



# Economic Aspects of Trauma Care

# 2

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## Learning Objectives

- Understand the incidence and major causes of trauma and associated mortality.
- Understand the direct and indirect costs of trauma on society.
- Understand the utility and effectiveness of preventative measures in reducing the economic burden of trauma.
- Understand and evaluate the disparity in road traffic safety across nations.
- Understand the effectiveness of osteosynthesis in decreasing costs and mortality associated with trauma.

represents 9.6% of global mortality and has been increasing over time [2]. The upward trend is largely attributed to a 46% increase in death due to road traffic trauma worldwide [2]. Alarming, despite their substantial economic burden, trauma accounts for 32% more deaths than tuberculosis, malaria, and HIV/AIDS combined (Fig. 2.1) [3]. Furthermore, trauma is the leading cause (40%) of death among young people (under 44 years of age) who often are economically essential members of society [4]. Furthermore, the Global Burden of Disease study group demonstrated that injuries account for 11.2% of disability adjusted life years (DALYs) worldwide [5]. Therefore, trauma and injuries are an economic burden due to healthcare expenditures as well as reduction in economic productivity of patients due to prolonged hospitalization, rehabilitation, disability and death [6].

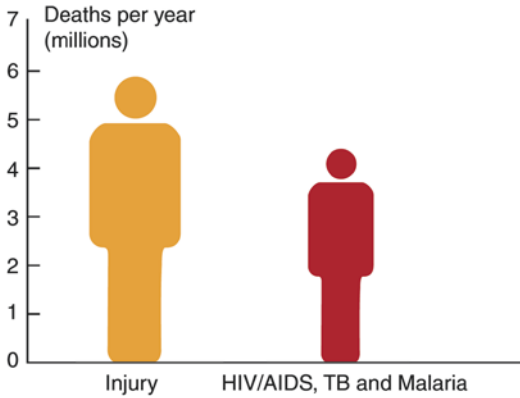
## 2.1 Introduction

Trauma and injuries are substantial causes of mortality and morbidity worldwide. It is estimated that over 5 million trauma related deaths occur on an annual basis [1, 2]. This

## 2.2 Cost of Injury

The total economic burden placed on society by trauma can be divided into direct and indirect costs. Direct costs include health care expenses to the individual and health care system due to the traumatic events. Indirect costs include expenses related to the decline of productivity due to disability, rehabilitation, prolonged hospitalization and death. In Canada, the total cost of injury in 2010 was \$26.8 billion with 59% calcu-

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**Fig. 2.1** Mortality due to injury compared to other causes worldwide [3, 5]

lated to be due to direct costs [6]. However, as indirect costs may be harder to estimate, it is possible this value could be even higher in reality. If current epidemiological trends continue, the Public Health Agency of Canada estimates that total costs related to trauma will rise by 180% in 2035 [6].

The distribution of direct costs to patients and the medical system vary from country to country due to public and private funding of medical care. Initial presentation to hospital usually activates a trauma team involving various physicians, nurses, social workers and coordinating staff. Often, medical or surgical interventions such as radiographic imaging, blood transfusions and utilization of operative and intensive care suites are required during the hospitalization period which include additional costs. Post hospitalization, costs of rehabilitation, prosthetics/aids, home care and medical prescriptions may also be endured. Data from the National Study on the Costs and Outcomes of Trauma of over 5000 moderate to severely injured patients who were treated and discharged from United States (US) hospitals was used to estimate overall treatment costs [7]. It was determined that the mean 1-year cost of trauma care per patient was \$75,210 USD and about 58% of that cost was accrued during the initial hospitalization period [7]. Meanwhile, the estimated total direct annual treatment costs of US adult trauma was approximately \$27 bil-

lion USD in 2005 [7]. These direct costs represent a significant financial burden to the healthcare system, the patient or private insurance depending on the method of funding.

Indirect costs of trauma care are much more difficult to quantify as they have variable and expansive effects for each individual. A nation's economy can be severely affected when patients are unable to return to their pre-injury societal productivity. Studies have shown that only 60–66% of moderate to severely injured patients return to their full-time work duties [8, 9]. In the United States, an estimated \$326 billion in loss of productivity costs occur annually due to trauma leading to missed work days [10]. Furthermore, costs incurred by patients with disabilities are severely underestimated in the literature as the loss of quality of life is a difficult intangible cost to quantify [11].

### 2.3 Implications of Economic Prosperity

Typically, economic improvements tend to lead to improvements of health indices within certain populations [12, 13]. Nonetheless, some studies have demonstrated an inverse relationship between injury rates and economic prosperity [12–14]. However, as road traffic trauma is one of the leading causes of injury, this may explain this effect. Despite conflicting literature, studies of developed countries indicate that sustained economic prosperity is associated with increased road traffic trauma, as more of the population would be able to afford to own and operate a motor vehicle [12, 13]. With regard to road traffic trauma, there has also been conflicting evidence regarding the association of increasing gasoline prices and rates of motor vehicle/motorcycle trauma [15, 16]. A Canadian study assessed the association of long-term economic prosperity and the resulting effect on trauma. Over a 16 year period of increasing mean annual gross domestic product (GDP), there was an increased risk of hospital admission due to trauma but no association was found with trauma mortality [14].

## 2.4 Prevention

Trauma can be divided into intentional and non-intentional injuries. Intentional injuries include those of self-inflicted harm, acts of violence towards self or others as well as combat related injuries. Non-intentional injuries such as falls, accidental fires, road traffic collisions and weather-related incidents tend to be more susceptible to preventative actions. Since trauma has significant costs to a country's economy and expenses, many governments have placed substantial efforts in developing and implementing preventative measures to reduce incidence and resulting costs of trauma (i.e. United States has founded the United States National Center for Injury Prevention and Control). As countries look to cut costs on the medical expenses related to triaging and treating trauma, it has been suggested that resources would be better allocated with injury prevention as more than half of fatalities may have been prevented with better preventative measures prior to the injuries [17]. This is especially true in higher income countries where there are only marginal improvements in medical care systems compared to low to middle income countries [17]. The Children's Safety Network, which is funded by the US Department of Health and Human Services, outlined a number of preventative measures (Table 2.1) and their associated societal cost savings in preventing trauma [18].

**Table 2.1** Preventative measures and associated overall societal cost savings [18]

For each USD spent on:	Societal savings (USD)
Childproof cigarette lighter	\$80
Booster seat	\$71
Bicycle helmet for ages 3–14 years	\$45
Child safety seat	\$42
Zero alcohol tolerance for drivers under 21	\$25
Smoke alarm	\$18

### 2.4.1 Road Traffic Injuries

Along with over 5 million deaths, the WHO estimates over 20 million non-fatal injuries occur worldwide on annual basis due to road traffic injuries [3]. Furthermore, despite having only approximately 60% of the world's motor vehicles, low and middle income countries account for 93% of road traffic fatalities [19]. Interestingly, even within countries of high income, those of lower socioeconomic status are more likely to be involved in road traffic trauma [3, 19]. These road traffic collisions can cost nations up to 3% of their GDP on an annual basis [19]. In 2017, the WHO created a report outlining worldwide recommendations of preventative actions against road traffic collisions that lead to trauma [20]. Their assessments focussed on improving speed regulation, infrastructure status and safety regulations.

Although the world's fleet of motor vehicles is projected to double to over 2 billion by 2030, safety regulations across the world vary significantly and are non-existent in certain countries [21]. The United Nations (UN) World Forum for Harmonization of Vehicle Regulations is the group with the goal of unifying safety standards for all countries that include regulations on seat belts, frontal/side impact, child restraint anchorage points and pedestrian protection. A recent report indicated that over 40,000 fatalities, 400,000 severe injuries and \$143 billion USD could be saved by 2030 in four Latin American countries if these regulations are abided by [22]. Furthermore, over 50% of roads assessed in 60 countries lacked basic infrastructure required for safe mobilization of pedestrians, cyclists and vehicle/motorcycle occupants. It was determined that merely improving the 10% highest risk roads in each of the 60 countries over the next 20 years would have the potential of preventing 3.6 million fatalities and over 40 million severe injuries [23].

### 2.4.2 Osteoporosis

Worldwide, one in three women and one in five men endure an osteoporotic fracture within their lifetime [24]. Hip fractures account for over half of osteoporotic fracture related costs as they are associated with a four-fold likelihood of requiring a long-term care facility post-treatment [25, 26]. This results in an expected annual direct cost of \$25.3 billion USD by 2025 for the treatment of osteoporotic fractures in the US [27]. Overall, osteoporotic fractures result in direct medical costs as well as quality adjusted life years costs due to subsequent impairments. These include impairments to mobility, social wellbeing, physical function and quality of life [25].

In response to the increasing prevalence and economic burden of trauma with underlying osteoporosis, the American Society of Bone and Mineral Research and International Osteoporosis Foundation (IOC) have developed Fracture Liaison Services (FLS). These services are based on multidisciplinary care models that provide treatment and secondary prevention of osteoporotic injuries. They provide long-term monitoring, risk evaluation and fall prevention initiatives among many best practice guidelines developed [28]. These services have been extensively studied worldwide to assess their cost effectiveness across many settings. A recent systematic review demonstrated that FLS was cost effective in all countries studied (Australia, Canada, Japan, Sweden, Taiwan, United Kingdom and the United States of America) in comparison to standard of care or no treatment [29]. These programs also yielded cost savings in certain populations such as patients with prior hip fractures in the US. These savings were estimated to be \$66,879 USD per lifetime/10,000 patients [25, 29]. Therefore, these economically and medically favourable services have

demonstrated encouraging results and the IOC plans to further expand their implementation internationally.

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## 2.5 Economical Impact of Osteosynthesis in Trauma Care

Prior to the visionary foundation of the Association of Osteosynthesis (AO) in 1958, the majority of fractures were treated conservatively in splints, casts and traction that resulted in significant immobilization for patients [30]. These Swiss founders established and popularized osteosynthesis for the treatment of long bone fractures to reduce hospital stay and time required until patients are able to return to work. It was only recently that studies evaluated the true economic impact of medical innovations in osteosynthesis. Eichler et al., performed a health economic evaluation of femur, tibia and radius fractures over a 60 year period (since the inception of AO) to estimate the health economic impact of innovations in osteosynthesis [31]. Within 17 high income countries, their modelling demonstrated total direct cost savings (Swiss Fracs) of \$507 billion with tibia fractures, \$272 billion with femur fractures, \$69 billion with proximal femur fractures and \$77 billion with radius fractures [31]. Furthermore, over 77.6 million years of life gained is estimated through the introduction of fracture osteosynthesis since its inception in 1958 to 2017 [31]. Despite limitations in the modelling design of the study, the impact of the AO founders' innovation has not only yielded substantial improvements to the medical management of fracture care, but also staggering economic relief to nations worldwide. The example of osteosynthesis exemplifies the impact of medical innovation in reducing the economic burden due to trauma, and provides potential evidence that initially costly interventions may be more cost effective in the long term.

## 2.6 Conclusion

In conclusion, trauma and injuries are an immense economic burden on nations, healthcare providers and patients. This is due to healthcare expenditure and reduction in economic productivity of patients due to prolonged hospitalization, rehabilitation, disability and death. Numerous political and health organizations have set out initiatives to decrease this economic burden through innovation of healthcare delivery and products as well as preventative measures lowering the incidence of trauma.

### Key Concepts and Take-Home Points

- The total economic burden placed on society by trauma can be divided into direct and indirect costs. Direct costs include health care expenses to the individual and health care system due to the traumatic events. Indirect costs include expenses related to the decline of productivity due to disability, rehabilitation, prolonged hospitalization and death.
- Road traffic collisions can cost nations up to 3% of their GDP on an annual basis.
- Road traffic collisions are a major economic burden on all nations regardless of their economic prosperity and average socioeconomic status. Further improvements in road safety and regulations are needed to reduce these burdens.
- Fracture Liaison Services are based on multidisciplinary care models that provide treatment and secondary prevention of osteoporotic injuries to decrease the potential economic burden of trauma.
- The development and innovation of osteosynthesis over the past 60 years have substantially reduced the economic burden of trauma in terms of costs as well as mortality.

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