The State of Global Trauma and Acute Care Surgery/ Surgical Critical Care

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KEYWORDS

• Global trauma • Acute care surgery • Surgical critical care
• Trauma economic burden • Trauma systems • Global trauma solutions
• Trauma registries

KEY POINTS

- Trauma is a leading cause of morbidity and mortality globally, with a significant burden attributable to the low- and middle-income countries.
- Road injuries are the major contributors to trauma-related economic burden, with the United States, China, and India being the highest impacted countries.
- Many injured patients are treated in critical care units, and timely intervention may improve the overall prognosis.
- Strengthening existing care mechanisms can help develop efficient and cost-effective trauma systems.

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INTRODUCTION

Trauma is a global health problem with an unevenly distributed impact, the major brunt borne by low- and middle-income countries (LMICs), where more than 90% of worldwide trauma-related deaths occur[1] (**Fig. 1**). Furthermore, countries belonging to lower socioeconomic strata have proportionally greater age-standardized injury-related death rates (**Fig. 2**). Within these regions, people from poor backgrounds are more vulnerable, making poverty a risk factor for trauma-related morbidity and mortality. In this review, we describe the worldwide distribution of trauma and critical care facilities and discuss solutions for mitigating the burden in LMICs.

TRAUMA AND GLOBAL BURDEN OF DISEASE

In 2019, 714 million people suffered, and 4.3 million died from injuries, accounting for 7.6% of the worldwide mortality.[2] Over the last 30 years, trauma has been consistently ranked as the leading cause of death in the 10–49-year age group and overall, the third most common cause of global deaths and disability-adjusted life years (DALYs). Although the incidence of trauma has increased by 12.5% between the years 2010 and 2019, the age-standardized death rates (see **Fig. 2**) and DALY rates (**Fig. 3**) have decreased by 19.4% and 18.6%, respectively. Since 1990, there has been a marked shift toward a greater proportion of the burden of DALYs due to years lost due to disability (YLDs) from noncommunicable diseases and injuries, compared with communicable, maternal, neonatal, and nutritional diseases, the epidemiological transition being most noticeable in high-income countries (HICs).

Unintentional injuries are a major contributor to the 4.3 million annual trauma-related deaths, with road traffic injuries (RTIs) being prevalent among adolescents and young adults and falls in the elderly. Geographic variations in fatal trauma mechanisms result from a higher proportion of penetrating injuries in HICs, which contribute significantly to the burden of self-harm and interpersonal violence.[2] Apart from leading to deaths, nonfatal trauma is associated with increased acute care hospital visits and disabilities requiring long-term rehabilitation. Hence, preventing injuries has been included in Sustainable Development Goal targets, focusing on unintentional injuries.[3]

It is difficult to characterize the burden of severe trauma in LMICs owing to a paucity of resources for quantifying outcome measures and the limited availability of critical care facilities,[4] because of which first-hand intensive care unit (ICU)-based data are likely to underestimate the true magnitude of the population at risk. However, mortality from critical illnesses in LMICs is reported to be higher than that in HICs and has been shown to affect younger age groups.[5,6]

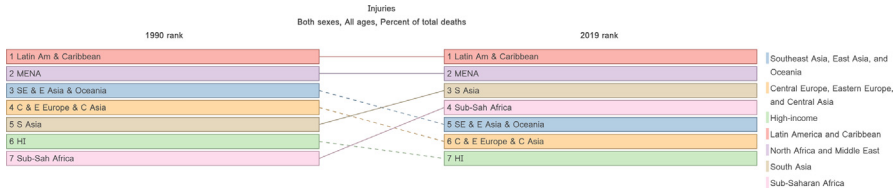

Fig. 1. Ranking based on percentage of total injury-related deaths with respect to Global Burden of Disease region in 1990 and 2019, showing that the least proportion of deaths occurred in HICs (5.48%) in 2019. (Institute for Health Metrics Evaluation. Used with permission. All rights reserved.)

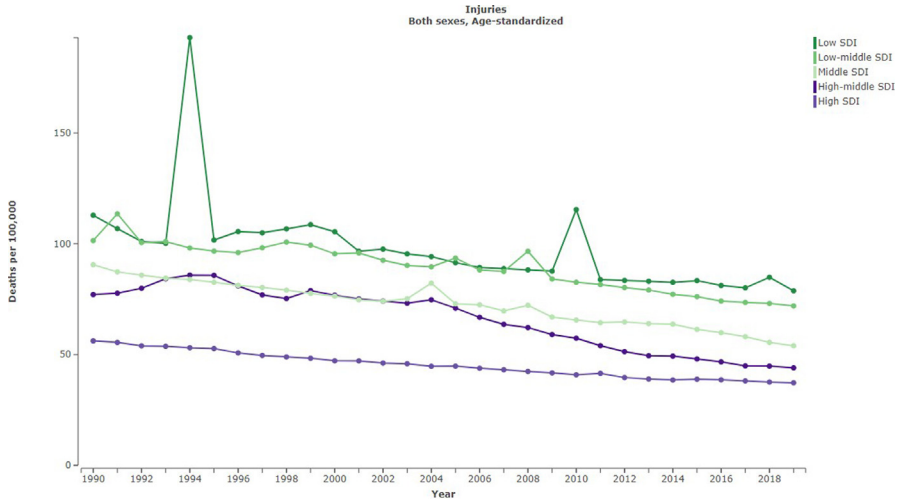

Fig. 2. Declining trend of age-standardized death rates from 1990 to 2019 categorized by Sociodemographic Index (SDI), a composite indicator of income per capita, years of schooling, and fertility rate in females under 25 years of age. (Institute for Health Metrics Evaluation. Used with permission. All rights reserved.)

ECONOMIC COSTS TO NATIONS

In addition to their direct medical consequences, trauma and critical illnesses have major economic implications. In a simulation study, Chen and colleagues[7] estimated that road injuries will cost the world economy about US$1.8 trillion (measured in constant prices as of 2010) in 2015–2030. The United States, China, and India will be the highest

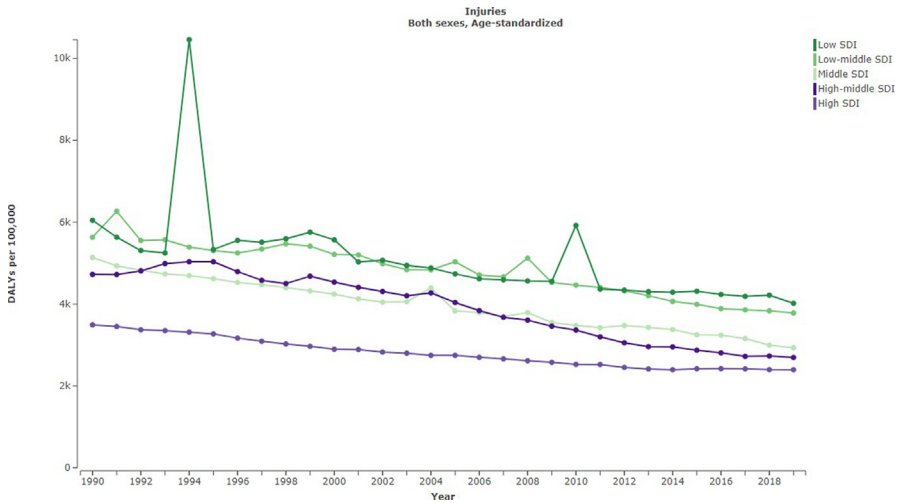

Fig. 3. Declining trend of age-standardized DALY rates from 1990 to 2019 categorized by Sociodemographic Index (SDI). (Institute for Health Metrics Evaluation. Used with permission. All rights reserved.)

impacted countries. Despite the large share of road injury-related DALYs contributed by LMICs, their share of the economic burden is only 46.4% of the global loss. This study suggested that though LMICs have the highest trauma burden, HICs share the largest economic fallout of road injuries. The macroeconomic burden among LMICs is expected to rise owing to increased motorization and infrastructure development.[8]

Trauma Systems Worldwide

A trauma system is a comprehensive and coordinated injury response network equipped with the facilities to care for an injured patient.[9] It includes emergency medical services (EMS) dispatch and pre-arrival instructions, EMS field triage and transport, trauma system hospital, inter-facility transfer, trauma team activation, operating room and interventional radiology, ICU, and general unit care, early rehabilitation, and injury prevention.[10] The World Health Organization (WHO) proposed a Trauma System Maturity Index which classified trauma centers from Level I to Level IV with the former being the least mature or unorganized and the latter being the most mature and well equipped.[11] This is contrary to the classification proposed by the American College of Surgeons/Committee on Trauma (ACS/COT), which classified centers from Level I to Level III.[11,12] The higher number of Level I and II trauma centers in LMICs as compared with Level III and IV systems in HICs is explained by the greater availability of trained personnel, ambulances, and better adherence to trauma management protocols supported by advanced facilities in HICs.[11]

The lacunae in trauma care at various stages likely account for the higher injury-related mortality in LMICs, which is approximately twice that in HICs.[13] To begin with, most LMICs lack organized prehospital care and triage, without systematic communication between the EMS team and hospital personnel before the transfer, leading to unpreparedness for critically injured patients.[14,15] Most emergency personnel in LMICs lack training in Basic Life Support (BLS) and Advanced Trauma Life Support (ATLS), as a consequence of which patients do not receive prehospital life-saving treatment.[14,16] Delays in seeking definitive care are prevalent among patients injured in smaller cities; many of whom clock unnecessary distances and receive nontherapeutic interventions at inadequately equipped basic and intermediate level health centers before arriving at tertiary care centers. The time from injury to receiving care varies widely within these countries, ranging from approximately 9–10 h in poorly resourced regions[17,18] to less than an hour in metropolitan cities.[19] Lack of training, equipment and drugs, and hospital policy-related issues contribute to the failure of provision of essential functions such as cervical spine and limb fracture immobilization, pelvic fixation, and immediate dressing of burns at peripheral and some district-level health centers.[20,21] District and central tertiary care centers experience a significant shortage of staff and resources needed round the clock for patient care, including laboratory and imaging investigations, and personal protection.[22,23] Lastly, long-term patient care services are not addressed adequately, with referral and transportation delays resulting in deficient patient rehabilitation via occupation and physical therapy.[24]

Acute Care Surgery

Acute care surgery applies similar principles of trauma care – team approach, processes, and quality improvement – to other time-sensitive non-trauma surgical conditions. It encompasses the management of critically ill patients developing shock, organ failure, sepsis, and requiring advanced organ support following acute non-trauma surgical conditions. This broadened scope of surgical care has led to the development of this specific field in surgical care. Initially in most places model started as on call surgeon for all emergency surgeries. This often-caused overburdening of the

emergency surgical sphere and restriction or cancellation of elective surgeries. To optimize the resources and efficient organized systems of surgical care delivery, the models of Acute Care Surgeries were developed and implemented across the healthcare system in North America. The model ensemble dedicated surgical teams – surgeons, residents, and nursing staff with expertise in surgical critical care as well. The essential structural components of ACS models are- ED, Trauma, and Critical Care coverage. The surgeons with such training are accountable for the Acute care chain, beginning from the emergency department, Operating room, and critical care of patients. This development of Acute care surgery and critical care enabled the rekindling of acute care surgery compared to other elective surgical branches. The adoption of acute care surgical models within the healthcare systems has been shown to improve patient outcomes and cost-effectiveness within the North American healthcare system[25]. However, there is considerable variation in the development and adoption of these ACS models worldwide due to nonuniform resources and priorities. In the recent systematic review, the authors investigated the essential components of the ACS model and their adoption worldwide.[26] They found that most developed ACS models were chiefly in North America and to some extent in Australia. While within Europe and in a few countries in Asia the studies reported either partial adoption of the model or the initial phases of adoption. The heterogeneous adoption of ACS models reflects larger variation in the healthcare environment, resources, needs, and competing priorities or it may be reflective of the time lag of the development of healthcare systems overall. In LMIC the focus is on overall access to emergency healthcare rather than acute care surgery, thus restricting the development.Of all the three components – ED, Acute Surgery, and Critical Care – the adherence to availability of dedicated surgical care for all non-trauma emergency surgery was highest in hospitals that adopted the ACS models, though the round–clock site attending coverage was found only in centers from US and Taiwan. Critical care services, which are integral to ACS models, have been largely confined to US models and have not been reported from other parts of the world. Though ACS models have shown improvement in the care of non-trauma acute care surgical practices, the widespread adoption in different health care environments remains little. Whether the adoption of ACS models in different health care settings would have a similar effect as in North American settings, is yet to be evaluated. Though the potential benefit can not be excluded, the ineffectiveness with wastage of resources, overburdening of healthcare system is also a possibility, given the mismatch between demand and availability of resources. The adoption of ACS models worldwide would require flexibility in approach and would need need to be context specific integrating the essential components of ACS with available resources.

THE INTERPLAY BETWEEN TRAUMA AND CRITICAL CARE

Critical care emphasizes life-saving and supportive therapies that maintain vital organ functions rather than the definitive treatment, which is the focus of other medical specialties. The core interventions for trauma management, similar to critical care, encompass physiologic monitoring and stabilization to allow specific therapies to improve the underlying condition causing acute deterioration. Most measures in acute trauma management rely upon timely interventions, beginning with securing the airway, breathing, and circulation, which if delayed or performed unsatisfactorily reduce the efficacy of the intervention. Khajanchi and colleagues[27] reported that only 15% of patients with severe isolated traumatic brain injury (Glasgow Coma Scale score < 9) received a definite airway before arriving at tertiary care centers in an Indian

trauma registry, in contrast with Level 1 recommendations for intubation by various trauma guidelines.[28,29] Deficiencies in fluids, vasopressors, and inotropes for maintaining circulation are common, exacerbated by a failure to display cardiopulmonary resuscitation (CPR) algorithms in resuscitation trolleys, even in tertiary care hospitals in LMICs.[30,31] Many trauma-related deaths occur in the first week, after 24 h in the ICU.[32] The delayed deaths are often attributed to post-injury complications such as acute respiratory distress syndrome, pneumonia, coagulopathy, and acute kidney injury.[33] The impact of post-injury intensive care complications is unknown owing to deficient data in LMIC settings.

Considering the urgent needs of critically injured patients, it is hypothesized that treating them in dedicated trauma units may improve outcomes compared with general care in emergency departments and ICUs catering to trauma and non-trauma patients simultaneously.[34,35] However, the availability of the former is variable, albeit negligible worldwide, especially in LMICs. Furthermore, a survey of trauma centers in the United States revealed distinct variability in managing patients in trauma ICUs, with many beds being occupied by non-trauma surgical patients.[36]

Global Trauma Management in Intensive Care Units

The availability of ICUs varies globally, irrespective of disease epidemiology. Although approximately 5–30 ICU beds are available per 100,000 people in HICs, only 0.1–2.5 ICU beds are available per 100,000 people in LMICs.[37] Fundamentally, the provision of critical care should be standardized as many trauma-related deaths are preventable. However, disparities exist and are multifactorial.

First, ICUs are resource-intensive, and despite using substantial resources, outcomes may be unfavorable. Compared with critical illnesses, fewer resources are needed for treating non-acute illnesses, which also provide favorable outcomes. Thus, it may not be cost-effective to set up ICUs. Costing studies from HICs report average daily costs of ICU care between US$230 and 4915 (as per costs in 2020).[38] Though the average cost reported in an LMIC-based study was US$109, it is not covered by insurance in many LMICs.[39–41] The severity of illness, mechanical ventilation, hemodialysis, and longer length of stay are associated with escalation of charges.[38,42,43] Although the growth of private-care hospitals in LMICs may partially offset the demand for critical care services, the quality of care is variable, and only a small subset of the population can afford the associated expenses.[8] This deficit is further compounded by reductions in international health care aids as countries transition from lower-income to lower-middle-income status.[44] Thus, there is an unmet need for an affordable critical care model and restructuring organization.

Second, most ICU interventions are technologically demanding, which hampers uniform availability and adoption, thus leading to a large variation in the quality of ICUs.[37] Although overall ICU-running costs are lower in LMICs, equipment costs can be significantly higher because of importation taxes and noncompetitive pricing structures resulting from a dearth of local manufacturers and indigenous products.[37,45]

Third, in low-resource settings, hospitals are often burdened with an influx of critically ill patients beyond their ICU capacity. This limited availability of ICU beds leads to spill over of acutely ill patients in the wards and other settings, compromising their care. Improvement in organizational structure, hospital-wide triage models, training and empowerment of nurses, and generation of local guidelines may help in providing critical care outside of ICU and improved triaging of patients requiring ICU care.

Lastly, the lack of reliable estimates of critical illnesses in resource-limited settings complicates the extrapolation of clinical management guidelines originating from HICs.[46] However, because of the absence of reliable data, the guidelines are adapted

with local modifications to incorporate variations in disease frequencies and available resources. It would be prudent to formulate critical care guidelines based on reliable estimates from local studies that will provide more effective solutions.

Trauma and Acute Care Surgery Solutions

Implementing well-structured protocols from prehospital settings to a designated care facility, culminating in meticulous rehabilitation for chronic sequelae, is necessary to reduce the global burden from injuries and critical illnesses.

A delay in seeking care for the trauma victim (first delay), untimely transportation of the victim to the nearest trauma center (second delay), and longer time taken for medical interventions (third delay) are some deficiencies that need to be highlighted in the LMIC setting. Factors such as illiteracy of the public, insufficient ambulances and health care personnel, and a scarcity of nearby trauma centers contribute to these delays.[47] Although HICs have road and air emergency transport systems, most patients in LMICs rely on private or commercial vehicles for transportation to the nearest trauma center.[48] Establishing prehospital care systems and formally training first responders through the assessment of knowledge and provision of basic equipment may help halve injury-related mortality in LMICs.[49,50]

Training health care workers, especially resident/postgraduate doctors involved in delivering trauma and critical care services, is of paramount importance as they form the pillars of care delivery in teaching hospitals. Although 51 of 79 LMICs offer surgical postgraduate medical education, only 34 of these include traumatology in their curriculum.[51] Masters and fellowship in trauma programs designed to facilitate acute care surgery systems in LMICs can help sensitize young trainees to limitations in resource-restricted settings and maximize and generate future leaders in the field.[52] Trauma life support training courses have been shown to improve the overall skill of health care workers.[49] Although ATLS training is variable among resident doctors in LMICs, owing potentially to its cost, alternate options such as the primary trauma care (PTC) course and its modules are available for free and have significant potential for implementation in LMIC settings.[53,54] Trauma team training is a novel approach that may reduce the time taken to administer critical interventions by directing training toward a group rather than an individual solely.[55] It must, however, be emphasized that training programs alone may not directly improve outcomes for injury victims, reiterating the importance of a multifaceted approach to strengthen trauma systems.[56]

Although there are various deficiencies in trauma and critical care delivery in LMICs, it must be acknowledged that several well-functioning informal mechanisms already exist and could serve as the foundation for a more robust system.[15,57] Gwaram and colleagues[58] elucidated numerous benefits of establishing a trauma center in a tertiary hospital in Nigeria. Equipped with dedicated trauma teams and resources over the clock, the center could address complex multisystem injuries and was pivotal in managing mass casualty situations from RTIs, fires, civil unrest, and bomb explosions. Requiring police officers to inform the hospital about crash victims beforehand promoted trauma team preparedness. The center also provided the infrastructure for developing fellowships in trauma and critical care and ATLS training and enabled fellows to engage in research activities. Modifying trauma systems in line with local needs helps individualize care delivery while adhering to basic protocols. The Hamad Trauma Center in Qatar besides maintaining trauma care units also offers clinical psychological services, efficient rehabilitation programs, and an Injury Prevention Program aimed at increasing awareness about trauma prevention among civilians.[59] Integrating major trauma centers with peripheral hospitals by strengthening referral systems improves the efficiency and cost-effectiveness of patient transfer.[60] Mobile

phone and WhatsApp-based groups are still being used widely in LMICs to coordinate the transfer of COVID-positive patients during the pandemic by communicating the patient status and the availability of beds and ventilators.[61] Multiple stakeholders are updated about the problems faced to plan for the subsequent work period via online video-based meeting platforms such as Zoom, serving as surrogates for quality control and assurance, which are necessary to build sustainable care capacity. Such features can be emulated into trauma systems at a smaller scale.[62,63] In 2019, the WHO launched "The WHO Global and Trauma Care Initiative'' (GETI), aiming to increase capacities for quality emergency and trauma care worldwide and foster awareness about life-saving measures.[63]

Trauma rehabilitation plays an important role in improving functional outcomes. Although rehabilitation is usually offered in a hospital environment under medical regulation, the same is not easily accessible to most patients in LMICs.[64] Trauma patients can gain significant support in their journey toward attaining physical and psychological health by involving their community.[65,66] Carefully considering the health priorities of victims and fostering community engagement improves acceptability of interventions, aiding not only in the recovery of function but also prevention of injuries such as falls in the elderly.[67]

Role of Trauma Registries

Trauma registries enable service evaluation, surveillance, research, and quality improvement activities. Most critical care registries encompass a broad group of patients, producing a heterogeneous case-mix that increases the complexities in evaluating a particular cohort of disease, more so for trauma patients arriving in the ICU. Therefore, disease-specific registries may provide better quality information. However, there are certain limitations, such as variability of data elements, absence of data regarding ICU admission and complications, and long-term functional outcomes.[68] Given the above deficiencies, developing a Trauma Critical Care Registry can help bridge the knowledge gap.[69]

SUMMARY

Trauma and critical illnesses lead to significant mortality and impairment of functional and psychological outcomes among survivors, with consequential economic strain exerted on patients and hospital services, more so in LMICs. Development and implementation of management protocols in line with existing systems at the prehospital, in-hospital, and post-injury rehabilitation levels can help address local needs resulting from heterogeneity in disease burden and resources.

CLINICS CARE POINTS

- Most trauma-related deaths occur in low- and middle-income countries (LMICs), and poor patients living in rural areas in these regions are more severely affected than those in metropolitan cities
- Delays at various levels in seeking, reaching, and receiving life-saving treatment lead to higher injury and critical illness-related mortality in LMICs than high-income countries (HICs)
- Measures taken to address these delays may decrease mortality and improve functional outcomes
- Developing trauma and critical care registries in LMICs can help formulate guidelines and protocols in line with local needs by providing crucial data

DISCLOSURE

The article is original, has not been published before, and is not being considered for publication anywhere else. All authors have sufficiently contributed for the article. There is no conflict of interests and financial support involved. The article has been read and approved for submission by all authors.

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