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Evaluation of Trauma Care Capabilities in Four Countries Using the WHO-IATSIC *Guidelines for Essential Trauma Care*

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Abstract

Background: We sought to identify affordable and sustainable methods to strengthen trauma care capabilities globally, especially in developing countries, using the Guidelines for Essential Trauma Care. These guidelines were created by the World Health Organization (WHO) and the International Society of Surgery and provide recommendations on elements of trauma care that should be in place at the range of health facilities globally.

Methods: The guidelines were used as a basis for needs assessments in 4 countries selected to represent the world's range of geographic and economic conditions: Mexico (middle income; Latin America); Vietnam (low income; east Asia); India (low income; south Asia); and Ghana (low income; Africa). One hundred sites were assessed, including rural clinics (n = 51), small hospitals (n = 34), and large hospitals (n = 15). Site visits utilized direct inspection and interviews with administrative and clinical staff.

Results: Resources were partly adequate or adequate at most large hospitals, but there were gaps that could be improved, especially in low-income settings, such as shortages of airway equipment, chest tubes, and trauma-related medications; and prolonged periods where critical equipment (*e.g.*, X-ray, laboratory) were unavailable while awaiting repairs. Rural clinics everywhere had difficulties with basic supplies for resuscitation even though some received significant trauma volumes. In all settings, there was a dearth of administrative functions to assure quality trauma care, including trauma registries, trauma-related quality improvement programs, and regular in-service training.

Conclusions: This study identified several low-cost ways in which to strengthen trauma care globally. It also has demonstrated the usefulness of the Guidelines for Essential Trauma Care in providing an internationally applicable, standardized template by which to assess trauma care capabilities.

Trauma is now a leading cause of death and disability globally, including in low- and middle-income countries (LMICs). Increased attention is being paid to this problem, especially from the viewpoints of road safety and injury prevention.[1] However, strategies to strengthen trauma care globally, especially in the setting of LMICs, have not been well worked out. Several studies have shown high rates of medically preventable trauma deaths in LMICs, many from conditions that could be treated well

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in most locations, such as airway obstruction and isolated intra-abdominal organ injury.[2–8] It is likely that improvements in organization and planning for trauma care could lower these death rates. Experience from high-income countries has demonstrated that such improvements in survival can accrue with better organization and planning for trauma care services. Well-organized trauma systems have decreased mortality among all treated trauma patients by 15%–20% and decreased medically preventable deaths by 50%.[9–13] Until recently, no set of standards existed to guide trauma system development in LMICs. Due to economic realities, it is not reasonable to utilize recommendations from high-income countries verbatim. In an effort to provide recommendations appropriate to the needs of LMICs, the Essential Trauma Care Project was established. Over the past 3 years, a collaborative working group involving the World Health Organization (WHO) and the International Association for Trauma Surgery and Intensive Care (IATSIC, an integrated society within the International Society of Surgery) has worked toward his end.[14–16]

The collaborative Working Group for Essential Trauma Care has published the Guidelines for Essential Trauma Care (EsTC).[14,15,17] This was developed with input from over 50 persons involved with providing or planning for trauma care services, including representatives of at least one country on each continent. This included many practitioners from LMICs, including general practitioners from small rural hospitals, general surgeons from several levels of hospitals, and subspecialists from major urban centers. This publication establishes 11 core essential trauma care services that can reasonably be provided to every injured person in every country. These include basic services such as opening obstructed airways, stopping hemorrhage, and preventing disability from extremity injuries. To assure these services, 260 individual items of skills and staffing (human resources) and equipment and supplies (physical resources) were deemed to either be essential or desirable at the range of health facilities globally, from small clinics to tertiary care facilities. These guidelines are intended to serve as a flexible template to assist ministries of health and individual facilities in planning to optimize their trauma services so as to improve both survival and functional outcome.

In the current study, we sought to identify priorities for affordable and sustainable methods to strengthen trauma care capabilities in countries world wide. To do so, we used the Guidelines for EsTC as a standard by which to evaluate these capabilities in the range of facilities providing trauma care in several countries.

METHODS

Site Selection

Four countries were studied representing the range of geographic and economic conditions in the developing world, as indicated in Table 1. In each country, facilities to be evaluated were selected somewhat differently based on local needs. In Ghana, facilities from 4 of the country's 10 regions were selected to represent the spectrum of health facilities in the country, especially those that had high volumes of trauma patients. In Vietnam, all hospitals and half of the rural clinics in the Hanoi Health Department were selected. Also, representative facilities from Khanh Hoa, a province in the southern part of the country, were evaluated. In India, all clinics and hospitals managed by the Public Health System in Bhavnagar District, Gujarat State, were evaluated. In Mexico, 3 of the 31 states were selected to represent the country's geographic spectrum, including Oaxaca (south, lower economic tertile), Puebla (center, middle tertile), and Nuevo Leon (north, upper tertile). In each state, representative facilities were selected.

The types of facilities evaluated were categorized into:

Clinic: all rural in location

These tended to have at least one doctor, except in Ghana. In all countries, they served populations of around 10,000.

Small hospital

These had 30–100 beds and usually medical staffs of 5–20. Most, but not all, had surgical capabilities. In Mexico and Vietnam, almost all had at least one surgeon. In India and Ghana, most did not. In India, those without surgeons did only minor surgical procedures. In Ghana, however, even hospitals staffed only with general doctors usually undertook a wide range of moderate-level operative procedures, including C-sections, laparotomies for trauma and other acute abdominal pathology, and open fracture management. These hospitals served populations of around 100,000.

Large hospital

These had 100–600 beds and multispecialty medical staffs. They served populations of 2–3 million.

Table 1.
Per capita gross national income (GNI), per capita health expenditures, and number of facilities studied

			Facilities studied		
Country	GNI	Health expenditures	Clinic	Small hospital	Large hospital
Ghana	$380	$17	4	8	2
Vietnam	$550	$23	14	8	5
India	$620	$30	28	14	1
Mexico	$6,770	$380	5	4	7

All values in US dollars at average exchange rates. Health expenditures are total, including private and public. Source: www.who.int/countries/en/ and www.worldbank.org/data/databytopic/GNIPC.pdf.

In all countries, the large hospitals evaluated tended to be the major trauma care hospitals in their cities and provinces/states. The small hospitals and clinics selected for evaluation tended to be those fairly busy with trauma. Each country had a lower level of health care system, such as health promoters and village health workers, which were not evaluated, as their trauma care involvement was low. Likewise, major academic tertiary care facilities in each country's capital city were not evaluated. However, in all locations, many of the large hospitals evaluated functioned in a tertiary capacity, with only rare referrals out.

Criteria for Evaluation

Methodology for 3 of the countries has been previously reported[18–20] and is summarized herein, along with methods for India. Two forms were created for this study. The first was a 2-page questionnaire that assessed overall characteristics, such as composition and availability of trauma care staff. The questionnaire also addressed the percent of trauma care providers who were credentialed in continuing education (in-service) courses such as Advanced Trauma Life Support (ATLS)[21] or Trauma Nursing Core Course (TNCC),[22] or local equivalents of these courses.[23,24] Information on trauma registries and quality improvement programs was obtained. Finally, staff were given open-ended questions to describe any problems they faced in providing trauma care. The second form was an 11-page checklist based on 200 of the 260 individual items of human and physical resources contained in the Guidelines for EsTC. The guidelines designate elements as essential or desirable. Essential items are those deemed as the most cost effective and as items that could realistically be assured to almost any patient at a given level of the health care system in any country. Desirable items are those that add value but are not as cost effective and are more applicable to middle-income environments or very high volume facilities everywhere.

Site Visit Process

The questionnaire and checklist were used to interview key staff at each facility. These included hospital or clinic directors; chiefs of surgery, orthopedics, and other relevant specialties; emergency department (ED) chief; nursing director; and clinicians (doctors and nurses) on duty in the ED, intensive care unit (ICU), and hospital wards. Direct inspections of facilities and equipment in EDs and ICUs were carried out. Visits lasted between 3 hours (clinics; small hospitals) and 10 hours (large hospitals). Visits were conducted in 2003–2005. In Ghana and Mexico, all site visits involved at least one person who was external to that site (RQ for Ghana; CAR and CM for Mexico). In India and Vietnam, site visits to large and small hospitals involved such external persons (RV for India, SN for Vietnam); evaluation of around one third of the rural clinics involved external site visits; however, two thirds involved interviews with clinic staff conducted by some of the authors (RV, SN) during the staff's visit to a central locations for meetings. Each of the 200 items on the checklist was assessed as:

- Not applicable at that level of the health care system: NA
- Absent: 0
- Inadequate: 1
  Less than half of those who need this service or item receive it when needed
- Partly adequate: 2
  Most, but not all, of those who need this service or item receive it when needed
- Adequate: 3
  Virtually all of those who need this service or item receive it when needed

Items were assessed based on the criteria for the corresponding level of the health care system, with

increasing requirements for higher levels. Items were assessed based on their timely availability for all who need them, not their mere physical presence. For example, a diagnostic test that could frequently not be performed because of lack of reagents or periods of inoperation while awaiting repairs would be ranked as a 1 or 2 even if the equipment for the test were present. Services that required payment in advance and which were not routinely provided to all who needed them without regard of ability to pay would be rated as 1 or 2. As indicated in the Guidelines for EsTC, cost-recovery schemes may be applied after care is rendered but should not interfere with the provision of initial, essential items of emergency care.

For purposes of this paper, 60 highly important individual items from among the 200 were selected for analysis. These 60 items were selected based on consensus among the authors. Likewise, summaries of the reports of the 2-page baseline questionnaire are reported. Names of respondents were not recorded. The study was approved by the ministry of health of each of the countries or of the specific provinces/states, as appropriate.

RESULTS

Sites

A total of 51 clinics, 34 small hospitals, and 15 large hospitals were surveyed (Table 1). Large hospitals had 800–9,000 trauma admissions annually. Small hospitals had 100–300 trauma admissions and equal or larger number of transfers to large hospitals annually. All hospitals had much greater numbers of trauma outpatient visits. Clinics reported 2–10 trauma outpatient visits daily, with 10–30 trauma transfers per month.

Human Resources

Nurses formed the foundation of the rural clinics (Table 2). In Ghana, these clinics did not have doctors. In the other countries, they tended to have 1–2 doctors and thus less than 24-hour availability if the doctor(s) was away. In all locations, clinic staff had low levels of training for trauma care.

Medical and nursing coverage at both small and large hospitals was more complete, with some shortages, especially of nurses, reported in EDs (casualty wards). Many small hospitals in India and Ghana did not have full-time surgeons. In Ghana, most such hospitals did have moderate-level surgical coverage by general practitioners. Subspecialty coverage was fairly complete at large hospitals, except for Ghana and except for less-than-complete neurosurgical coverage elsewhere. In-service trauma training for doctors, in the form of courses such as ATLS or local equivalents,[21,23,24] was minimal at most rural clinics and small hospitals. Coverage was better, but still incomplete and variable, at large hospitals. Coverage varied considerably among facilities. For example, in Mexico, where the ATLS course has been established for many years, ATLS credentialing for attending/consultant-level doctors working in the ED and surgeons taking trauma call varied from 15% to 100% at large hospitals. In-service trauma training for nurses was especially deficient. Many hospitals did have some in-house trauma-related in-service training for ED nurses. However, externally validated training, such as TNCC,[22] was nearly absent. Staffing for rehabilitative services varied widely. However, everywhere, human resources for rehabilitation were not as well developed as for acute care (Table 2). Highly specialized services, such as speech pathology, were nearly absent.

Physical Resources

As would be expected, availability of physical resources paralleled the economic resources of the countries. However, in all countries, resources for acute resuscitation (Table 3) were extremely limited at clinics. Especially problematic was oxygen. This was not supplied at clinics in Ghana. There were only minor problems in India. However, in Vietnam and Mexico, oxygen availability was identified as a major problem at all clinics. Problems ranged from no supply to frequent, prolonged shortages with the one tank per clinic away for refilling. Likewise, airway equipment and fluid resuscitation capabilities were extremely limited. In Ghana, IV fluids were available but for restricted uses, such as labor and delivery—not for trauma.

Some small and many large hospitals tended to be fairly well supplied. However, at both levels, there were several specific problems, many of which could be corrected at low cost (Table 3). For example:

- Airway equipment (especially at small hospitals in Ghana) often was kept in operating rooms (theaters), not in the ED, and there were considerable delays in its availability in emergency situations.
- The same situation pertained to the availability of chest tubes in some locations.
- Some airway and other equipment (*e.g.*, urinary catheters) were available in adult sizes, but in only some, or no, pediatric sizes.

Table 2.
Training and staffing levels for trauma care at facilities in 4 countries: Ghana (G), Vietnam (V), India (I), Mexico (M)

	Clinic				Small hospital				Large hospital			
	G	V	I	M	G	V	I	M	G	V	I	M
Resuscitation and definitive, acute care												
Nurse in emergency department	2	3	2	3	2	3	2	2	2	3	3	2
Doctor for emergency call[a]	0	1	1	2	2	3	3	3	3	3	3	3
General surgeon[a]	NA	NA	NA	NA	1	2	1	2	2	3	3	3
Orthopedic surgeon[a]	NA	NA	NA	NA	0	0	0	2	0	3	3	3
Neurosurgeon[a]	NA	NA	NA	NA	NA	NA	NA	NA	0	2	2	2
Anesthetist/Anesthesiologist[a]	NA	NA	NA	NA	2	3	1	3	3	3	3	3
CE course for doctors (such as ATLS)[b]	NA	0	0	0	1	1	0	1	1	1	1	2
CE course for nurses (such as TNCC)[c]	0	0	0	0	0	1	0	1	0	1	0	1
Rehabilitation												
Specialized rehabilitative nursing	NA	NA	NA	NA	NA	NA	NA	NA	0	1	0	2
Physical therapy	NA	NA	NA	NA	1	1	0	1	1	3	1	2
Speech pathology	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	1
Physical medicine and rehabilitation specialist	NA	NA	NA	NA	NA	NA	NA	NA	0	2	1	2

If more than one institution evaluated in a category, average score is given.
The ratings in the table are: NA (not applicable for that level), 0 (absent), 1 (inadequate), 2 (partly adequate), 3 (adequate).
CE: continuing education.
[a]Available 24 hours per day, 7 day per week in hospital or promptly available on call from home.
[b]Advanced Trauma Life Support or local equivalent: ideal is that all doctors who provide first-line trauma care in emergency department and all general surgeons who provide trauma care are credentialed in such an in-service training course.
[c]Trauma Nursing Core Course or local equivalent: ideal is that all nurses who provide first-line trauma care in emergency department are credentialed in such an in-service training course.

- Some equipment, such as pulse oximetry and ventilators, were available in limited numbers and thus were not available to all who needed them on an emergency basis.
- Some nonreusable items, such as chest tubes, frequently ran out of stock. The problem was often not cost of repurchase, but difficulties and delays in the procurement process.
- Arterial blood gas determinations were possible at some large hospitals. However, the cost of the test kept it from being used frequently. For example, repeat tests on the same patient on the same day were rare.

Resources for management of specific injuries mostly did not apply to clinics (Table 4). Small hospitals were only modestly supplied. Especially problematic was diagnostic capabilities for abdominal injuries and some operative capabilities. Large hospitals reported some shortcomings, such as difficulties with optimizing head injury management. Some specific issues to note, including some which could be corrected at a low cost, included the following:

- There were frequent, often long, periods of inoperability of pieces of equipment while awaiting repairs. Especially problematic were computerized axial tomography (CT) and image intensification (C arms).
- There were occasional periods of unavailability of laboratory tests when reagents ran out of stock.
- Sometimes, services (such as CT scanning) were available but only to those who could pay, often in advance. This limited the availability of such services on an emergency basis.
- No facility had capabilities for autotransfusion from chest tubes.
- Prostheses for amputees were absent in almost all locations. They were sometimes available in capital cities, at the patient's own expense. The cost and time for travel to distant locations and the cost of the prostheses greatly limited their availability.
- Almost every institution reported difficulties with trauma-related medications, especially antibiotics and analgesics. There were frequent shortages, with relatives needing to buy medications from private pharmacies.
- Tetanus prophylaxis was limited at the clinic level. In some locations, antitetanus serum (ATS) was available, but not toxoid. In some locations, toxoid was present, but its use was restricted to pregnant women and children.

Table 3.
Physical resources for acute resuscitation of trauma victims at facilities in 4 countries: Ghana (G), Vietnam (V), India (I), Mexico (M)

	Clinic				Small hospital				Large hospital			
	G	V	I	M	G	V	I	M	G	V	I	M
Airway												
Oral and nasal airways	0	0	1	1	1	2	3	3	2	3	3	3
Suction device	1	0	1	0	1	3	3	3	2	3	3	3
Yankauer or other stiff suction tip	0	0	0	0	1	1	1	1	1	1	0	2
Laryngoscope and endotracheal tubes	0	0	0	0	1	2	2	2	1	3	3	3
Breathing												
Stethoscope	2	3	2	3	3	3	3	3	3	3	3	3
Oxygen	0	1	2	1	1	2	3	3	1	3	3	3
Chest tubes	NA	NA	NA	NA	1	1	0	2	1	3	2	2
Pulse oximetry[a]	NA	NA	NA	NA	0	1	0	1	0	2	1	2
Arterial blood gas determinations[a]	NA	NA	NA	NA	0	0	0	0	0	2	0	2
Bag-valve-mask	0	0	0	2	1	3	1	3	2	3	2	3
Mechanical ventilator[a]	NA	NA	NA	NA	0	0	0	0	0	2	1	2
Circulation												
Blood pressure cuff	2	3	3	3	3	3	3	3	3	3	3	3
Crystalloid	1	2	1	2	2	3	2	3	2	3	3	3
Blood transfusion capability	NA	NA	NA	NA	1	2	0	2	2	2	2	2
Urinary catheter	1	2	1	2	3	3	3	3	3	3	3	3
Electronic cardiac monitoring[a]	NA	NA	NA	NA	0	1	0	2	0	2	1	2
Hemoglobin determination	0	0	1	1	3	3	3	3	3	3	3	3
Electrolyte determinations[a]	NA	NA	NA	NA	0	1	0	2	0	2	0	3
Lactic acid determination[a]	NA	NA	NA	NA	0	0	0	0	0	0	0	1

If more than one institution evaluated in a category, average score is given.
The ratings in the table are: NA (not applicable for that level), 0 (absent), 1 (inadequate), 2 (partly adequate), 3 (adequate).
[a]Equipment categorized as ''desirable'' rather than ''essential'' in the Guidelines for EsTC.

Mismatch of Human and Physical Resources

There were several instances in which mismatch of the availability of human and physical resources prevented full availability of specific trauma care services. For example, in Ghana, one large hospital had an image intensifier (C arm), but no staff trained to use it; the machine lay idle. In India, several small hospitals had functioning X-ray machines and trained staff. However, the facilities were greatly limited in the number of plates (films) they received each month. Thus, many persons needing X-rays did not receive the service or were referred long distances. In many small hospitals everywhere, staff and equipment for X-rays, ultrasound, and laboratory tests were available during usual business hours. However, trained staff were not available during many nights or weekends, which were peak trauma times. Hence, the various tests and procedures were not available for a great many trauma patients. Many small hospitals did have ultrasound machines. However, technicians were trained for obstetrical ultrasound and not other tests, such as focused assessment with sonography for trauma (FAST) or other means to detect hemoperitoneum. Thus, the ultrasound machines were used infrequently or not at all for trauma. Many of these items are prime targets for improvement through strengthened organization and planning for trauma care.

Security for Health Care Personnel

Protection from potential body-fluid-borne diseases was partially adequate (Table 5). Antiretroviral postexposure prophylaxis was only intermittently available. In all cases, there were established policies. In many, but not all, situations, antiretroviral medications were available. However, the practice of testing patients and providers involved with needle-stick exposure was not well utilized in most locations.

Administrative Functions

Administrative functions specific to trauma care were notably weak everywhere (Table 6). Although many facilities had good medical record systems and could

Table 4.
Physical resources for management of specific injuries at facilities in 4 countries: Ghana (G), Vietnam (V), India (I), Mexico (M)

	Clinic				Small Hospital				Large Hospital			
	G	V	I	M	G	V	I	M	G	V	I	M
Head												
Computerized axial tomography[a]	NA	NA	NA	NA	NA	NA	NA	NA	0	2	2	3
Operative neurosurgical capabilities	NA	NA	NA	NA	1	NA	NA	NA	1	3	1	3
Intracranial pressure monitoring	NA	NA	NA	NA	NA	NA	NA	NA	0	0	1	1
Full compliance with AANS[a] guidelines for head injury	NA	NA	NA	NA	NA	NA	NA	NA	0	1	1	1
Neck												
Contrast radiography for esophageal injuries	NA	NA	NA	NA	0	0	0	1	0	0	0	3
Angiography[a]	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	1
Operative capabilities for neck injuries	NA	NA	NA	NA	1	2	1	2	2	3	2	3
Chest												
Autotransfusion from chest tubes[a]	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Operative capabilities for intermediate thoracotomy[c]	NA	NA	NA	NA	1	0	0	2	2	3	2	3
Operative capabilities for advanced thoracotomy[d]	NA	NA	NA	NA	NA	NA	NA	NA	0	0	1	2
Abdomen												
Diagnostic peritoneal lavage	NA	NA	NA	NA	1	2	0	1	2	2	2	2
Ultrasound[a]	NA	NA	NA	NA	1	2	0	0	1	2	2	2
Operative capabilities for laparotomy	NA	NA	NA	NA	1	2	1	3	2	3	3	3
Extremity												
Skeletal traction	NA	NA	NA	NA	1	1	0	1	2	3	3	3
External fixation	NA	NA	NA	NA	0	1	0	1	1	3	3	2
Internal fixation	NA	NA	NA	NA	0	2	0	1	1	3	3	2
X-ray	NA	NA	NA	NA	1	2	2	3	2	3	3	3
Portable X-ray	NA	NA	NA	NA	1	0	0	1	2	1	2	3
Image intensification[a]	NA	NA	NA	NA	0	0	0	0	0	1	1	1
Limb prosthetics	NA	NA	NA	NA	0	0	0	0	0	0	0	1
Spine												
Operative capabilities for spine management	NA	NA	NA	NA	NA	NA	NA	NA	0	1	1	3
Burns and wounds												
Topical antibiotic dressings	1	3	1	1	2	3	3	3	2	3	3	3
Skin grafting	NA	NA	NA	NA	1	2	1	2	2	3	3	3
Tetanus prophylaxis (toxoid and antiserum)	1	2	2	2	3	3	3	3	3	3	3	3
Medications	1	2	2	2	2	3	2	2	2	3	2	2

If more than one institution evaluated in a category, average score is given.
The ratings in the table are: NA (not applicable for that level), 0 (absent), 1 (inadequate), 2 (partly adequate), 3 (adequate).
[a]Equipment categorized as ''desirable'' rather than ''essential'' in the Guidelines for EsTC.
[b]AANS: American Association of Neurological Surgeons.[40]
[c]Intermediate thoracotomy: lung resection, repair cardiac lacerations, control bleeding from chest wall.
[d]Advanced thoracotomy: repair of great vessels using graft.

identify the number of trauma admissions of various types, none had a formal trauma registry with severity adjustment by injury severity scores or other scoring systems. Most hospitals integrated trauma cases into broader quality improvement programs. In Vietnam, facilities of all levels indicated that government-mandated review of deaths, including trauma, did lead to occasional improvements in the process of care. However, none of the larger hospitals in any country had a specific trauma-related quality improvement program identifying medically preventable deaths. Nowhere were autopsy findings used in any sort of quality assurance efforts. This is despite the fact that, in most locations, the majority of all trauma fatalities undergo an autopsy.

DISCUSSION

The purpose of this study was to identify priorities for affordable and sustainable methods to strengthen trauma care globally. Before drawing conclusions, the limitations of the study must be addressed. First, there was variability between countries as to how sites were chosen. This was

Table 5.
Security for health care personnel at facilities in 4 countries: Ghana (G), Vietnam (V), India (I), Mexico (M)

	Clinic				Small hospital				Large hospital			
	G	V	I	M	G	V	I	M	G	V	I	M
Training in universal precautions	2	2	2	3	2	1	2	3	2	3	2	3
Gloves	2	3	2	3	3	3	3	3	3	3	3	3
Goggles	0	0	0	0	0	3	0	1	1	3	1	2
Sharps and biological waste disposal	1	2	1	3	1	2	2	3	1	3	2	3
Antiretroviral postexposure prophylaxis	0	3	1	1	0	3	0	1	1	2	0	2

If more than one institution evaluated in a category, average score is given.
The ratings in the table are: 0 (absent), 1 (inadequate), 2 (partly adequate), 3 (adequate).

Table 6.
Administrative and organizational functions at facilities in 4 countries: Ghana (G), Vietnam (V), India (I), Mexico (M)

	Clinic				Small Hospital				Large Hospital			
	G	V	I	M	G	V	I	M	G	V	I	M
Trauma-related quality improvement program	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0
Trauma cases integrated into broader quality improvement programs	0	1	0	0	0	2	0	1	1	2	1	1
Trauma registry with severity adjustment	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0

If more than one institution evaluated in a category, average score is given.
The ratings in the table are: NA (not applicable for that level), 0 (absent), 1 (inadequate), 2 (partly adequate), 3 (adequate).

due to the need to meet local priorities in the work. Thus, comparisons between countries should be cautious. For example, in Vietnam, the capital city was studied. It would be expected that the capabilities there would be more advanced than in most other Vietnamese cities. It is also important to note that the structure of the health care systems were fairly different. While rural clinics and large hospitals were fairly similar in organization in all countries, there was great variability in what constituted a small hospital, especially as regards surgical and trauma care capabilities. However, the purpose of this study was not to make comparisons between countries but rather to identify priorities to improve trauma care globally. Limitations in comparability between countries do not materially hinder this main goal of the study. Second, this study evaluated the government-run systems but not private facilities. In India and Mexico, the private sector is fairly well developed and, in general, runs at a higher level than the government system. However, even in these countries, the government system takes care of most trauma patients, especially those who are lower income. Third, although physical inspection of equipment and supplies was fairly objective, information on the process of care depended mostly on key informant interviews. Ratings (0–3) were often based on subjective opinions. At each facility, the authors attempted to overcome this potential problem by interviewing a range of persons, including chiefs, administrators, and doctors and nurses who were directly providing care.

Despite the above limitations, this study provides a more comprehensive assessment of global trauma care capabilities than has been previously reported. This study builds on prior shorter reports on individual countries, some of which reported only on 11 selected variables for each facility.[18–20] The current study also provides a previously unreported global comparison and perspective. Several important conclusions to assist global trauma care development can be drawn.

In terms of human resources, there were shortages in doctors available for trauma care. However, shortages of nurses were especially evident, particularly in Ghana. This is only in part related to inadequate capabilities for training. It is related in larger part to the ''brain drain'' issues that have led many trained professionals to migrate from rural to urban areas and especially from LMICs to industrialized countries. This is especially a problem in Africa and has reached critical levels for nurses. Strategies to promote retention of trained personnel are desparately needed. Barriers should also be created to prevent the early loss of graduates from medical and nursing schools. Recruitment of nurses by foreign agencies should be strongly confronted and regulated.[25–27] The low development of human resources for rehabilitation is also noteworthy. In many

LMICs, the preponderance of injury-related disability is from extremity injuries.[28,29] Functional outcome from these is eminently amenable to low-cost improvements in orthopedic care and rehabilitation.

A final human resource issue is the paucity of in-service training for trauma care. The importance of regular in-service training bears emphasis. In Trinidad, Ali *et al*.[30] decreased mortality (67%–34%) among the most severely injured patients by institution of uniform ATLS training at that country's major hospital. Part of the solution is greater promulgation and establishment of such training courses. However, the solution is not all supply sided. Although all countries in this study had some type of in-service trauma course, use of the courses was suboptimal. For example, the ATLS program has been established in Mexico for over 10 years and has trained thousands of doctors.[31,32] Despite this, at most hospitals in Mexico, in this study less than 50% of doctors with significant trauma care responsibilities were ATLS certified, and at some, none were certified. Reasons included lack of availability of courses in some rural areas, long waiting times for courses (sometimes 2 years), and, principally, the cost of the course, which is equivalent to several weeks' salary for doctors in the public sector. This emphasizes the need for a more unified approach to assuring ATLS and other in-service training, especially in high-volume hospitals. Of note, hospitals that both required and subsidized ATLS for their staff had the highest levels of ATLS training. This is a model that might be considered for wider implementation.

This study identified several items of equipment that could be better supplied, especially at small hospitals and rural clinics. Sometimes the issue was not lack of these resources but rather that they were located elsewhere in the facility, and their use entailed significant delays. Many of these problems could be solved by improved planning for the layout and equipping of resuscitation area in EDs.[33] Likewise, facilities that reported shortages of low-cost items for resuscitation often indicated the problem was delays in the procurement process, which could be tightened up by improved planning, especially at the ministry of health level.

There are several higher-cost items that the Guidelines for EsTC list as ''desirable'' for small and large hospitals. These items, such as image intensification, angiography, pulse oximetry, and electronic cardiac monitoring, were frequently absent or deficient in this study. Staff frequently indicated they would like these items. The need for such higher-cost items could be better justified if it could be documented that a significant number of patient outcomes could be improved by these modalities. This would imply an adequate source of information (*e.g.*, trauma registry) and a process to monitor such outcomes through quality improvement programs. Such a process would likewise be useful for documenting how periods of inoperability of X-ray, laboratory, or other equipment were hindering patient care and the extent to which addressing such problems should be a priority.

Thus, a major finding of this study is the low level of development of such organizational and administrative mechanisms, such as the lack of severity-adjusted trauma registries and formal trauma-related quality improvement programs. Quality improvement programs have been increasing identified as useful ways by which to strengthen medical care in general in LMICs.[34–37] Recently, more is being reported on their use in trauma. For example, in Pakistan, Siddiqui *et al*.[7] and Jat *et al*.[3] reported on preventable death reviews carried out by peer review committees. They reported a higher rate of preventable deaths than in high-income countries. They attribute this to lapses in interhospital communications, prolonged ED stays, delayed ICU availability, lack of portable ventilators in the ED, inadequate initial resuscitation, and an overall absence of integrated and organized trauma care. Such peer review activities also hold promise for improving outcomes. In Thailand, Chardbunchachai *et al*.[38] identified a high rate of medically preventable deaths due to correctable problems, such as inadequate resuscitation for shock, delayed surgery for head injuries, and problems with record keeping and communications. They took targeted corrective action, including improving communications with radios within the hospital, increasing ED staffing by stationing fully trained attending (consultant) surgeons there during peak times, and improved monitoring of trauma cases, including use of a trauma registry. These improvements resulted in a decrease in mortality among all admitted trauma patients from 6.1% to 4.4%, all at an affordable and sustainable cost.[38] Such programs should be eminently transferable to other LMICs.

Thus, major recommendations from this study include the need to strengthen organization and planning for trauma care services through regular in-service training, improved procurement and placement of essential supplies, improved monitoring of the functioning of essential equipment, and use of trauma-related quality improvement programs (Table 7).

Finally, these health care issues cannot be considered separately from broader societal and economic issues. Although much can be improved at a low cost, more extensive improvements are hampered by economic constraints. Most countries spend only very small sums

Table 7.
Summary table of recommendations

Human resources
Decrease the migration of doctors and especially nurses from low-income countries.
Increase training capacity for certain highly deficient specialties, such as those involved with rehabilitation.
Increase the capacity for conducting trauma continuing education.
Increase the utilization of such continuing education courses such as by institutional policies that both require and subsidize these courses for key staff.
Physical resources
Each country or region should define trauma-related equipment and supplies that are ''essential'' at different levels of the health care system.
Availability of such essential items should be assured through an appropriate monitoring process, which might involve hospital inspection.
Availability of such essential items could be promoted by tightening up processes for procurement and timely repair of equipment, as well as by arrangements within facilities to locate essential items where they can be rapidly utilized when needed.
Better optimize the planning for both human and physical resources so as to avoid wasteful mismatches.
Security for health care personnel
Increase capacity for sharps and biological waste disposal as well as training in universal precautions.
Increase capacity for delivery of antiretroviral postexposure prophylaxis.
Administrative functions
Strengthen the capacity for trauma organization and planning in both individual facilities and in ministries of health.
Establish trauma-related quality improvement programs that identify and address correctable factors in preventable deaths and that are appropriate for local conditions.
Broader societal issues
Increase funding available to the health sector through such measures as debt relief; relaxation of health-sector restrictions in structural adjustment policies; and promotion of policies directed towards a more equitable world economic order within the World Trade Organization, the World Bank, and other international institutions.

on health, US $17–$30 per capita for the low-income countries in this study, in comparison to US $5,000 for the United States. Increasing health expenditures is limited by overall poverty and debt and specifically by restrictions imposed by the World Bank as part of structural adjustment policies. Care of the injured would be strengthened by measures that would allow greater funding of the health sector, including many measures being debated currently, such as debt relief, relaxation of structural adjustment restrictions, and creating a more equitable world economic order, such as by requiring the World Trade Organization proceedings and rule making to be more open and democratic.[39]

CONCLUSION

This study has identified several specific ways in which trauma care could be improved in an affordable and sustainable fashion. Several important low-cost resources could be better provided at clinics/small hospitals in middle-income countries and at most facilities in low-income countries. More generally, in all settings, continuing education for trauma care could be improved. Most deficiencies identified in this study could be improved upon through improved organization and planning for trauma care services, both at the level of individual facilities and within ministries of health. The Guidelines for EsTC offers the first internationally applicable standard for countries to use to assess their trauma systems. In so doing, the guidelines offer a way to promote realistic, minimum standards for trauma care in a comprehensive fashion worldwide.

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