.06**	**394,550**	**106,678**
	Percentage of LMIC total	45	36		43	22

Source: Global Burden of Disease Project 2001.

YLL = years of life lost to premature mortality; YLD = years lived with disability; LMICs = low- and middle-income countries.

a. Pertussis, poliomyelitis, diphtheria, measles, and tetanus.

all contribute to make emergency care effective in reducing death and disability.

Prehospital Care

Prehospital care encompasses the care provided from the community (scene of injury, home, school, or other location) until the patient arrives at a formal health care facility capable of giving definitive care. This care should comprise basic and proven strategies and the most appropriate personnel, equipment, and supplies needed to assess, prioritize, and institute interventions to minimize the probability of death or disability. Most effective strategies are basic and inexpensive, and the lack of high-tech interventions should not deter efforts to provide good care. Even where resources allow them, the more-invasive procedures performed by physicians in some prehospital settings, such as intravenous access and fluid infusion or intubations, do not appear to improve outcomes, and evidence suggests that they may, in fact, be detrimental to outcomes (Liberman and others 2003; Sampalis and others 1994, 1995, 1997).

Prehospital care should be simple, sustainable, and efficient. Because resource availability varies greatly among and within countries, different tiers of care are recognized. Where no formal prehospital system exists, the first tier of prehospital care may be composed of laypeople in the community who have been taught basic techniques of first aid. Recruiting and training particularly motivated citizens who often confront emergencies, such as drivers of public transportation, to function as prehospital care providers can add to this resource.

The second tier comprises paramedical personnel who use dedicated vehicles and equipment and are usually able to get to patients and take them to hospitals within the shortest possible time. This second tier may involve the performance of advanced procedures, the administration of intravenous and other medications by physician or nonphysician providers, or both. This care is not always available in low-income countries; few trained personnel and inadequate funding make round-the-clock coverage impossible. Although providing advanced life-saving measures in the prehospital environment may be beneficial in some cases, these benefits may be negated if such measures divert scarce resources from more basic interventions that can benefit far larger numbers of patients (Hauswald and Yeoh 1997). In most low- and middle-income countries of Africa, Asia, and Latin America, high maternal and child mortality are linked to inadequate emergency care, especially poor access to quality hospital care. In these settings, it is imperative that resources be integrated, instead of one system for injuries and another for obstetric emergencies.

Personnel. Most of the world's population does not have access to formal prehospital care. No personnel are employed for the sole purpose of dealing with medical emergencies outside of hospitals, and no transportation is dedicated to the task of getting patients in need of emergency care into hospitals. There is a paucity of literature on the effect of first responders, except for one study that evaluated a program to train a core group of paramedics, who then trained thousands of lay first responders in northern Iraq and Cambodia. No data are available on the effectiveness of lay responders compared with the more trained paramedics.

The following discussion introduces a scenario in which the observed mortality rate reduction could be achieved in a developing country's health system by a small group of paramedics working together with a large group of trained lay responders. The scenario uses only emergencies caused by trauma, although it is expected that both the paramedics and the lay first responders would also save lives from medical or obstetric emergencies. Existing studies have not been large enough to document these effects, and they are not included in the estimates of cost-effectiveness.

Trained Lay Responders A case is made for training lay persons able to recognize threatening conditions—whether obstetric, traumatic, or medical. Cultural reasons may require that those responding to obstetric emergencies be traditional birth attendants or similar persons in the community. Husum and colleagues demonstrated that lay people who are given first-aid skills could effectively respond to emergencies in a community with a high trauma burden (Husum, Gilbert, and Wisborg 2003; Husum, Gilbert, Wisborg, and others 2003). In Ghana, it was demonstrated that commercial taxi and minibus drivers trained in first aid could provide effective prehospital care (Mock and others 2002). Lay responders are likely to be successful where the burden of injuries and other emergencies is high. Attrition of both the responders and the skills is a concern unless they are put to frequent use.

Paramedical Personnel In most middle-income countries and some cities of low-income countries, trained paramedical personnel render prehospital care (Mock and others 1998; Tannebaum and others 2001). As for lay responders, coverage varies by country. In most of Sub-Saharan Africa and Asia, paramedical personnel and ambulances transfer patients between health facilities and not from the scenes of injury or from homes (Joshipura and others 2003). In middle-income countries, though, they are a major component of existing emergency medical systems (Arreola-Risa and others 2000; Mock 2002). Their presence (coupled with vehicle ambulances) reduces the interval between the recognition of an emergency and the arrival at the hospital, and some evidence suggests that training them in basic life-saving skills improves patient outcomes (Ali and others 1997, 1998; Arreola-Risa and others 2000).

Effectiveness has also been demonstrated for well-placed dispatch sites in urban populations, where the vehicles and

personnel can be optimized. There is no evidence, however, for the effectiveness of training prehospital care paramedical personnel in advanced life-saving skills (Sethi and others 2003). Shorter prehospital times, in general, are considered an important parameter of the quality of prehospital care. These times have the following components:

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

Notification time is influenced by the availability of telecommunications. Response time is influenced by the capabilities of a dispatch center to handle emergency calls and especially by the geographic distribution of sites of ambulance dispatch. The greater in number and the more widely distributed the number of ambulance stations are, the shorter the response times are.

Geographic distribution and associated response times can be improved in some circumstances by using a tiered or layered response system. This system requires having a relatively larger number of basically trained and equipped first responders with wider geographic distribution and a smaller number of centrally located, more highly trained and equipped second responders. This system allows the first responders to respond more rapidly, with second responder involvement only if needed (Arreola-Risa and others 1995).

Accordingly, paramedical personnel should be introduced in large urban areas where they do not function at present and should be stationed at dispatch sites with dedicated vehicles, fast communications with the hospitals in the area, and links with other emergency services such as the fire and police departments. The communities served by the system should have a well-known and rapid method of calling the paramedical teams when an emergency arises. Because skills depreciate with time, these personnel require refresher courses. Where paramedical personnel already exist as part of the EMS, their numbers and organization (location, training, deployment, and monitoring) should be enhanced to improve response times and, hence, patient outcomes, especially for cardiac and obstetric emergencies. Availability of EMS for a given population can be looked at either as number of units on duty or number of sites of ambulance dispatch. They are usually closely related, with one or two units per site, but not in systems where a large number of units are on duty from one central dispatch station.

The recommended ratio of one unit for 50,000 people suggested by McSwain (1991) results in response times as low as four to six minutes. The ratio does not distinguish between basic life-support and advanced life-support capabilities. Traffic congestion, poor maps, and poor road signs may all increase this response time in cities with poor infrastructure. In Monterrey, Mexico, one unit per 100,000 people manages an average response time of 10 minutes. Hanoi, Vietnam, with one unit for 3 million people, has an average response time of 30 minutes (Mock and others 1998).

Where paramedical services exist alongside lay responder services, these two could be managed by the same organizational unit. The paramedical staff will be more successful in urban areas, where distances between dispatch sites, communities served, and hospitals are short. Other enabling factors are good telecommunications; rapid and dedicated transportation; and coordinating capacity among the community, hospitals, and other emergency services.

Intervention Cost and Effectiveness Training lay responders is an intervention potentially available in low-income countries. Projections for costs and effectiveness have been made based on the following assumptions:

- Serving a population of 1 million requires 7,500 trainees. Sensitivity analysis ranges from 5,000 to 10,000 trained lay responders.
- Trained lay responders can be trained in half a day (St. John Ambulance 1996).
- Training would have to be repeated every three years to maintain efficacy.
- Annually, 2,500 laypeople would be trained on a rolling basis.

Using these assumptions (see annex 68.A for technical details on costing guidelines) would require the following:

- 1,250 days of trainees' time (0.5 days each) valued at salary level 1
- 62.5 trainer days of time, with a ratio of 20 trainees per trainer, valued at wages for salary level 3
- one training facility with a classroom (100 square meters) valued at rent for basic space for 62.5 days
- 2,500 copies of photocopied curricula annually valued at US$1 each.

The costs of providing trained paramedics can be estimated using the following assumptions:

- Trained paramedic responders can be trained in 25 days (St. John Ambulance 1996).
- Serving a population of 1 million requires 7,500 trainees. Sensitivity analysis ranges from 100 to 200.

- Training would have to be repeated every three years to maintain efficacy.
- Annually, 50 paramedics would be trained.

As a result, the following would be required:

- $25 \times 50 = 1{,}250$ days of paramedic trainee time (salary level 1)
- 125 trainer days, with a ratio of 10 trainees per trainer valued at salary level 3
- one training facility offering a classroom (100 square meters) valued at basic building values
- 50 photocopied curricula annually, valued at US$1 each
- one paramedic kit with stethoscope, gloves, bandages, and splint material for each trainee (kits would be renewed by patient contributions).

The trainees would offer volunteer services after training. We assume that volunteers are highly motivated individuals who consider emergency medical service to their community as the most rewarding use of their leisure time (Fiedler 2000). The opportunity cost of their recurrent emergency service is assumed to be zero. Communities or cultures that have a shortage of individuals with an ethic of volunteer service may have to devote funds toward maintaining incentives for "volunteer" paramedics to serve. In such cases, this strategy may not be cost-effective.

Table 68.3 shows the estimated costs of the lay first responders and paramedics intervention, drawing on the Disease Control Priorities Project's standardized input prices by region for low, best, and high estimates.

Outcomes According to the World Health Organization burden-of-disease estimates, the global incidence of trauma is 410 per 100,000 or 4,100 per million. Husum, Gilbert, and Wisborg (2003) indicate that first-level responders and trained paramedics can lower mortality in trauma by 9 percent; thus, in 4,100 traumas, 370 lives can be saved. Dividing the sum of the costs in table 68.3 by the 370 deaths averted provides a rough estimate of costs per death averted. These costs per death averted are divided by the regional life expectancy at age 20 (LE 20), with the assumption that the average age of trauma is 20, to give the cost per life year saved. LE 20 is roughly 50 years in every region except Sub-Saharan Africa, where it is only 37 years. Shortages of equipment and supplies may reduce the effectiveness of the prehospital personnel.

It is possible to offer more refined "regional" estimates of the numbers of deaths averted by using local estimates of the burden of injuries instead of the global estimate of 4,100 injuries per million people. Yet given the uncertainty about regional variation in the effectiveness of the intervention based on administrative, infrastructure, and human resource capacity, it would perhaps give a false impression that a firm and universal basis exists to speculate quantitatively on the relative effectiveness of the intervention in various regions. As a result, the above estimates, as used in table 68.4, serve to inform global dialogue rather than offer specific empirical numbers.

Equipment and Supplies. Equipment and supplies should match the knowledge and skills of the personnel available to use them. Even teams with the least resources should have the following:

- protective wear, especially gloves and aprons
- a stretcher or the equivalent
- pressure dressings (bandages—elastic, if possible—and cotton or gauze dressings)
- splints—various sizes, made out of local materials
- radio, telephone, or other mode of rapid communication.

Annex 68.A provides a comprehensive list for better-resourced communities. Intervention cost and effectiveness

Table 68.3 Cost of Using Trained Lay First Responders Together with Trained Paramedics
(local currency converted to 2001 U.S. dollars using exchange rates)

Region	Low	Best	High
East Asia and the Pacific	27,539	48,050	75,232
Europe and Central Asia	30,209	52,339	79,605
Latin America and the Caribbean	32,777	74,589	110,453
Middle East and North Africa	33,050	104,585	261,935
South Asia	27,183	45,637	116,456
Sub-Saharan Africa	30,765	52,339	115,171
Unweighted average	30,254	62,923	126,475

Source: Authors.
Note: Cost of treating community of 1 million.

Table 68.4 Cost-Effectiveness of Combining Paramedics with Lay Responders
(local currency converted to 2001 U.S. dollars using exchange rates)

Region	Low	Best	High
Cost per death averted with trained lay first responders together with volunteer paramedics			
East Asia and the Pacific	74	130	203
Europe and Central Asia	82	141	215
Latin America and the Caribbean	89	202	299
Middle East and North Africa	89	283	708
South Asia	73	123	315
Sub-Saharan Africa	83	141	311
Unweighted average	82	170	342
Cost per life year saved with trained lay first responders together with volunteer paramedics			
East Asia and the Pacific	3	5	8
Europe and Central Asia	3	5	8
Latin America and the Caribbean	3	8	11
Middle East and North Africa	3	11	27
South Asia	3	5	12
Sub-Saharan Africa	4	6	14
Unweighted average	3	7	13

Source: Authors.
Note: Cost of treating community of 1 million.

cannot be estimated because no studies are available on this issue from low-income countries.

Traditional and Innovative Communications Systems. Nowhere is the demand for efficient communication and rapid transportation more critical than in emergency medical care. The best teams equipped with state-of-the-art technology and supplies will be wasted if they cannot be reached quickly or if they have no contact with the hospitals where patients are to be taken. Most of the world's population lives in areas where there is no telecommunications infrastructure, and this situation may not change significantly in the near future. Innovation is needed so that these populations can be enabled to access effective emergency care interventions that already exist without waiting for traditional telephone lines to get to their rural homes. Radio communication is one solution in such settings. Equipping traditional birth attendants and remote health units with radio receiver sets linked to local hospitals has been used to shorten the response time and reduce maternal deaths (Samai and Sengeh 1997). Cellular telephones may offer communities that are remote from standard communications infrastructure an opportunity to leap into a more modern and efficient mode.

Intervention Costs and Effectiveness There are no studies from low-income countries on which to base intervention cost and effectiveness estimates. The costs will depend on whether the community adopts traditional communication or more modern communication systems. If radio communication were introduced, the purchase and maintenance of radio receivers, supplies, and government licensing costs would need to be estimated. If cellular telephones options were being explored, then the purchase of telephones, plans, licenses, and maintenance costs would need to be included. Where satellite towers need to be installed, however, this cost will be much higher than for all other components. Finally, if traditional landline installation is being considered, the lines, equipment, and telephone bills will need to be taken into account. The health sector may be able to share the costs of such interventions, especially traditional telephone lines, with other development and infrastructure units of a national government.

Basic and Advanced Transportation Systems. Transporting a patient from the location of the acute event to a hospital facility is a critical element of the prehospital component. Lack of transportation is often a major barrier to accessing emergency care (Lungu and others 2001; Samai and Sengeh 1997). In devising a prehospital system of transportation, one should consider locally available resources and the range of viable alternatives for transportation. In some countries such transportation may be part of a formal EMS system, whereas in other cases it is entirely informal. For example, commercial vehicles, the police, and relatives using private motorized or

nonmotorized forms of transportation may bring seriously ill and injured patients to medical facilities (Andrews, Kobusingye, and Lett 1999; Joshipura and others 2003; Kobusingye and others 2002). A bicycle ambulance in Malawi set up to improve emergency obstetric care was actually used more often for injuries and medical emergencies (Lungu and others 2001).

Transportation should be accessible at short notice. A vehicle with a stretcher is ideal, but almost any transportation that will get a patient to a facility where definitive care can be obtained is acceptable. Although a fully fitted and equipped ambulance vehicle complete with trained paramedics delivers better outcomes, ethical and equity considerations dictate that before this vehicle is made available to an elite population in the urban areas, basic transportation must be assured for all who need emergency transportation and care.

In a city setting, a vehicle ambulance can make as many as 20 trips per day. On average this schedule will require salaries for an administrator and two crews, each comprising a driver and two paramedics or nurses, as well as expenses for communication, supplies, pharmaceuticals, and the costs of operating the vehicle. A study of a decision to develop an EMS in Kuala Lumpur (1.1 million people, 243 square kilometers) estimated that the purchase and staffing of 48 ambulances at US$53,000 each per year would be required, totaling US$2.5 million per year (Hauswald and Yeoh 1997). The authors noted that, despite the paucity of ambulances, severely injured or ill patients did get to a hospital with only minor delays by using taxis, family transportation, or the police. Ambulances need accurate maps, house numbers, and street or road signs, all of which might not be in place in low-income cities. It was estimated that ambulances were unable to locate patients in 20 percent of calls in Kuala Lumpur because of mapping and signage problems (Hauswald and Yeoh 1997).

A study conducted in Turkey found that ambulance vehicle costs were the leading component of capital costs (Altintas, Bilir, and Tuleylioglu 1999). The cost per trip was US$163, and the cost per patient transported was US$180.50, which the authors thought were beyond the means of the private sector. In state-run ambulance services in New Delhi, India, the cost per trip was approximately US$40, yet one in three of the ambulances served only to transport patients, with no paramedic staff on board (India, Government of Delhi 2001).

The debates in high-income countries about helicopter ambulances provide lessons for low-income countries. In some cases, helicopter services have been discontinued because they were not considered cost-effective (Hutton 1995). A study conducted in the United States, which concluded that helicopters were cost-effective, found that the cost per patient transported was US$2,214 and that for every 100 flights there were six survivors more than was predicted on the basis of injury severity indices (Gearhart, Wuerz, and Localio 1997). Each additional survivor cost an average of US$15,883, and the authors acknowledged that the helicopter had to be used fully to spread the high fixed costs across many patients and trips. A review of civilian helicopter ambulance programs in the United States concluded that the primary factor in the reduction of trauma mortality was not the speed at which the patient was transported but the administration of life-saving care by the helicopter medical crew at the scene or at the outlying hospital (Moylan 1988). In low-income countries, for the very few who benefit from such a high-end intervention, there are likely to be thousands who cannot access care even using the most basic means.

Intervention Costs and Effectiveness Costing transportation systems requires the following assumptions:

- In an urban population, one ambulance unit can serve a population of 30,000 people. Thus, 1 million people would require 33 ambulance units (1 million/30,000).
- Each ambulance unit requires staffing of a rotation of six paramedic-drivers and a seventh paramedic-driver to cover vacation times and sick leaves.
- A supervisor oversees three ambulance units per year.
- A garage for the ambulance and communications equipment would be 100 square meters but would entail rental of office-style accommodations.
- A vehicle to be outfitted as an ambulance can be purchased for as much as an off-road vehicle with a useful life of nine years.
- The cost to modify the vehicle into a basic ambulance is US$5,000 for a useful life of nine years.
- The ambulance will require fuel and maintenance based on usage of 20,000 kilometers per year.

Given the preceding assumptions,

- The 231-member ambulance staff (33 ambulance units of 7 persons each) would be paid at salary level 2.
- The 10 administrators would be paid at salary level 2.

We ignore the additional burden on the health system from additional visits. Quite possibly, hospital costs will rise as more patients now get to the hospital with the help of ambulances. It is also possible that patients currently arrive in less desperate condition, so that the cost of care is lessened. No studies are available on which to base cost estimates to address those issues.

Table 68.5 shows the estimated costs of the ambulance intervention, drawing on the Disease Control Priorities Project's standardized input prices by region for low, best, and high estimates.

Outcome Based on the World Health Organization's 2001 burden of disease estimates on epidemiology of trauma, ischemic heart disease, and obstetric emergencies, we estimate that for each 10,000 population there will be 9 deaths from trauma,[1]

Table 68.5 Cost and Effectiveness of Ambulances
(U.S. dollars)

Region	Low	Best	High
Cost of treating community of 1 million with urban ambulances			
East Asia and the Pacific	691,603	871,208	1,090,032
Europe and Central Asia	839,468	1,024,235	1,220,888
Latin America and the Caribbean	849,556	1,550,521	1,747,630
Middle East and North Africa	894,379	2,435,000	4,960,705
South Asia	676,111	803,361	1,973,093
Sub-Saharan Africa	781,568	951,906	1,905,417
Unweighted average	788,781	1,272,705	2,149,628
Cost per death averted of treating community of 1 million with urban ambulances			
East Asia and the Pacific	988	1,245	1,557
Europe and Central Asia	1,199	1,463	1,744
Latin America and the Caribbean	1,214	2,215	2,497
Middle East and North Africa	1,278	3,479	7,087
South Asia	966	1,148	2,819
Sub-Saharan Africa	1,117	1,360	2,722
Unweighted average	1,127	1,818	3,071
Cost per life year saved of treating community of 1 million with urban ambulances			
East Asia and the Pacific	50	63	79
Europe and Central Asia	62	75	90
Latin America and the Caribbean	61	111	126
Middle East and North Africa	65	176	359
South Asia	50	60	147
Sub-Saharan Africa	67	81	163
Unweighted average	59	95	161
Cost per death averted of treating community of 1 million with rural ambulances			
East Asia and the Pacific	2,978	3,748	4,686
Europe and Central Asia	3,613	4,405	5,248
Latin America and the Caribbean	3,652	6,656	7,500
Middle East and North Africa	3,847	10,449	21,274
South Asia	2,911	3,457	8,470
Sub-Saharan Africa	3,361	4,092	8,178
Unweighted average	3,394	5,468	9,226

Source: Authors.

11 deaths from ischemic heart disease,[2] and 2 deaths from lethal obstetric emergencies.[3] For modeling purposes, we confine our attention to trauma, ischemic heart disease, and obstetric cases. Although many possible lethal emergencies may present, such as sepsis, malaria, snakebites, and asthma, by confining attention to the major emergency conditions we locate 2,200 (900 + 1,100 + 200) potentially savable lives in a population of 1 million. The savings are outlined as follows:

- *Savings from trauma reductions.* Saving lives from trauma depends on the quality of trauma care at the destination facility. In one year for 1 million people, there will be 4,100 trauma cases and 900 trauma deaths. With rapid resuscitation and oxygen available through use of ambulances, we assume we can save 300 lives.
- *Savings from myocardial infarction management.* In one year for 1 million people in low-income countries, 1,100 deaths will typically result from myocardial infarction. Low-dose aspirin provided to myocardial infarction victims lowers mortality by 18 percent (Weisman and Graham 2002). In a population without ambulance services, rapid aspirin administration cannot be ensured; with EMS, aspirin use can potentially be increased from about 0 percent to 100 percent for heart myocardial infarction. Therefore, instead

of 1,100 deaths, there will be $1{,}100 \times (1 - 0.18)$ deaths, saving 200 lives, but with only an average of five life years per life saved.

- *Savings from emergency obstetrics management.* Obstetric deaths for medically attended patients are approximately 100 times lower than for patients who do not receive medical care. Accordingly, an ambulance system essentially saves all of the obstetric emergencies from death; this saving would amount to 200 deaths averted in the case described previously. As a result, in the hypothetical population of 1 million people in low-income countries, 700 lives can be saved by an ambulance system focusing on three causes only: ischemic heart disease (200), obstetric (200), and trauma (300).

The middle section of table 68.6 displays the cost per death averted. To compute life years saved in the last section of the table, we assume that the 500 deaths averted from obstetric emergencies and trauma occur at age 20, but the 200 deaths averted from ischemic heart disease save only five additional life years per case. Regional life expectancy at age 20 years (estimated) is used as before.

Costs for a Rural Ambulance Service The key difference determining higher costs for rural ambulances is that more ambulance units are necessary to cover the population. We assume that in rural areas one ambulance unit can cover a population of 10,000, although variation will occur, depending on population density and geographical topography. On the basis of this assumption, all of the cost estimates for rural ambulances are essentially three times higher for a population of 1 million, as are the costs per death averted and per life year gained. They are assumed to have the same effectiveness as the urban services because the increase in units aims at delivering the same quality

Table 68.6 Summary of Cost and Effectiveness
(U.S. dollars)

Region	Intervention		
	Trained lay first responders and paramedic responders	Staffed community ambulance, urban	Staffed community ambulance, rural
Costs for a population of 1 million			
East Asia and the Pacific	48,050	871,208	2,623,392
Europe and Central Asia	52,339	1,024,235	3,083,637
Latin America and the Caribbean	74,589	1,550,521	4,659,017
Middle East and North Africa	104,585	2,435,000	7,314,544
South Asia	45,637	803,361	2,419,607
Sub-Saharan Africa	52,339	951,906	2,864,062
Unweighted average	62,923	1,272,705	3,827,376
Cost per death averted for a population of 1 million[a]			
East Asia and the Pacific	130	1,245	3,748
Europe and Central Asia	141	1,463	4,405
Latin America and the Caribbean	202	2,215	6,656
Middle East and North Africa	283	3,479	10,449
South Asia	123	1,148	3,457
Sub-Saharan Africa	141	1,360	4,092
Unweighted average	170	1,818	5,468
Cost per life year gained for a population of 1 million[a]			
East Asia and the Pacific	5	63	190
Europe and Central Asia	5	75	227
Latin America and the Caribbean	8	111	335
Middle East and North Africa	11	176	530
South Asia	5	60	180
Sub-Saharan Africa	6	81	245
Unweighted average	7	94	284

Source: Authors.
a. Personnel consist of lay first responders together with paramedics.

of care as in the urban centers. This assumption may not hold true if the quality of care at the receiving facilities is lower than that in the urban areas.

Uncertainty of Estimates Substantial uncertainty remains over the actual effectiveness of the interventions in emergency medicine. The tables in this chapter should be approached with due caution because ultimately the projections of the effectiveness of interventions have been patched together from a handful of intervention trials whose success may or may not be similar in other contexts. The projections include the following:

- Ambulance services can and do save lives by performing field stabilization and by hastening the arrival of critical patients when time makes a difference in the outcome.
- Only several dozen ambulance runs per year for a unit serving a population of 10,000 will actually have the potential to save lives.
- Ambulance services are more cost-effective in denser populations and when roads are more passable, making trips shorter.
- Training lay responders and paramedics can be relatively cost-effective.

The financial support of an ambulance unit may rely on the value perceived by the hundreds of patients who are comforted by having rapid access to care or by knowing ambulances are there if needed, even though their lives and health are not actually improved by ambulances.

Table 68.6 summarizes the best estimates of cost, cost per death averted, and cost per life year.

Health Facility–Based Subsystem

This subsystem refers to a level within the health care system where appropriate definitive care is delivered. Formal health facilities vary immensely between and within countries. In some countries, this subsystem may be a regional hospital with specialists; in others, a district hospital with general practitioners or nonspecialist doctors; and in still others, a health center with competent nonphysician clinicians. In some low-income countries, some types of emergency medical care, for conditions such as acute diarrhea or severe malaria, may be effectively delivered at a health center staffed by nondoctor clinicians. However, such a facility will be grossly inadequate for the management of a severe multiple injury or obstructed labor. The triage process in the prehospital subsystem should determine which patients receive transportation to which facility, instead of merely transportation to the nearest facility. Precious time and lives may be lost when patients are taken to facilities where the desired definitive care is not available.

Because the goal of an effective EMS is the provision of emergency care to all who need it—*universal emergency care*—the following section presents guidelines on the necessary inputs at different levels. Two of the components in hospital emergency care are discussed in more detail: (a) training and (b) equipment and supplies. The first level of formal health care is often staffed by nonphysician clinicians; the second level is staffed by at least one physician and other trained health care professionals; and the third is staffed by specialists in addition to other health care professionals. Some middle-income countries have additional levels (major emergency care centers), and some hospitals are specialized (chapters 65 and 66).

Training. Most in-service training for emergency care professionals working in hospitals is designed to address a particular problem, such as severe injuries, emergency pediatrics, or obstetric emergencies. Yet because of the resource constraints of low-income countries, the same personnel will be confronted with all these problems. Few courses in emergency care have been rigorously evaluated (Black and Brocklehurst 2003; Sethi and others 2003). The Advanced Trauma Life Support (ATLS) course for doctors has resulted in improved patient outcomes in some settings, although it may be too expensive for most low-income countries and inappropriate in settings where doctors do not see the majority of patients. In a tertiary hospital in Trinidad and Tobago, injury mortality was reduced by 50 percent following ATLS training (Ali and others 1993).

Life-saving obstetric skills training was found to contribute to a reduction in maternal deaths. In Kebbi state in Nigeria, this training led to a drop in case-fatality rates among women with obstetric complications from 22 percent to 5 percent. Similar trends were observed in other sites where the intervention was implemented (Oyesola and others 1997; Prevention of Maternal Mortality Network 1995). Emergency Triage Assessment and Treatment has been used in many countries to improve pediatric emergency care (WHO 2000). Other examples are Primary Trauma Care, which is a trauma management course to train doctors and other health workers in district hospitals and remote locations (Wilkinson and Skinner 2000), and Advanced Life Support in Obstetrics (see http://www.aafp.org/also). These courses have been beneficial in standardizing protocol-based emergency care, but their outcome evaluations are still awaited. Low-income countries need to identify training models for their versatile emergency care personnel, especially those working at middle-level facilities, who respond to different types of emergencies.

The costs of this intervention are not available in the literature and will require an estimation of trainer costs, space, materials, and refresher courses.

Equipment and Supplies. A specimen list of resources for emergency care required at different levels of facilities is

provided in annex 68.A. This template is flexible, and countries can customize it to suit local conditions, such as existing facility levels and prevailing burden of emergency disease conditions. Equipment and supplies at each level should match the knowledge and skills of the personnel available to use them.

Systems Organization

Emergency care needs to be planned and implemented carefully. The various components that make up the EMS should be linked to ensure that the entire system operates as a unit. A coordinator should be responsible for monitoring and coordinating all emergency medical care in the community or district and should work with a committee to which the other components send representation. A community representative should be a key member of this committee.

Coordination costs are very important and should not be overlooked in the development of a new EMS. Such costs include the salary of the coordinator, an efficient telephone or communication system, a vehicle, fuel, and a budget to organize meetings of stakeholders at least twice a year (Bazzoli, Harmata, and Chan 1998; Nurok 2001).

Health Financing for Emergency Care

Emergency medical systems in low-income countries must be pro-poor in their orientation, which requires explicit consideration of how the poor interact with an EMS and how barriers to acute care for the poor can be overcome. Issues of access to an EMS become critical because the lack of money often keeps people from using emergency services. Direct payment of costs for transportation, medical treatment, and drugs makes lack of money a major barrier to EMS for the poor in every country. As a result, emergencies frequently cripple individuals and families financially in poor communities, often for many years in the future.

Financial protection for emergency health care is a necessity in low-income countries and has not received adequate attention. The goal of such protection is to ensure that individuals and families do not spiral down the pathway to abject poverty as a result of interaction with the national health system. Such financial protection may be achieved by a number of different means, including community financing (Ande and others 1997; Desmet, Chowdhury, and Islam 1999; Macintyre and Hotchkiss 1999). Community loan funds to cover transportation and other requirements for emergencies, especially for obstetrics, have been explored with mixed results (Essien and others 1997; Shehu, Ikeh, and Kuna 1997). Some experience seems to indicate that these approaches can indeed overcome several of the barriers to accessing emergency medical services and should be explored further.

Documentation and Quality Assurance

Quality of care is critical to the interaction of the poor with the EMS. Lack of funds, lower-paid jobs, social class distinctions, ethnicity, and other affiliations make the already vulnerable poor susceptible to receiving poor-quality care. For an EMS to maintain and improve the care of patients, systematic documentation and periodic audits, or other processes to ensure quality of care, need to be incorporated. Quality management systems that are simple, are continuous, and allow for rapid changes in the system need to be implemented.

Because of scarcity of resources, expensive machines and elite specialists should not be advocated for the urban privileged at the expense of the majority of the rural poor. The most difficult decisions concern balancing funds invested in the emergency care capacity of secondary and primary care centers with support for referral and transportation networks to feed tertiary care centers. These decisions are too variable and too system specific to yield to a uniform policy prescription. Two principles are advocated to inform these difficult decisions:

- Collect data on costs, capacities, and outcomes.
- Tighten the integration of the emergency care system to improve function and lead to wiser decisions on where to invest.

Legislative Instruments to Ensure Emergency Care

The issues discussed in the preceding sections supply the rationale for countries to have specific legislation addressing the provision of emergency care. This area requires major cooperation between public health and law, which together provide the legal framework for ensuring that all individuals who deserve emergency care can receive it, irrespective of their personal characteristics or their ability to pay. Having laws that protect trained individuals and laypeople as they provide such care is also important.

IMPLEMENTATION OF CONTROL STRATEGIES: LESSONS OF EXPERIENCE

A large proportion of trauma patients in developing countries do not have access to formal emergency medical services. Boxes 68.1 and 68.2 contain examples of interventions to provide appropriate emergency care in such countries.

THE RESEARCH AND DEVELOPMENT AGENDA

The research and development priorities for emergency care are challenging to define because emergency care is a neglected area of research in low-income countries and the needs are

Box 68.1

Improving Trauma Care in the Absence of a Formal Ambulance System

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

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

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

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

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

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

Source: Mock and others 2002.

Box 68.2

Training for Emergency Care in India

The training of personnel working in emergency medical services is crucial to the success of efficient delivery of care. Evidence exists to support usefulness of life-support training for emergency caregivers in low- and middle-income countries. Courses such as the ATLS are available and well established in some high- and middle-income countries. In most low-income countries, such training is not available, mainly because of prohibitive costs. The three-day ATLS course costs on average US$700 per trainee and is taught by six trainers to a group of 20 trainees at a time. The National Trauma Management Course is an indigenous two-day course developed in India by the Academy of Traumatology (India) with the help of international peers. The curriculum takes into account local conditions and capabilities. The cost is US$50 per trainee, and the course is taught by local trainers to a group of 100 trainees at a time. Animal specimens are used to teach life-saving procedures instead of expensive commercially produced manikins. More than 2,000 health professionals have been trained in less than three years. The course has now become a national training standard for immediate trauma care in India.

Source: Authors.

great. As a neglected topic, emergency care is part of the "10-90" gap of health research: less than 10 percent of global research investments are for problems affecting 90 percent of the world's population (Global Forum 2000).

Approach to Research and Development for EMS

The spectrum of research required is diverse and may be easily understood with the help of the schematic shown in figure 68.2. The rectangle is a schematic representation of the totality of the global burden of disease that can be potentially addressed by EMS (see "Burden of Disease"). A portion of this potential burden is being addressed (or reduced) by those existing interventions that have been implemented, defined by box A. If the efficiency of current interventions were to be enhanced and their coverage increased, then another portion of the burden defined by box B could be addressed; this increase

D: No emergency care interventions currently available to address this burden		
A: Currently implemented emergency care interventions that are addressing this burden	**B:** Existing emergency care interventions that are able to address existing burden if efficiency enhanced	**C:** Potential emergency care interventions that could address this burden if they were made cost-effective

Figure 68.2 Schematic Illustration of the Burden of Disease Potentially Addressed by EMS

in efficiency will require operations research, policy research, and social science research. If existing interventions, which have not been implemented because of their high costs, were made more cost-effective, then another portion of the burden defined by box C could be reduced. This process of making interventions more cost-effective will require economic analysis and clinical research in many instances. Finally, a portion of the burden exists for which we do not have existing interventions, defined by box D; it requires basic and clinical research to develop and pilot interventions that can address other determinants of the emergency care–related burden in the future.

This schematic representation is thus useful to demonstrate two critical needs:

- essential research on emergency care in low-income countries
- a diverse set of research studies and approaches to reduce the burden that can be addressed by EMS.

Priority Setting for Research and Development of Emergency Care

Setting priorities for research and development on EMS needs to be a region-specific, if not country-specific, process. No current list exists of global research and development priorities for EMS, again reflecting the need for more attention and investments in this area. This chapter does not intend to prescribe a list of issues or topics for global research and development efforts, but rather to highlight the gap in global research and development and to suggest possible issues and topics that may be broadly relevant to low-income countries for these efforts in the short to middle term.

A number of methods exist for setting research priorities in the health sector, such as the Combined Approach Matrix promoted by the Global Forum for Health Research (Global Forum 2002) and the Essential National Health Research process promoted by the Council for Health Research for Development. Countries and regions can use these approaches to help develop their research agenda for EMS.

The review of evidence available in the field of emergency care as applicable to low-income countries reveals many gaps in global knowledge. Following on the illustration of figure 68.2, there is a need to better understand the epidemiology of those conditions that can be addressed by an EMS in a low-income country and which interventions currently in place are addressing them. We have little knowledge of how to enhance the efficiency of these existing interventions and reduce their costs. Most important, the lack of intervention trials done in low-income countries creates a major research priority for the field of EMS. Well-designed, locally appropriate interventions that establish their effectiveness are urgently needed and should include both interventions that may be available in high-income countries and new ones. Economic analysis is another area for major research input in the field of EMS, where cost and cost-effectiveness information from low-income countries is scant. These gaps only reflect the need for a more systematic analysis of where research investments should be directed in the next five years for EMS.

CONCLUSIONS: PROMISES AND PITFALLS

Emergency medical systems are a critical component of national health systems in low-income countries. Governments and ministries of health in low-income countries need to pay specific attention to the development of EMS in their countries and to ensure that the evolution of any EMS is both evidence based and appropriate to their national needs. More important, the context and implementation of EMS should help health equity and not widen existing health disparities.

This chapter highlights not only the urgent need for more attention to EMS in low-income countries but also points out an opportunity for these countries in defining better EMS for their needs. In promoting the systematic development of an evidence-based EMS, low-income countries could help define more effective and cost-effective emergency systems than currently exist in high-income countries. This opportunity should not be lost as a result of political inattention or lack of funds; the international and national stakeholders must move forward to stem the preventable loss of life from the lack of an EMS.

Emergency care needs to be planned as an integral component of public health systems in low-income countries. Too little is known about the true extent of the need for emergency care, the designs of EMS that would work well for different communities and populations, and the costs and benefits of delivering emergency care in low-income countries. These gaps are a call for more investments in the research, development, and implementation of EMS, especially in these countries. Universal emergency care is consistent with the right to health care because, by definition, emergency care is a matter of life and death. Society should endeavor to ensure that prompt appropriate care is available in critical moments when a delay in care—or the delivery of inappropriate care—could mean loss of lives.

Annex 68.A Essential Resources for the Delivery of Emergency Care in Hospitals

Resources	Major emergency care center	Regional emergency care center	District emergency care center	Primary emergency care center
Organization and administration				
Multidisciplinary emergency care team	✓	✓		
Maintenance of statistical data	✓	✓	✓	
Resources				
Immediate access to radiology or CT and ultrasound scan facility on site	✓	✓		
Blood bank on site	✓			
Access to blood bank		✓	✓	
Radiological technician on site 24 hours a day	✓	✓		
Radiological services available promptly			✓	
Clinical laboratory services				
Laboratory services on site available 24 hours a day (including, but not limited to, the following tests)	✓	✓		
Hemoglobin, glucose, gram stain, blood slide test	✓	✓	✓	
Bacterial cultures	✓	✓		
Quality improvement				
Evidence of quality improvement program in accident and emergency department	✓	✓	✓	
Monthly morbidity and mortality review	✓	✓		
Medical nursing audit and utilization review	✓	✓		
Personnel				
Designated doctor in charge, member of the emergency care team, with special competence in care of critically ill and injured patients, present in the emergency care unit 24 hours a day	✓	✓		
Designated doctor in charge, member of the emergency care team, with special competence in care of critically ill and injured patients, available on call			✓	
Nursing personnel with special competence in the care of the critically ill and injured patients, designated member of the emergency care team, present in the emergency unit 24 hours a day	✓	✓	✓	
All personnel trained in airway, breathing, and circulatory support techniques	✓	✓	✓	✓
Equipment required for resuscitation per station shall include but not be limited to				
Bag valve resuscitator with reservoir	✓	✓	✓	
Sphygmomanometer (blood pressure cuff)	✓	✓	✓	
Cervical collars	✓	✓	✓	✓
Chest decompression set	✓	✓	✓	

(Continues on the following page.)

Annex 68.A Continued

Resources	Major emergency care center	Regional emergency care center	District emergency care center	Primary emergency care center
Cut down set	✓	✓	✓	
Delivery pack	✓	✓	✓	✓
Diagnostic peritoneal lavage set open (1)	✓	✓		
Dressing trolley	✓	✓	✓	✓
Drip stand	✓	✓	✓	
Laryngoscope and blades (adult)	✓	✓	✓	
Laryngoscope and blades (pediatric)	✓	✓	✓	
McGills forceps (adult and pediatric)	✓	✓	✓	
Ophthalmoscope	✓	✓	✓	
Overhead x-ray gantry (full access to all beds)	✓			
Portable ventilator capable of pediatric vent	✓			
Resuscitation patient trolley	✓	✓	✓	
Scissors to cut clothing	✓	✓	✓	✓
Scoop stretcher (1)	✓	✓	✓	✓
Spine board (1)	✓	✓	✓	✓
Spot lamp (1)	✓	✓		
Sterile basic packs (2 per station)	✓	✓	✓	
Stethoscope	✓	✓	✓	✓
Suction apparatus	✓	✓	✓	✓
Wheelchair (1)	✓	✓	✓	✓
X-ray gowns (staff)	✓	✓		
X-ray viewing box	✓	✓	✓	
Consumables (adult and pediatric)				
Catheters (all sizes)	✓	✓	✓	
Central lines	✓	✓		
Chest drains	✓	✓	✓	
Diathermy	✓			
Endotracheal tubes	✓	✓	✓	
Eye protection for staff	✓	✓	✓	✓
Gloves	✓	✓	✓	✓
Humidification filters	✓	✓	✓	
Intraosseous needles	✓	✓		
Intravenous cannulas, fluids, lines	✓	✓	✓	
Introducers and endotracheal tubes (all sizes)	✓	✓		
Lumbar puncture set	✓	✓	✓	

Annex 68.A Continued

Resources	Major emergency care center	Regional emergency care center	District emergency care center	Primary emergency care center
Malaria test kits	✓	✓	✓	✓
Masks	✓	✓	✓	✓
Medical waste disposal systems	✓	✓	✓	✓
Nasal cannula	✓	✓	✓	✓
Nasogastric tubes (all sizes)	✓	✓	✓	✓
Nebulization masks	✓	✓	✓	
Oropharyngeal airways	✓	✓	✓	
Oxygen mask	✓	✓	✓	✓
Suction catheters	✓	✓	✓	✓
Syringes (assorted)	✓	✓	✓	✓
Tracheotomy tubes	✓	✓		
Urine dipstick				✓
Wound care products	✓	✓	✓	✓
Drugs shall include but not be limited to the following				
Activated charcoal	✓	✓	✓	✓
Adrenaline	✓	✓		
Flumazenil (or similar benzodiazepine)	✓	✓	✓	
Antihistamine (such as diphenhidramine)	✓	✓	✓	✓
Atropine	✓	✓	✓	✓
Ciprofloxacin or equivalent	✓	✓	✓	
Beta-2 antagonist (such as propranolol)	✓	✓	✓	✓
Calcium chloride	✓	✓	✓	✓
Calcium gluconate	✓	✓	✓	✓
Dextrose, 50 percent	✓	✓	✓	✓
Diazepam	✓	✓	✓	
Dopamine	✓	✓		
Emetic (ipecac)	✓	✓	✓	✓
Metronidazole IV	✓	✓	✓	
Furosemide or equivalent	✓	✓	✓	
Heparin, 1,000 μg/ml	✓	✓	✓	
Hydrocortisone	✓	✓	✓	✓
Lidocaine IV	✓	✓	✓	✓
Magnesium sulfate IV	✓	✓	✓	
Midazolam	✓	✓	✓	
Morphine	✓	✓	✓	

(Continues on the following page.)

Annex 68.A Continued

Resources	Major emergency care center	Regional emergency care center	District emergency care center	Primary emergency care center
Naloxone	✓	✓	✓	
Nitroglycerin	✓	✓	✓	✓
Crystalloids (such as normal saline)	✓	✓	✓	✓
Phenytoin	✓	✓	✓	
Polyvalent snake venom	✓	✓		
Potassium chloride	✓	✓	✓	
Scoline (suxamethonium chloride)	✓	✓		
Sodium bicarbonate	✓	✓	✓	✓
Streptokinase	✓	✓		
Tetanus toxoid	✓	✓	✓	✓
Vitamin K	✓	✓	✓	✓

Note: Additional information on recommended drugs is available in the *Model List of Essential Medicines* (WHO 2002) and the WHO's *Complementary Model List.*

NOTES

1. There are 4,715,000 trauma deaths in low- and middle-income countries per population of 5,219,401,000; thus, there are 9.033 trauma deaths per 10,000 people.

2. There are 5,699,000 ischemic heart disease deaths per 5,219,401,000 population; thus, there are 10.9 ischemic heart disease deaths per 10,000 people.

3. There are 2,000 to 4,000 births among 10,000 people based on crude birth rates of 26 (South Asia), 39 (Sub-Saharan Africa), 22 (Latin America), and 17 (East Asia). Maternal mortality runs at 1 per 1,000 people.

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