6 Motor Vehicle Accidents: The Scourge of the Developing World

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Road traffic injuries (RTIs) are one of the leading causes of death and disability worldwide, are the leading cause of death in persons aged 15–29 [1], and are seeing increasing incidence in low- and middle-income countries (LMICs). According to the World Bank, countries are classified as low-income countries which have upon a gross national income (GNI) per capita of less than $1036 and as middle-income countries which have a GNI less than $12,615 [2]. Major increases in motorization without concomitant increases in infrastructure improvement and investment are driving the increase in road traffic injuries (RTIs) (Fig. 6.1). In many places roads are choked with cars, motorcycles, minibuses, trucks, pedestrians, bicyclists, livestock, and potholes. Traffic laws are typically all but nonexistent, and in many places where they do exist are rarely enforced [3]. The bedlam on the streets of a typical low-income (LIC) or middle-income country (MIC) is often indecipherable and intimidating to visitors from high-income countries (HICs), and for good reason, as these congested and raucous streets are the cause of much of the world's burden of road traffic injury.

By unanimous vote, United Nations member states designated the decade 2011–2020 "A Decade of Action for Road Traffic Safety" with the intention to focus international attention on the issue of road traffic safety. The World Health Organization (WHO) has been involved in gathering the existing evidence on road safety with the goals of focusing attention on the magnitude of the problem of road safety and to help identify solutions to the problems of road traffic injuries. The first *World report on road traffic injury prevention* was published by the WHO in 2004 [4] and reviewed the evidence for the burden of injury due to RTCs and recommended specific prevention measures be adopted by countries to reduce the burden of these injuries. A second report was published in 2009 *Global status report on road safety*: *A time for action* and outlined the progress to date on the recommendations made in 2004 [5]. There were improvements in many countries, yet most LICs had seen increases in death rates that seemed unchanged despite some enactment of preventive measures. To date, in many LICs, there are few laws designed to govern traffic safety, and those laws that do exist are hardly enforced. The WHO and UN initiative is pushing this agenda forward, and progress can be observed in the Global Status Report documents [3–5].

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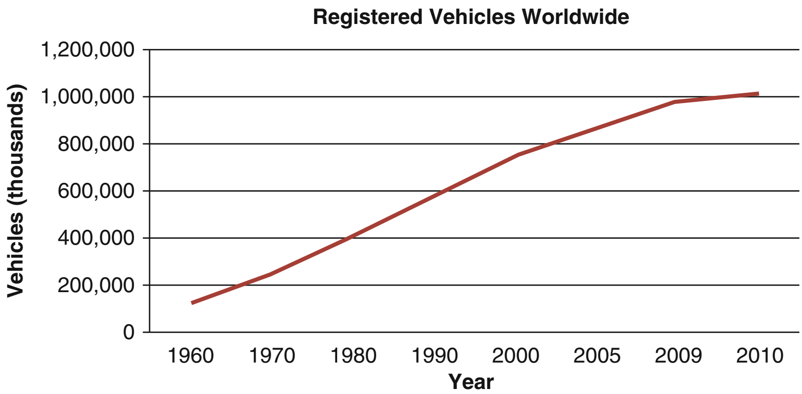


Fig. 6.1 Registered vehicles worldwide by year (From Davis SC, Boundy R, Diegel S. *2012 Vehicle Technologies Market Report*. Oak Ridge National Laboratory; 2013. http://www-cta.ornl.gov/cta/One_Pagers/VTMR_2012.pdf)

The *Global Status Report on Road Safety 2013* provides an update on progress from the 2004 and 2009 reports [3]. The data included in the 2013 report were collected via a survey tool administered to select persons within the governments of 184 participating countries. LICs had 12 % of RTC-related deaths but only 1 % of the world's registered vehicles. Most deaths in LICs were among pedestrians, followed by car occupants. MICs were found to have the highest burden of fatality due to road traffic injury, accounting for 80 % of all road traffic deaths worldwide but only 52 % of the world's registered vehicles. In middle-income countries, the proportion of deaths due to motorcycles or other two-wheeled motor vehicles was higher than in either LICs or HICs but still was not as high as the proportion of deaths among car occupants. Most of these are difficult to categorize into mechanism of death or diagnoses, so drawing conclusions on the type of injuries seen among RTC victims remain difficult. The makeup of road users, types of prevalent vehicles, and road speed will all influence the types of injuries seen. It may be useful to conceptualize RTIs in the same way as for many other human diseases: the interaction between host-vector-environment, as illustrated in Fig. 6.2a and shown in matrix form in Fig. 6.2b.

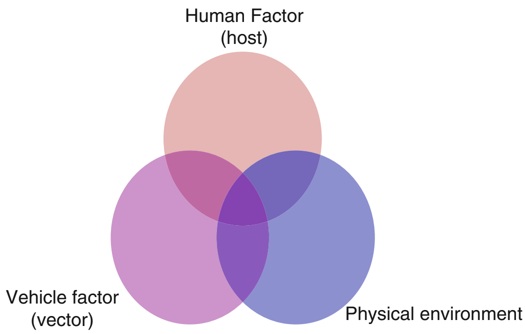
6.1 Road Traffic Injuries

In many LMICs, transport around cities can be challenging. Many people purchase motorcycles rather than cars, as they are inexpensive both in initial purchase price and operation costs. Countless entrepreneurial new owners have improvised themselves as moto-taxi drivers. Oftentimes a single motorcycle is the only transport available for a family, so it is not unusual to see a family of four or more on a motorbike (Fig. 6.3). Unfortunately it is also not unusual to see members of these families in the accident and emergency departments of hospitals serving cities in LICs and MICs.

Pedestrians, two-wheeled motor vehicle drivers, and cyclists are all termed non-enclosed road users and are at higher risk for more devastating injury in road traffic crashes [6]. A typical motorcycle accident in Kumasi, Ghana, for example, involves a Gustilo grade IIIa–b open tibia fracture, a closed midshaft femur fracture, and multiple abrasions and lacerations. These patients often get transported to the hospital in a private car or taxi, and if they are lucky enough to make it to a trauma center in a reasonable time, they will receive some treatment. Unfortunately patients that have blunt abdominal trauma or severe head injuries resulting in life-threatening injuries typically do not make it to the hospital [7].

The types of injuries seen by surgeons treating road traffic victims vary by location, predominant type of vehicular transport, and the infrastructure of the location and country in which they are practicing. In high-resource settings, teams of surgeons and physicians respond to traumatic injury with highly coordinated trauma response systems. Prehospital care is highly effective at reducing mortality; surgeons, emergency physicians, and teams of highly trained responders all focus on quick assessment

a



b

Phase	Goals	Human	Vehicle	Environment
Pre-Crash	Crash prevention	KAP Impairment Law enforcement	Roadworthiness Speed management	Road design/layout Speed limits Pedestrian facilities
Crash	Injury Prevention	Impairment Use of Restraints	Occupants restraints Other safety devices Crash protection	Crash protective roadside objects
Post-crash	Life & limb salvage	First aid skills Access to care	Ease of access Fire risk	Rescue facilities Congestion

Fig. 6.2 (**a**) The intersection of host, vector, and environmental factors lead to road traffic crashes and subsequent injuries. (**b**) These different factors can be split into their component parts and analyzed for planning potential interventions for pre-crash, crash, or post-crash time points

Fig. 6.3 A common sight on the roads of low- and middle-income countries

and treatment of major trauma, which results in good outcomes for patients. In most low-resource settings, these response systems are nonexistent, with trauma centers few and far between. Komfo Anokye Teaching Hospital (KATH) in Kumasi, Ghana, for example, has a catchment area that includes almost all of Northern Ghana and extends into neighboring countries of Benin, Togo, and Cote d'Ivoire. Patients will come in with minimal bandaging and occasionally splints to help stabilize their fractures, but they may have traveled days to get to KATH (Direct Observation at KATH).

In addition to acute fractures of all types, neglected trauma is a huge problem in these countries. Patients that sustain a closed or even an open fracture may go to traditional healers before presenting to a physician (very few actually make it to a trained orthopedic or trauma surgeon), as these healers are available, accessible, and significantly more affordable [8]. Especially in West Africa, traditional bonesetters are well known, so many people feel comfortable going to them for care before going to a hospital. The perception of many patients is that hospitals are "places to go to die," and therefore should be avoided at all costs. This is a self-fulfilling prophecy as many patients are brought in only when agonal. Many times patients treated by these traditional bonesetters end up with malunions, nonunions, limb length discrepancies, gangrene, osteomyelitis, and contractures [8, 9]. There are examples of orthopedic surgeons reaching out and teaching these bonesetters how to properly treat certain pathologies, when to refer a patient, and have been met with some success [9]. Nonetheless often significant complications due to delays and poor initial management must be dealt with by an orthopedic surgeon dealing with road traffic injury in LMICs.

6.2 Epidemiology

The first Global Burden of Disease (GBD) study was performed in 1990, and the latest iteration, the GBD 2010 study, was published at the end of 2012. The GBD study attempts to offer a baseline of what etiologies are responsible for what proportion of disease worldwide with an aim to inform policy decisions and resource allocation regarding health globally. The study attempts to quantify the burden of disease of each selected etiology and then compare that burden between diseases. It also aims at assessing the impact of selected risk factors. Comparison is achieved through the use of a composite unit of measurement made up of components of mortality and morbidity combined into one metric referred to as the disability-adjusted life year (DALY). All injuries account for 11 % (278,665,000 DALYs) of DALYs worldwide, more than HIV, malaria, and tuberculosis combined which together account for 8.5 % of total DALYs (213,628,000 DALYs). RTIs account for 27 % of the total DALYs attributable to injury [10], were the eighth highest overall cause (all ages) of death in 2010 [1], and were the leading cause of death in the age group 15–29 years old [1]. In countries that have limited access to orthopedic trauma care, musculoskeletal injuries due to RTCs cause lifelong disability and typically affect young people in their prime income earning years [3, 11, 12].

Despite the GBD and other studies, the total burden of injury due to RTCs remains poorly elucidated. Much of the data in the GBD study are ultimately based on extrapolations from "similar" locations or hospital bases studies. There have been many epidemiological studies examining the burden of road traffic injury in developing countries, yet most have been hospital based and therefore not capture patients that do not present to a hospital for treatment.

Bayan et al. profiled the injuries that presented to a hospital in Primpri, Pune, India [13]. Patients having multiple injuries were the most common admissions, followed by injuries to the lower limbs (38 %). Fractures (71 %) were by far the most common type of injury seen in patients presenting due to RTIs. Whiteside et al. profiled pediatric injuries presenting to the accident and emergency department (ED) at KATH in Kumasi, Ghana [14]. Most ED admissions were due to injury (66 %), and 43 % of these were due to RTIs. Fifty-eight percent of these RTIs occurred while the child was a passenger in a car, 26 % were pedestrian injuries, and 14 % were from motorcycle injuries. Musharrafieh et al. surveyed every 12th patient that presented to the ED after a traumatic event over the course of 1 year [15]. RTIs were responsible for only 11.8 % of all admissions, with the upper extremity (38 %) followed by the lower extremity (31.9 %) representing the most commonly injured body parts. Herbert et al. used national injury registry data to evaluate injury in children in South Africa [16]. Falls (39.8 %) were the most common cause of injury, followed by road traffic (15.7 %). The upper extremity (30 %) was the most commonly injured body part, and the child was most often a pedestrian (69 %). Ultimately, the patterns of injury seen in a given situation will reflect the types of transportation used locally.

Herman et al. performed a systematic review of the literature on RTIs in the Pacific region countries [17]. Most of the studies were performed in Papua New Guinea (PNG), and most of which are outdated. In a study of all postmortems performed at Port Moresby General Hospital between the years 1961–1989, RTIs were responsible for 45 % of all deaths, 75 % of which were male [18]. Two other studies included in the review examined the proportion of deaths that occurred prior to hospital arrival, 66 % prehospital in one study [19] and 81 % in another [20]. At least one study attempted to quantify the number of injury incidences in Accra, Ghana, using police records but was unable to describe the injuries incurred by the victims of RTIs [21]. A study from Nigeria highlights the increasing popularity of motorcycles as means of transportation and their impact on RTIs. One hundred and twenty-two admissions to the ED at the Federal Medical Center in Azare were reviewed for epidemiologic data. Motorcycles constituted 73 % of RTCs involving pedestrians 54 % of which were children or adolescents. The head and neck (43 %) were the most commonly injured area of the body followed by the extremities (37 %) [22] (Fig. 6.4a, b).

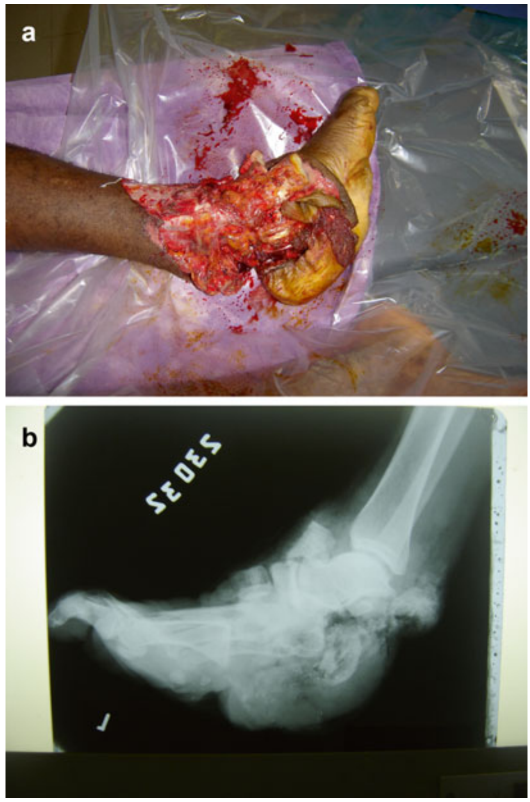


Fig. 6.4 (**a**) Severe lower extremity injury sustained in a motorcycle crash. This can be a typical presentation for open injury. (**b**) Radiograph showing extent of injury seen in (**a**)

Population-based studies allow the examination of the incidence of some problem within an entire population. Whereas hospital studies necessarily miss persons with RTIs, population-based surveys can elucidate the incidence and prevalence of a disease within a population regardless of access to healthcare. Well-designed cross-sectional studies are viewed as the gold standard for epidemiological study of diseases/conditions in areas without robust healthcare systems.

Moshiro et al. performed a population-based survey of injury in an urban vs. a rural area in Tanzania [23]. Residents of urban areas were four times as likely to have an RTI as residents of rural areas. In urban areas, transport-related injuries were the leading cause of major injuries (41.2 % of the total), but in rural areas, they were the second most common cause of major injury (30.4 %) behind falls (38.6 %), with young males accounting for the majority of transport-related injuries in both. Mock et al.

performed a population-based survey of injury in Ghana in 1998 comparing injury profiles in the urban to the rural environment [24]. Transport-related injury accounted for 16 % of the overall number of injuries, less than unintentional lacerations and falls, but was responsible for 75 % of injury-related deaths and accounted for 73 % of the overall long-term disability. In both environments, motorcycle crashes were less common than motor vehicle crashes or pedestrians hit by motor vehicles. The majority of RTIs were due to minibus crashes or pedestrians hit by minibuses. Since this survey, Ghana has seen an increase in two-wheeled transport, so the injury profile likely looks different 15 years after the study was performed. Zimmerman et al. performed a population-based study of road traffic injury and crash statistics in Dar es Salaam, Tanzania, in 2011 [25]. They showed an overall yearly incidence of 33 per 1000 people, with the majority of injuries occurring in the lower extremities. The most common road users injured were passengers in cars or minibuses followed by pedestrians. Stewart et al. performed a country-wide population-based survey of surgical disease in Sierra Leone in 2012 [26]. They found that transport-related injuries accounted for 13 % of total injuries sustained in the previous 12 months. RTIs were the most common cause of injury-related death, and for nonfatal injury, the extremities were the most commonly injured part of the body. Guerrero et al. performed a population-based study of the incidence of road traffic injury among children in Accra, Ghana [27]. The incidence was found to be 34 RTI per 1000 person years among the entire pediatric population but was higher 43 per 1000 person years in the age group 5–14. The upper extremity (56.5 %) and the back (14.4 %) were the most frequently injured body parts followed by the legs (7.5 %). Children were most commonly injured as pedestrians, which accounted for 78.5 % of pediatric RTIs (Guerrero).

The cost of road traffic injuries has been analyzed by several authors using different methods. One study in South Africa estimated the cost of care for RTI patients to be approximately $700 per patient in the hospital. They used a micro-costing approach and added up hospital overhead, orthopedic implant costs, consumables, and all medical testing to estimate their cost but did not include time away from work or cost of disability for these patients [28]. Nunez et al. estimated the cost of RTIs to the state of Jalisco in Mexico using a model that took into account all medical costs as well as time lost from work and time lost by caregivers [11]. They estimated that the cost of care for patients seen only in the ED was approximately $89 each, but for hospitalized patients it jumped to $800 each with an average stay of 10 days. The post-hospital cost for those patients that were hospitalized was approximately $588 each. In an area where the average monthly income is $398, this total cost of injury of $1388 is a very significant expense. Orthopedic care is often necessary for good functional outcome, for reducing long-term disability and lost income, but perceived to be outside the immediate means of many people in low- and middle-income countries. To challenge this assertion, Gosselin et al. examined the cost of locked intramedullary nailing versus Perkin's femoral traction for patients at a hospital in Cambodia [29]. They found an average cost per patient of $1107 in the Perkin's traction group compared to $888 in the locked intramedullary nail group ($p<0.01$). Their findings indicate that a more aggressive intervention can also be a more cost-effective intervention.

6.3 Own Experience

Road traffic injuries will present late in many countries, especially if the catchment areas are spread over a wide geographical distribution. Because of the generalized lack of formal prehospital care systems, first responders are usually lay persons with little or no first aid training. Victims are brought to healthcare facilities by private vehicles and most often based on their ability to pay more than the severity of the injuries. Management in the emergency department will depend on available human and material resources. Even the most basic tools for resuscitation and monitoring are often lacking: oxygen, pulse oximetry, chest tubes, etc. Blood banks, if present, are usually poorly stocked and then only with whole blood units. It is very common to find significant resistance to giving blood, even among family members, for sociocultural or religious reasons. The patterns of injury seen in any given hospital will reflect the modes of transportation that are most common in the given area, and the patient volume may depend on factors that are not readily apparent. Certain times of year may be "the busy season," in which mass casualty bus crashes come in more often than motorcycle crashes. Investigation and discussion with local partners is essential to understanding the patterns of injury, timing of injury presentation, and logistical necessities of the hospital.

Conclusions

Road traffic injury is a major cause of death and disability worldwide. Orthopedic trauma care is essential to providing the best functional outcomes for victims of RTIs. The surgeon practicing in the humanitarian setting is likely to see neglected trauma, open fractures, high rates of infection of open fractures, and patients from all age groups. The incidence and severity of trauma seen will depend on the country of practice and type of vehicles prevalent in the area. With increasing motorization, and lagging infrastructure improvements, the incidence of orthopedic trauma due to road traffic crashes will continue to increase.

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