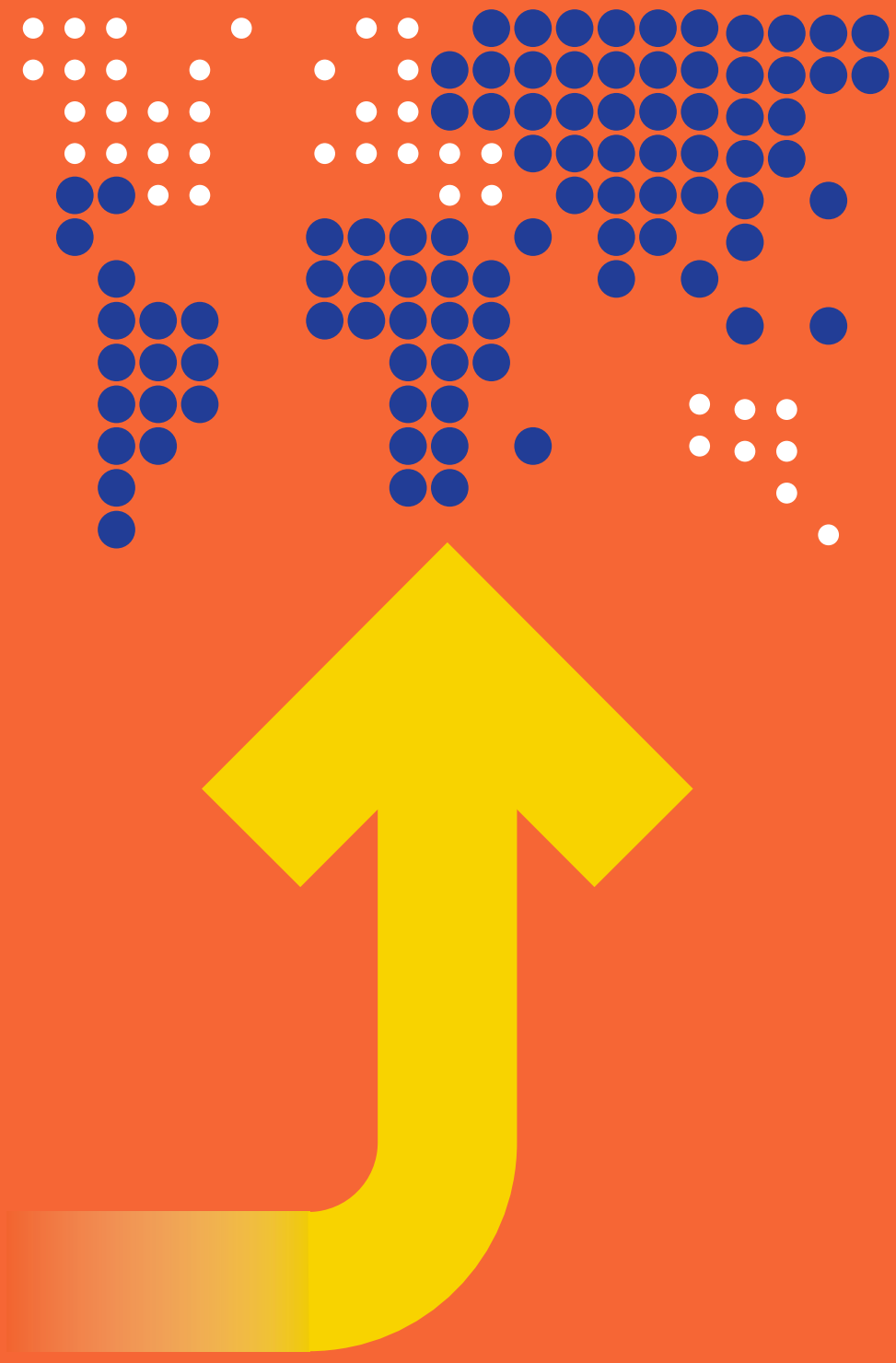

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Background Paper

The Neglected Burden of Death and Disability from Injuries in Low-Income Countries

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JICA

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AO Alliance Foundation

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Executive summary

Of all trauma-related deaths, 90% occur in LMICs, and Africa is particularly affected

Trauma is a neglected source of death and disability in low- and middle-income countries (LMICs) that causes **close to 5 million deaths each year, more than all deaths due to HIV/AIDS, malaria and tuberculosis combined.** Nevertheless, many nonprofit organizations and philanthropists predominantly support such infectious diseases, while such support is practically nonexistent for trauma-related initiatives.

For every trauma-related death, there are 10 to 50 others living with a trauma-related disability, often related to an orthopedic ailment

Of all trauma-related deaths, 90% occur in LMICs, and Africa is particularly affected. Trauma accounts for 40% of deaths among young people worldwide, and it is estimated that for every death, there are 10 to 50 others living with a trauma-related disability, often related to an orthopedic ailment. There is currently a global epidemic of road traffic injuries, resulting in over 1.25 million deaths and many more disabilities annually, making these injuries the eighth leading cause of mortality and the sixteenth leading cause of years lived with disability. Road traffic injuries are on the rise, particularly in LMICs – where rates of trauma and disability are disproportionately higher. **Injuries in LMICs contribute to the vicious cycle of poverty: keeping poor people out of work and incurring high costs for treatment.**

This silent epidemic in developing countries must be acknowledged as a global health concern

Understanding and addressing the global need for orthopedic trauma care warrants that this silent epidemic in developing countries be acknowledged as a global health concern, and be tackled as such. With the launch of the Sustainable Development Goals by the United Nations, road safety is receiving increased international attention, and is included in two of the 17 goals of this new global agenda. Most high-income countries have reduced their road traffic deaths in recent decades. Prevention strategies and enforcement of road traffic laws are part of it. When road traffic injuries do occur, much of the trauma-associated death and disability would also be avoided with better orthopedic trauma care. Improved access and more resources are needed.

There are many challenges associated with caring for orthopedic trauma in economically developing nations. Barriers to the delivery of services occur at multiple levels, and include deficiencies in infrastructure, physical resources (equipment and supplies), appropriately trained staff, and access to reliable health care information (trauma registries). Improving the quality of services at the population level can only be achieved through reforms at the level of the health system. While orthopedic services in industrialized nations have become increasingly dependent upon technology, and there will always be some debate over the optimal treatment for any given condition, a public health approach aimed at reducing death and disability must rely upon the effective use of simple, proven and cost-effective methods of treatment. Furthermore, **focus must be placed on developing public-private partnerships that lead towards sustainable financing structures for essential health care, including orthopedic procedures and implants.**

Orthopedic trauma care is essential; it is cost effective and must be a priority in the development of strategies to curb the devastating effects of traumatic injuries. It makes sense that it be a part of the development of global health systems in LMICs. The education of surgeons, nonphysician clinicians and other health care staff in LMICs is central to improving access and quality of care. Volunteer surgical missions from high-income countries can sustainably expand and strengthen orthopedic trauma care only when they serve a local need and build local capacity. A much-needed awareness drive in Africa to sensitize governments and policy makers is needed. And only when African philanthropists join and become part of this emergence of an imaginative and proud community of donors will advancements and popularity be gained to curb the burden of trauma in Africa.

The education of surgeons, nonphysician clinicians and other health care staff in LMICs is central to improving access and quality of care

The global need for orthopedic trauma care: Understanding the facts

The term "global health" refers to the health of populations in the global context.[1] Once focused on infectious diseases (tuberculosis, malaria and HIV/AIDS), it is the area of study, research and practice that places a priority on improving health and achieving equity in health for all people worldwide.[2] Problems that transcend national borders or have a global political and economic impact are often emphasized.[3] Global health is about worldwide health improvements, reduction of disparities, and protection against global threats that disregard national borders.

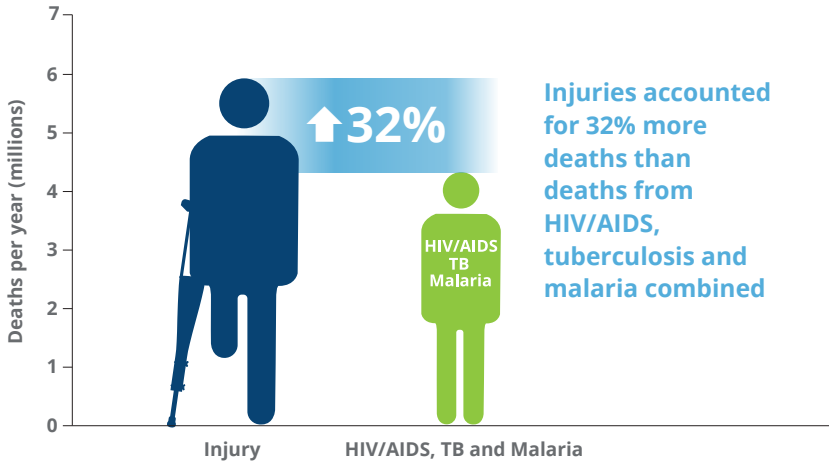
The worldwide inequity in health and the cry for help from the world's poor is often more visible during humanitarian crises and ongoing armed conflicts, which overwhelm strained capacity in many developing countries to manage the traumatic injuries.[4-10] This barely speaks of a silent killer that has received little attention, the worldwide trauma epidemic with injuries resulting from traffic accidents, drowning, poisoning, falls, burns and violence – from assault, self-inflicted violence or acts of war – particularly affecting low- and middle-income countries (LMICs). Road traffic injuries account for 25% of this burden and cause considerable economic losses to victims, their families and nations as a whole. These losses arise from the cost of treatment, as well as reduced/lost productivity for those killed or disabled by their injuries, and for family members who need to take time off work or school to care for the injured. The World Health Organization (WHO) has termed injuries occurring in developing countries as "the neglected burden". While data on the epidemiology, effectiveness and cost effectiveness of many diseases and interventions in developing countries are available and fairly reliable, particularly for infectious diseases or nutrition, such information is sorely lacking for traumatic injuries and their management. Perhaps this explains why other problems may be perceived as more urgent, making trauma advocacy that much more difficult.

The World Bank defines LMICs, or developing countries, as those having a gross national income (GNI) per capita of ≤$1,045 (low-income) and >$1,045 to <$12,736 USD (middle-income) in 2014.[11] Many countries located within Asia, Latin America, the Caribbean region and especially Africa are classified as LMICs based on these criteria, and includes a substantial proportion of the world's population.

The burden of injuries has become a global health concern as injuries are predicted to be a leading cause of death and disability over the next few decades.[12-14] According to the Global Burden of Disease Study 2013, the estimated number of yearly deaths due to injury, across 188 countries, increased from approximately 4.3 million to 4.8 million (10.7% increase) between 1990 and 2013.[12-14] Trauma kills more people worldwide than HIV/AIDS, malaria and tuberculosis combined (Figure 1)[15] and disproportionately affects LMICs, as well as the young who constitute the backbone of any country's workforce.[12-14] There are no definitive data on the number of people who survive with some form of permanent disability for every injury-related death, but estimates run between 10 and 50 times more suffer nonfatal injuries and live with trauma-related disability.[16] This would translate to between 50 million to 250 million individuals annually with some form of trauma-related disability.

Trauma disproportionately affects LMICs, as well as the young who constitute the backbone of any country's workforce

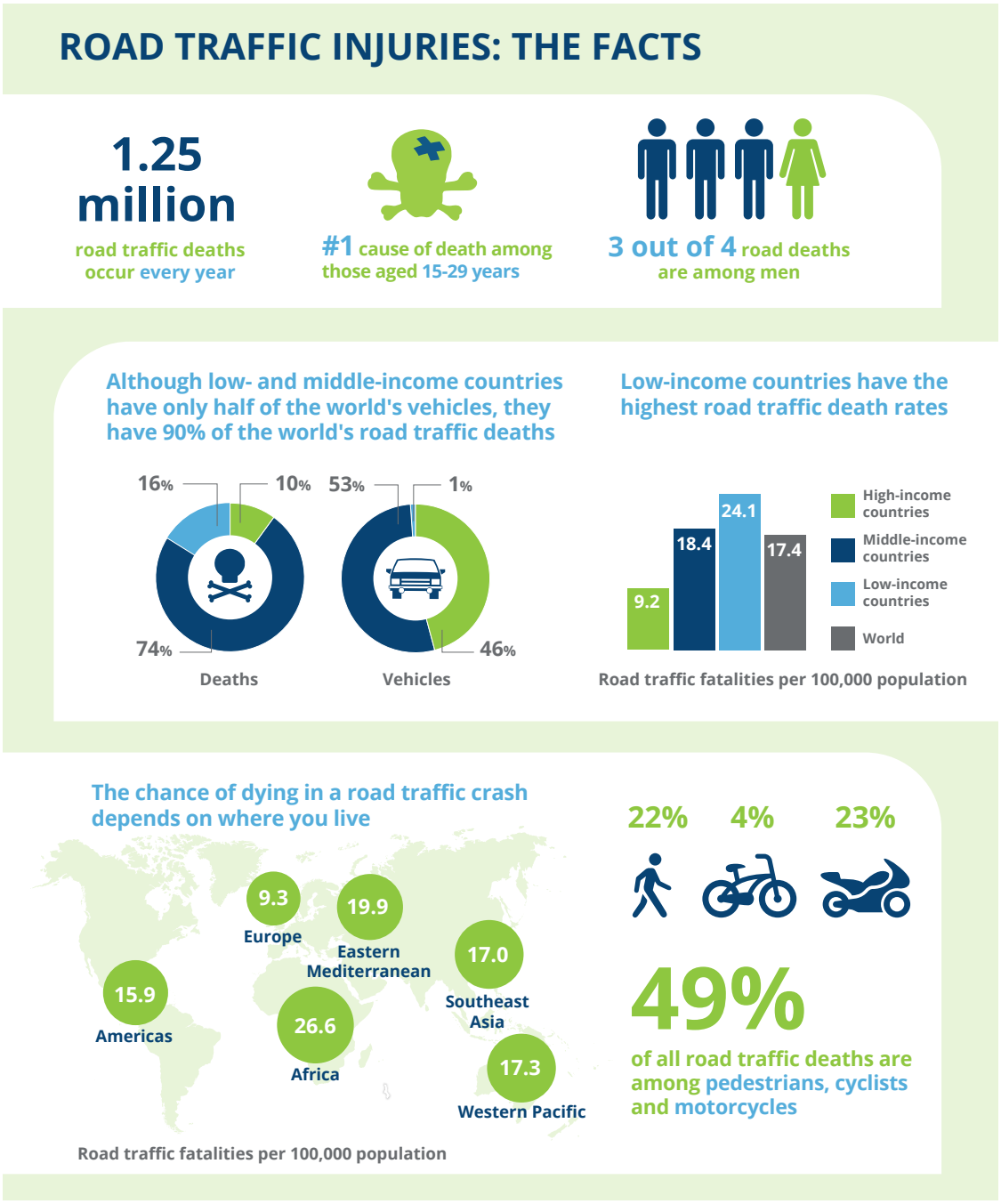
Figure 1. Total deaths (in millions) annually from trauma vs HIV/AIDS, tuberculosis (TB) and malaria[15]



Road traffic accidents

Over 1.25 million (25%) of these 4.8 million deaths occur on the world's roads. Of the global road traffic deaths, 91% occur in LMICs[17] and this is increasing due to the growth in the number of motorized vehicles (49% worldwide), whereas traffic-related deaths are decreasing in high-income countries (HICs).[18] The individuals most affected by such injuries are pedestrians, followed by car occupants and motorcyclists (Figure 2).[18,19]

Figure 2. Global Status Report on Road Safety 2015: Facts on road traffic injuries[19]



By 2020, road traffic accidents are expected to be the third leading cause of DALYs lost worldwide, and the second leading cause in LMICs

By 2020, road traffic accidents (RTAs) are expected to be the third leading cause of Disability-Adjusted Life Years (DALYs) lost worldwide, and the second leading cause in LMICs. Only ischemic heart disease and lower respiratory infections will continue to be ahead. The DALY is a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability or early death. It was developed in the 1990s as a way of comparing the overall health and life expectancy of different countries.

Halving the number of global deaths and injuries from RTAs by 2020 has been identified by the United Nations as a Sustainable Development Goal (SDG) (Figures 3 and 4).[20] However, road traffic injuries are still on the rise, almost exclusively in LMICs, where traffic regulations and infrastructure development have not kept up with the increasing number of vehicles on the road. The African region is particularly affected (Figure 5).[19]

Figure 3. 17 Sustainable Development Goals (SDGs) identified by the United Nations[20]

Figure 4. UN SDGs 3 and 11 have targets related to road traffic accidents and road safety[20]

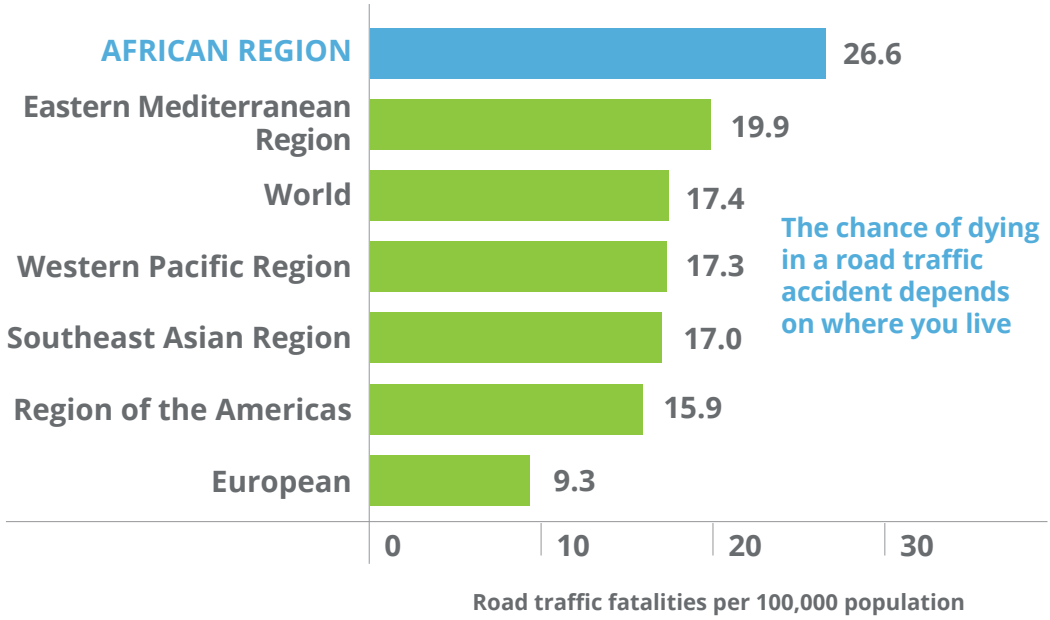
Goal 3 Ensure healthy lives and promote well-being for all at all ages

3.6. By 2020, halve the number of global deaths and injuries from road traffic accidents

Goal 11 Make cities and human settlements inclusive, safe, resilient and sustainable

11.2. By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons

Figure 5. Chance of dying in a road traffic accident by WHO region: Africa has the highest rate[19]



African country case studies: Malawi and Ghana

An appropriate, robust and sustainable model for improvement in health system performance, especially when addressing the care of the injured (trauma), is essential in order to reverse the declining trends in health and development status and break the vicious cycle of poverty and ill-health in Africa. Given the diversity of the health systems across Africa, improvement would be contingent upon the convergence of commitment, expertise and resources throughout the system, and working with "local champions" on the ground. A robust model for improvement would embrace all dimensions that are critical to health by addressing not only the risk factors of disease but also cross-cutting issues and linkages between health and employment, and financing for health.

The AO Alliance has been active in such attempts over the last two years in a selected number of countries in Africa. Over the course of more than 15 years, leveraging the work of the former AO Foundation Socioeconomic Committee (AO SEC), the AO Alliance has developed a network of over 350 faculty and "local champions" in more than 20 countries in sub-Saharan Africa. This program of development through training the trainers is vital to local sustainability and is a pivotal cornerstone of the AO Alliance strategy for country initiative developments.

Two country case studies highlighting problems associated with many aspects of orthopedic trauma care on a country level and driving home the seriousness of the problem are detailed with specific actions supported by the AO Alliance.

Malawi

Malawi, a landlocked country in sub-Saharan Africa, has a population of 17 million with more than 80% living in rural areas. The GNI per capita is about US $250 (compared to an average in low-income countries [LICs] of $1,313 and a global average of $11,536), and the total expenditure on health per capita is about US $74 per year (compared to $63 on average in LICs and $1,017 globally). The Malawi economy is largely agricultural and the largest foreign exchange earner is tobacco. There are few natural resources, but some uranium is mined in the north of the country. A large lake called Lake Malawi occupies much of the eastern border with Tanzania and Mozambique. On the western side, Malawi borders Zambia.

Malawi is estimated to have the second highest incidence of road traffic deaths of all countries, at 35 deaths per 100,000 population per year

Malawi has a high burden of trauma from RTAs, industrial accidents, as well as domestic accidents. Malawi is estimated to

The socioeconomic impact of trauma on Malawi is considerable and the lack of orthopedic surgery services is a major part of this challenge

have the second highest incidence of road traffic deaths of all countries, at 35 deaths per 100,000 population per year, which is only marginally less than in Thailand (36 per 100,000). RTAs in Malawi mostly involve pedestrians and cyclists run down by cars, or passengers in pickup trucks and minibuses. These accidents also result in a much higher rate of serious limb injury, with many more complicated open fractures. Unfortunately, these injuries often end with an amputation because of the lack of qualified orthopedic surgeons and modern orthopedic equipment. These patients have difficulty doing work in the villages and often cannot look after themselves, becoming a burden to their family and ultimately the whole village. The socioeconomic impact of this on Malawi is considerable and the lack of orthopedic surgery services is a major part of this challenge.

The Queen Elizabeth Central Hospital (QECH) is one of four referral hospitals in Malawi, of which only two have permanent orthopedic specialists. QECH provides primary and secondary care for the district of Blantyre (population ~1 million), as well as being a tertiary referral hospital for the Southern Region of Malawi with a catchment population of 6-8 million. For other specialist services, such as spine surgery and complex orthopedic services, QECH is the only center for the entire nation. QECH is also the main teaching hospital for Malawi.

Various cadres of health care workers, including undergraduate medical students, Orthopedic Clinical Officers (OCOs), as well as postgraduate orthopedic trainees (who will be the future specialists of Malawi), are trained at the facility. Currently there are only two orthopedic surgeons at QECH – one trauma specialist and one spine specialist. Five other orthopedic surgeons from a nearby pediatric orthopedic hospital (Beit CURE) support teaching and clinical service activities at the College of Medicine and QECH as honorary staff.

The Kamuzu Central Hospital (KCH) is the referral hospital for 6 million people in the Central Region of Malawi (Figure 6 shows the number of patients admitted to KCH for femoral fractures[21]). Despite being situated in the capital city, Lilongwe, KCH is drastically underfunded and lacks many basic facilities and human

resources. There are currently six OCOs with three to four years of training experience at KCH. OCOs fill much the same role as doctors in Malawi, including treatment of outpatients and patients in the wards. They also do some surgery, but their level of knowledge and surgical skills varies considerably according to their experience and interest. Before 2008, there were no qualified orthopedic surgeons at KCH. The whole country has only five orthopedic surgeons working in government hospitals. If one were to expect something close to European standards of orthopedic surgical care in Malawi, one would expect to have more than 1,500 orthopedic surgeons in the country. KCH has been working with Haukeland University Hospital and other international partners to establish a training program for Malawian surgeons in Lilongwe.

If one were to expect something close to European standards of orthopedic surgical care in Malawi, one would expect to have more than 1,500 orthopedic surgeons in the country

Projections for the future should always be interpreted with caution, especially when based on only six years of data. However, the findings do illustrate the front-line impact of the growing epidemic of injuries in the region, with an increasing gap between the burden of trauma and the capacity to deliver a surgical service in Malawi (Figure 7). No reliable national statistics are available for Malawi, but if the WHO 2015 estimates hold true, this would indicate that more than 110,000 people are injured on Malawi's roads every year, and that thousands end up with permanent disability.

The Lancet Global Surgery Commission recommended in its 2015 report that a minimum rate of 5,000 surgeries per 100,000 population should be available to ensure equitable service delivery in LMICs. This is an aspirational goal in Malawi, but with the right support of surgical training centers and infrastructure in the country, delivery of surgical services could be scaled up considerably in the near future. The burden of orthopedic trauma in Malawi is rapidly increasing and the available surgical capacity cannot meet the current demand or the projected demand. Urgent investment in infrastructure and surgical education is needed. The limited funds for orthopedic trauma care are better invested in central training hospitals to develop a sustainable mass of trained orthopedic surgeons, with good infrastructure and equipment. The centralization of orthopedic surgical care delivery at training hospitals would lead to better access to surgical care and early return of patients to district hospitals for rehabilitation. This would increase surgical throughput and efficiency with a view to expanding the orthopedic surgical workforce to meet the national need.

Figure 6. Patients admitted to KCH for femoral fractures from 2009 through 2014[21]

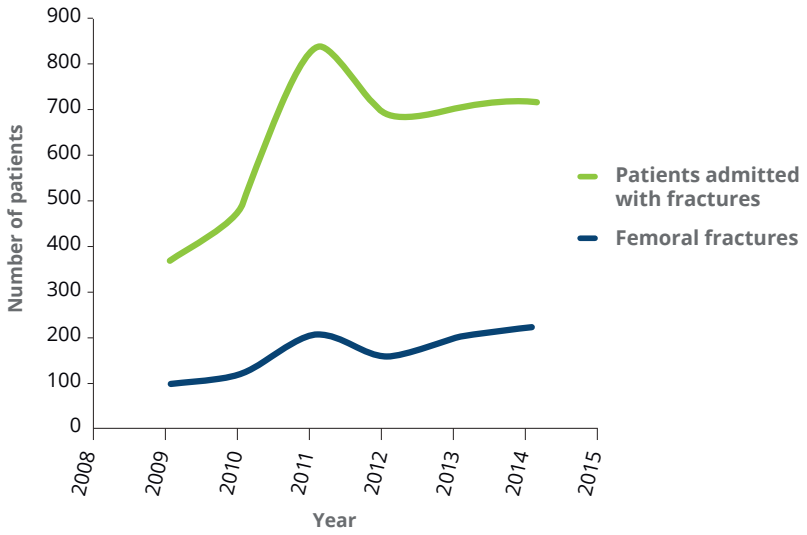
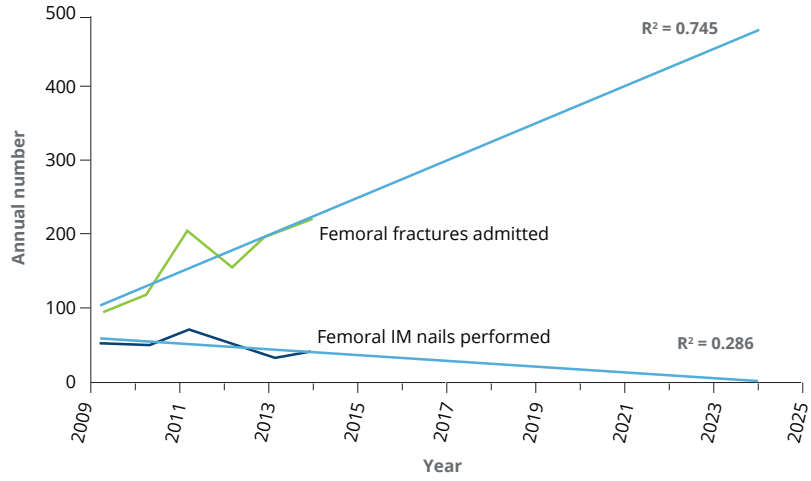


Figure 7. KCH: Dealing with a capacity problem[21]

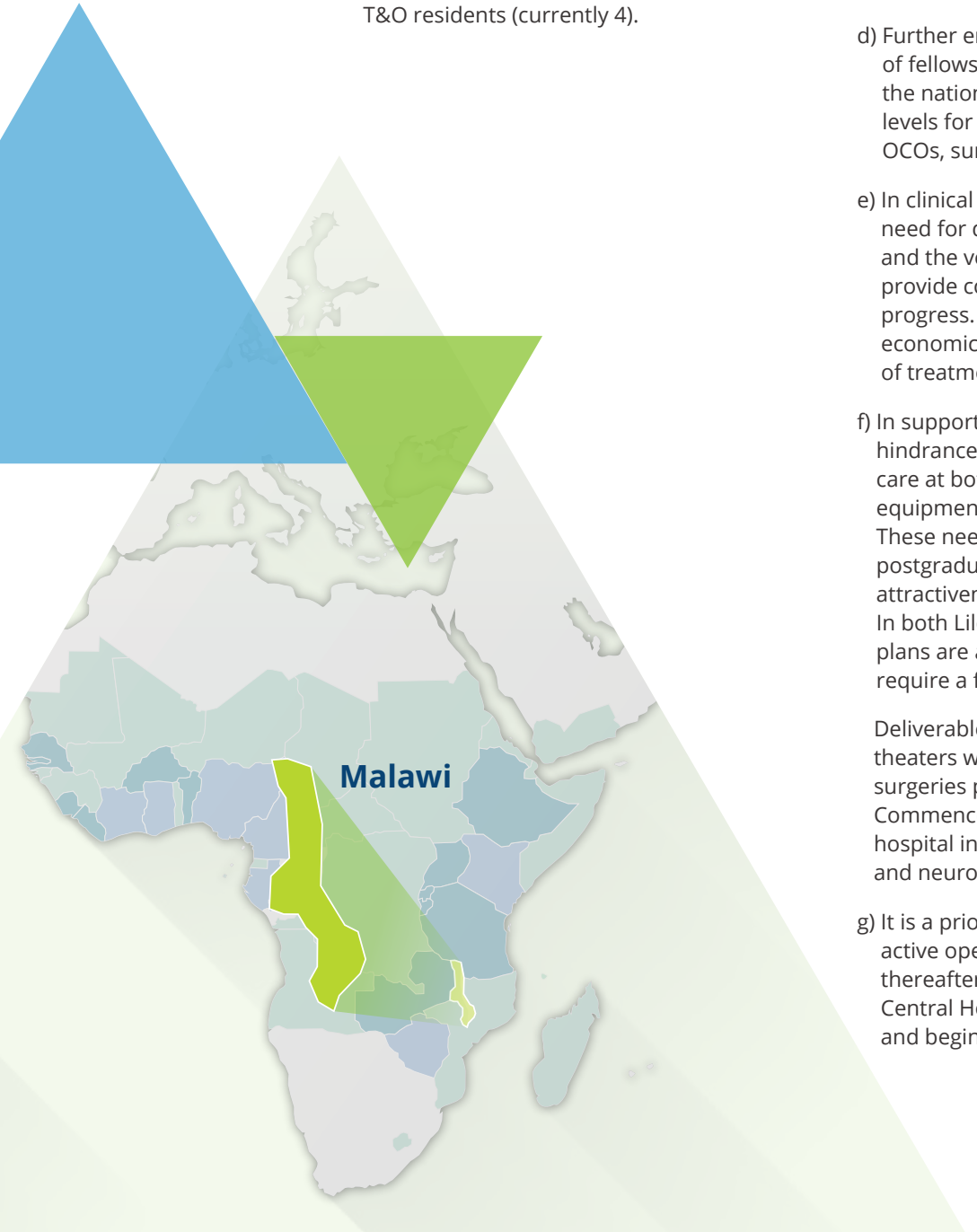


Observed annual number of adult femoral fractures admitted to KCH (top, green), and the annual number of femoral intramedullary (IM) nails performed at KCH (bottom, dark blue). The straight lines in light blue are the regression-line estimations with projections for the coming years. An increasing gap is apparent between femoral trauma burden and delivery of service.

Based on the recommendations and analysis, as well as a needs assessment exercise performed in November 2014 by a group of experts, the following initiatives will be undertaken over the next five years to increase and strengthen local capacity in the following areas:

a) In education, the priority is to attract young graduating doctors to Trauma & Orthopedic (T&O) training and optimize that training, together with the successful conversion from training to productive and fruitful specialist practice.

   Deliverable: Increase from current 9 to 18 T&O surgeons and increase residency program to 14 Malawian T&O residents (currently 4).



b) The other main educational priority is to support OCO education, most immediately in the Diploma school. There is a need for more teachers and for hands-on mentors. OCO will provide all trauma care at District level for the foreseeable future.

   Deliverable: Staff and educate 24 District hospitals with 2 active OCO in each, providing safe nonoperative fracture care and appropriate referral for all fractures.

c) Further development of the trauma education curriculum and integration in education activities will continue in parallel, with Malawi contributing the spinal injury component to the overall curriculum for LMICs.

d) Further enhancement and development of fellowships and reverse fellowships at the national, regional and international levels for Operating Room Personnel (ORP), OCOs, surgical trainees and surgeons.

e) In clinical research, there is an immediate need for data sets on the burden of trauma and the volume of care given. These will provide context within which to measure progress. Clinical outcomes research and economic analysis in the cost effectiveness of treatments should follow soon thereafter.

f) In support for clinical services, the main hindrance is the lack of facility for surgical care at both KCH and QECH. Basic surgical equipment is lacking, particularly in QECH. These needs equally hamper the possibility of postgraduate clinical training and diminish the attractiveness of T&O as a specialist career. In both Lilongwe and Blantyre, appropriate plans are afoot to address these needs, but require a further one-off financial support.

   Deliverable: Add two surgical referral theaters with capacity for 3,000 fracture surgeries per year (currently two theaters). Commence construction of a new surgical hospital in Lilongwe dedicated to orthopedic and neurosurgical trauma only.

g) It is a priority to see QECH and KCH as highly active operative and training centers, and thereafter to see the Mzuzu and Zomba Central Hospitals take on T&O surgeons and begin regular operative services.

COUNTRY SNAPSHOT: MALAWI

Region
Africa

Land area
118,484 sq km

Population (mid-2015)
17,174,000

Capital
Lilongwe

Climate
Tropical
(cooler in highlands)

Languages
English, Chichewa

Currency
Kwacha

GNI (PPP)† per capita (2014)
US $780

Life expectancy at birth (2014)
61 years
Males: 60 years
Females: 62 years

Population <15 years old (2015)
44%

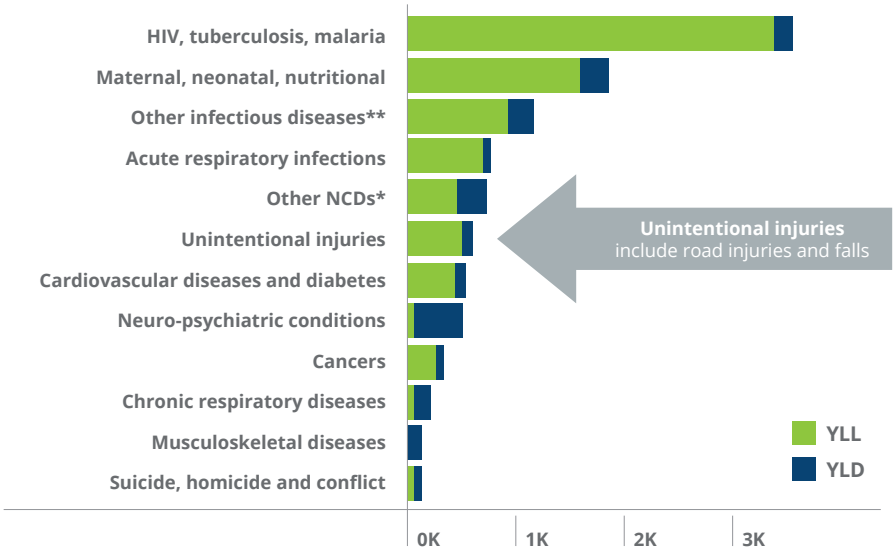
Population ≥65 years old (2015)
3%

Data from references a and b.
† Gross national income (GNI) per capita at purchasing power parity (PPP)

Burden of disease (2012)

Disability-adjusted life years (DALYs) are the sum of years of life lost due to premature mortality (YLL) and years of healthy life lost due to disability (YLD).

DALYs, YLL and YLD (thousands) by broad cause group[c]



* *Other noncommunicable diseases (NCDs) including nonmalignant neoplasms; endocrine, blood and immune disorders; sense organ, digestive, genitourinary, and skin diseases; oral conditions; and congenital anomalies.*
** *Infectious diseases other than acute respiratory diseases, HIV, tuberculosis and malaria.*

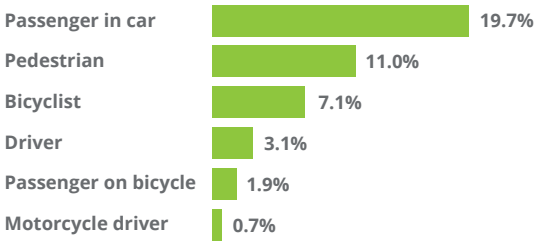
Road traffic fatalities[d]
35/100,000 population
84% male, 16% female

2/3 of all people that die on the road are pedestrians and cyclists[d]

Only 9 T&O surgeons working full time in government hospitals

At the Kamuzu Central Hospital in Lilongwe, road traffic injury was the most common reason for treatment (43.4%)[e]

Common injury mechanisms (Feb-Jun 2008)



References: (a) Malawi profile. Population Reference Bureau DataFinder. Available at: www.prb.org. (b) Official Website for the Government of the Republic of Malawi. Available at: www.malawi.gov.mw. (c) Malawi country profile. World Health Organization Global Health Observatory data. Available at: www.who.int/gho/countries/mwi/country_profiles/en/. (d) Malawi country profile 2015. Violence and Injury Prevention. Available at: www.who.int/violence_injury_prevention/road_safety_status/2015/country_profiles/Malawi.pdf. (e) Samuel JC, et al. *World J Surg* 2009;33:1836-1841.

Ghana

The Republic of Ghana is centrally located on the West African coast. It is bordered by three French-speaking countries: Togo on the east; Burkina Faso on the north and northwest; and Côte d'Ivoire on the west. Ghana's population is 28 million. Ghana has 10 regions that are divided into 216 districts. About 45% of the economically active population are engaged in agriculture, and 41% provide services. A high proportion of the employed population of Ghana works in the informal sector, the majority being self-employed.[22] The leading export commodities of Ghana are cocoa, gold and timber.

Ghana is a politically and socially stable country in West Africa. It enjoys strong civil service institutions and has good standards of education within a regional perspective. There are five medical schools with an annual output of 300 graduates. Historically, specialists were trained overseas and were lost to HICs. More recently, national and regional postgraduate curricula have been accredited and specialist retention is improving. The emphasis of the health service has had to lean towards public health, infectious diseases and mother-and-child conditions. Only recently has awareness of surgical, trauma and fracture care needs increased. The country operates a national health insurance system (NHIS) to which 60%-70% of the population subscribe. The insurance cover is very limited with regard to treatment of fractures. Thirty-four T&O surgeons serve in 14 institutions; 17 residents are training in T&O spread over seven years of training. Currently, the country has two T&O residency training hospitals in Accra and Kumasi. There is an ORP specialist training in Accra, although it does not teach specifics of T&O surgical care and equipment. There is no school for Plaster Assistants. There is no designated cadre of paramedic trained to deliver basic fracture care.

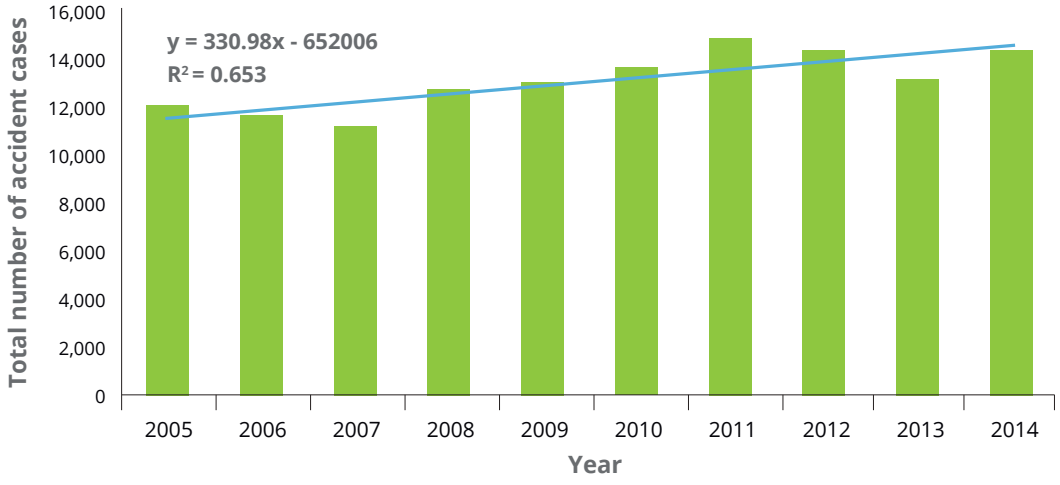
Data on RTAs show an increasing incidence nationally and a high rate of death and disability (Figure 8). Trauma is expected to rise to third place in the causes of death in Ghana over the next five years.

The Ghana Ministry of Health has raised concerns regarding RTAs and has designated 10 hospitals as "regional trauma centers". These centers have quite good physical infrastructure but are poorly equipped, lacking in specialist trained staff, equipment, supplies and systems of care.

The Millennium Development Goal (MDG) Acceleration Framework assessment was carried out to transfer benefits for general health service improvement across the country. The new SDG is now invoked (Figure 4). SDG 3 is "Ensure healthy lives and promote well-being for all at all ages" and the proposed target is to halve RTA deaths per 100,000 population by 2030. This poses a huge challenge to the clinical services of the health sector because of the challenges of the current health care financing mechanism through the NHIS. There has been an increase of 60% in the number of health training institutions established over the last five years (2009-2013) leading to an increase in the production of all categories of health professionals. There has also been an encouragement for the private sector to establish health training institutions to complement that of the Government.

The AO Alliance has proposed to partner with the Ghana Government and Ghana College of Physicians and Surgeons (GCPS) to increase the capacity for training T&O surgeons through the focused development of two additional sites as T&O residency centers. The AO Alliance proposes to develop the training of all T&O residents through access to appropriate fracture care education, and development of clinical research and audit techniques.

Figure 8. Road traffic accident trend in Ghana (2005-2014)



The AO Alliance also proposes to focus on two other cadres of health care worker, essential for provision of T&O care, namely ORP (operating theater nurses) and Plaster Assistants. All interventions will partner with Ghana Government bodies and aim to be sustainable locally.

In five years, the following are planned to have been achieved:

a) Established full resident training capacity in Cape Coast and Tamale hospitals (two additional training sites)

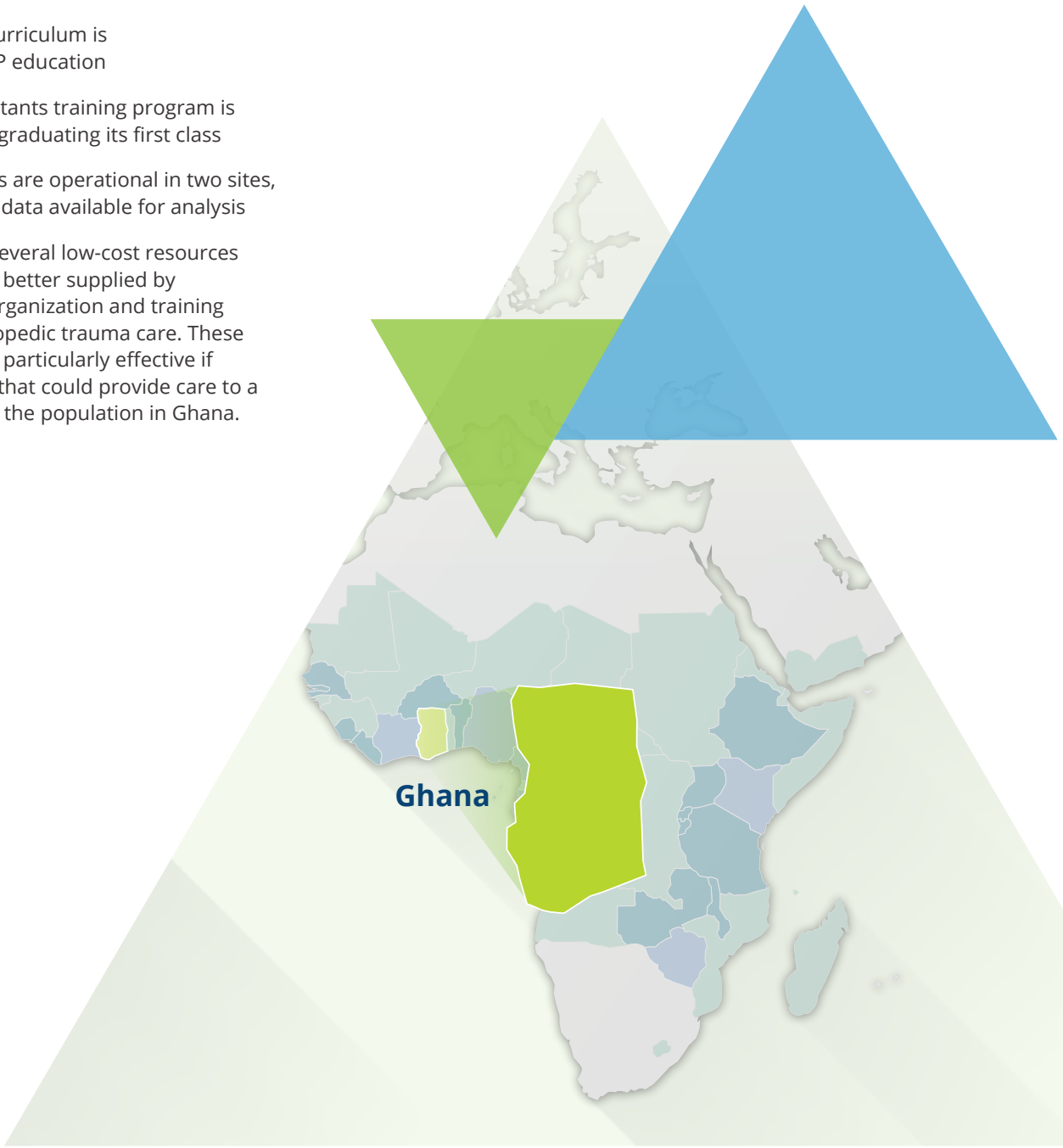
b) All first year T&O trainees have access to AO Alliance basic operative fracture care education

c) A fracture care curriculum is integrated in ORP education

d) The Plaster Assistants training program is established and graduating its first class

e) Trauma registries are operational in two sites, with preliminary data available for analysis

The availability of several low-cost resources solutions would be better supplied by improvements in organization and training personnel for orthopedic trauma care. These initiatives might be particularly effective if aimed at hospitals that could provide care to a large proportion of the population in Ghana.



COUNTRY SNAPSHOT:
GHANA

Region
Africa

Land area
238,533 sq km

Population (mid-2015)
27,672,800

Capital
Accra

Climate
Tropical

Languages
English, African languages (Akan, Ewe)

Currency
Cedi

GNI (PPP)[†] per capita (2014)
US $3,960

World Bank Income classification (2013)
Lower middle

Life expectancy at birth (2014)
61 years
Males: 60 years
Females: 63 years

Population <15 years old (2015)
39%

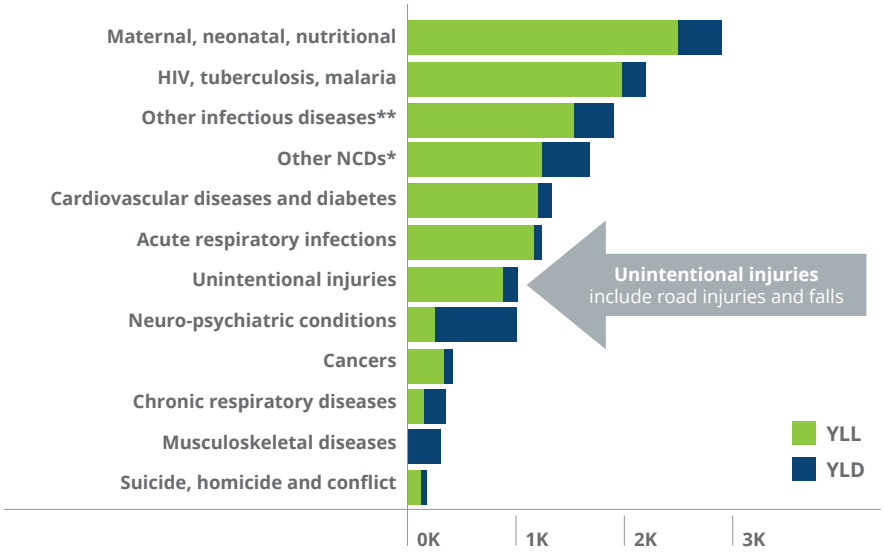
Population ≥65 years old (2015)
5%

Data from references a-c.
[†] Gross national income (GNI) per capita at purchasing power parity (PPP)

Burden of disease (2012)

Disability-adjusted life years (DALYs) are the sum of years of life lost due to premature mortality (YLL) and years of healthy life lost due to disability (YLD).

DALYs, YLL and YLD (thousands) by broad cause group[c]

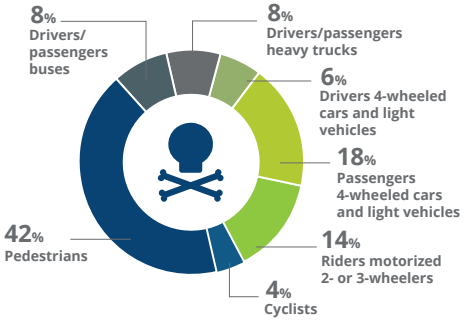


* *Other noncommunicable diseases (NCDs) including nonmalignant neoplasms; endocrine, blood and immune disorders; sense organ, digestive, genitourinary, and skin diseases; oral conditions; and congenital anomalies.*
** *Infectious diseases other than acute respiratory diseases, HIV, TB and malaria.*

Road traffic fatalities[d]
26.2/100,000 population
77% male, 23% female

An overwhelming majority of people that die on the road are pedestrians

Death by road users (2012)[d]



In the country:

34 T&O surgeons in 14 institutions

17 T&O residents

2 T&O residency training hospitals in Accra and Kumasi

At the Komfo Anoche Teaching Hospital in Kumasi, Ghana (2014)[e]

Trauma accounted for 95% of operations

29% of surgeries were devoted to severe fractures

Children involved in motor vehicle crashes represented the largest proportion of road traffic injuries (2009)[f]

In 2010, unintentional injury accounted for 37 deaths/100,000 children under age 14[g]

~1/2 of families did not seek care for an injured child

References: (a) Ghana profile. Population Reference Bureau DataFinder. Available at: www.prb.org. (b) Ghana country profile. BBC News. Available at: www.bbc.com/news/world-africa-13433790. (c) Ghana country profile. World Health Organization Global Health Observatory data. Available at: www.who.int/gho/countries/gha/country_profiles/en/. (d) Ghana country profile 2015. Violence and Injury Prevention. Available at: www.who.int/violence_injury_prevention/road_safety_status/2015/country_profiles/Ghana.pdf. (e) Brouillette MA, et al. *World J Surg* 2014;38:849-857. (f) Whiteside LK, et al. *Int J Emerg Med* 2012;5:36. (g) Pediatric fracture care solutions for Ghana. AO Alliance Foundation. Available at: ao-alliance.org/2016/12/pediatric-fracture-care-solutions-ghana/.

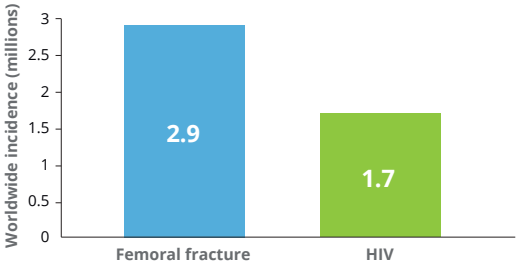
Cost and cost effectiveness of fracture care treatment or neglect: Femoral shaft fractures

Economic development in LMICs is accompanied by an increase in the burden of trauma, particularly injuries due to RTAs. It also provides the opportunity to improve on the management of some of those injuries, such as fractures of the femur (thigh bone). Skeletal traction or closed manipulation and casting remain the most common treatments of long bone fractures in resource-poor settings. The literature from HICs is replete with studies showing better functional outcomes with locked intramedullary nails for femoral fractures over conservative management, even in the adolescent population. In poor countries, lack of human and material resources, and an often-unsafe surgical environment, may preclude operative fixation of bones. Femoral shaft fractures are thus treated with skeletal traction with its known complications of prolonged bed rest and hospitalization, along with pin tract infections, decubitus ulceration, malunion/nonunion and shortening.

> Skeletal traction or closed manipulation and casting remain the most common treatments of long bone fractures in resource-poor settings

Femoral shaft fractures are one of the most common injuries seen by surgeons in LMICs. The worldwide annual femoral fracture incidence secondary to RTAs is estimated to be between 1.0 and 2.9 million (Figure 9). Of all the femoral fractures, 91% occurred in LMICs, where 84% of the world's population lives, and 9% of femoral fractures occurred in HICs, where the remaining 16% lives. In LMICs, approximately one third (30%) of femoral fractures occurred in those between 5 and 14 years old; one third (33%), in those between 15 and 44 years old; and one third (32%), in those 45 years old and older.

Figure 9. A comparison of the worldwide incidence of femoral fracture and HIV[23]



In LMICs, approximately one third (30%) of femoral fractures occurred in those between 5 and 14 years old; one third (33%), in those between 15 and 44 years old; and one third (32%), in those 45 years old and older

Surgical repair in LMICs is often dismissed as not being cost effective or unsafe, though little evidence exists to support this notion. In 1999, the Surgical Implantation Generation Network (SIGN) introduced a technology that allows orthopedic surgeons to treat femur and tibia fractures with intramedullary nailing (a steel rod) without the need for image intensifiers (special X-ray machine), surgical tables or power tools. The SIGN nailing system has a long track record of success throughout many LMICs.

When estimating the cost of operative fracture care treatment, many contributors to the final price tag need to be considered. The largest contributor is usually ward personnel costs. This cost is directly correlated with patient length of stay (LOS). The second largest variable cost is the cost of the implant. The SIGN nail is a simple stainless steel rod that is inexpensive to produce. The third largest contributor is the cost of medical personnel – those involved directly in providing the surgical care.

It has been estimated that the total cost for femoral nailing with the SIGN nail system in Cambodia was "cost effective" at $820 per patient.[24] The analysis did not attempt to assess societal costs or lost wages. A systematic review of traction for femoral shaft fractures in LMICs suggests that the mean LOS for nonoperative treatment is 55.4 days. Therefore, in addition to the direct medical costs associated with prolonged hospitalization, there is likely a large economic burden from the lost productivity and travel for family members who frequently tend to the injured daily for the duration of their hospital stay. Operative treatment of femoral fractures reduces the LOS to about 10 days, with no negative effect on treatment outcomes. It decreases the largest driver of cost and there may be substantial indirect economic benefit from intramedullary nailing because patients treated with surgery are able to return to work more quickly and achieve a higher level of function compared to nonoperative treatment.

Intramedullary nailing is more cost effective than skeletal traction. The cost is lower when compared to skeletal traction and the outcome is better compared to skeletal traction. The best way to manage closed fractures of the femur shaft is intramedullary nailing, and should be done as soon as possible if there are no other comorbidities. This will help reduce the cost to the patient, help decongest the wards and reduce the complication rates. Thus, other orthopedic conditions can be managed because of the available ward beds, and can increase the productivity in the country overall by aiding people to get back to work sooner.

In resource-limited environments where surgery is currently out of reach, training in nonsurgical skills, such as closed reductions, skeletal traction and wound toilet for open fracture, remains essential. In the case of femoral shaft fracture, skeletal traction has shown modest success, although with complication rates and prolonged treatment that would be otherwise unacceptable if safe surgery were available. Intramedullary nailing of a femoral fracture is a clinically and cost-effective treatment option, with high rates of union and low infection rates comparable with those done in HICs.

The AO Alliance: A private initiative to raise awareness and contribute to solutions for care of the injured in Africa

The AO Alliance was founded only by end 2014, being the brainchild of the AO Foundation (AOF) and supported financially by the AOF, to the tune of CHF 25 million, and a philanthropist from the medical device world, with the perspective to also contribute up to CHF 50 million over the next 10 years on a project basis.

> The AOF has led the way to improved care of the injured with innovation and technology second to none

The AOF is the largest surgeon network, with more than 15,000 members in the world in trauma care, training over 50,000 surgeons and health care workers annually across the globe, while conducting its own research. Indeed, the AOF is the base upon which the medical device industry was built – 60 years ago, pioneering Swiss surgeons invented the implants which revolutionized the trauma world, and took practice away from casting and traction methods. These traditional methods are still applied today in LICs. Ever since the AOF closely cooperated with industry for maximum leverage for the benefit of the patient while retaining its full independence in its activities, the AOF has led the way to improved care of the injured with innovation and technology second to none.

> The AOF facilitated the creation of a new foundation, the AO Alliance, which could exclusively and entirely focus on the specific trauma epidemic in LMICs

The AOF, being global, still has little activity in LMICs as it has focused mainly on surgical education and less on nonoperative education. Becoming aware of the magnitude of the problem in LMICs as described in previous sections, it decided to pay increasing attention to these particular issues. Providing financial support and through its huge network, the AOF facilitated the creation of a new foundation, the AO Alliance, which could exclusively and entirely focus on the specific trauma epidemic in LMICs.

The AO Alliance pursues two mutually reinforcing objectives: to use its reputation and its reach to facilitate and lead the necessary “awareness process” while conducting developmental activities in the form of “country initiatives” and education training programs throughout Africa. Its “fil conducteur” is to invest in local capacity – training mainly local surgeons and other health care workers and providing an enabling framework for them to be able to practice their acquired trade and added education.

Initiative to build a coalition: The Davos Global Fracture Care Consultation Event and the Africa Emerging Markets Forum

To achieve the awareness objective, in December 2016, the AO Alliance brought together to Davos, Switzerland, a broad group of opinion leaders in the field of orthopedic trauma – practitioners, researchers, public health specialists and people from African countries to form a coalition of like-minded people with "prevention and treatment of the injured in LMICs" as a common goal. Follow-up and further development are planned to strengthen the argument and its reach globally, but particularly also in Africa – the Emerging Markets Forum (EMF) for Africa being a first step to improve awareness and identify partners.

With the rise in the incidence of road traffic injuries, and unintentional orthopedic trauma in general in these areas, orthopedic trauma services will need to be developed to ensure appropriate patient care.[1] Addressing this need may not only reduce premature death and disability, but will also have positive effects on welfare, economic productivity and long-term development in LMICs.[1] Orthopedic trauma care is essential and must be a priority in the horizontal development of global health systems. The education of surgeons, nonphysician clinicians and ancillary staff in LMICs is central to improving access to and quality of care. Volunteer surgical missions from rich countries can sustainably expand and strengthen orthopedic trauma care only when they serve a local need and build local capacity. Innovative business models with partnerships in the private sector may help to pay for care of the poor.

Africa has been described as the least healthy continent in the world to live. The average annual per capita income is in the range of US $400 or less. The average per capita expenditure on health in most sub-Saharan African countries is less than US $14 per annum. Against this background, most governments are attempting to industrialize their nations, with an attendant increase in the influx of motorized machines, cars and motorcycles. This has increased the incidence of trauma in these countries, and trauma is fast becoming a leading cause of death. The exact scope of the burden of trauma in Africa is difficult to ascertain, as there are very few reports about this emerging public health problem. Most of the available records are from hospital-based data and inferences from such reports are difficult to extrapolate to the general population. Much of the death and disability is preventable by implementing an effective trauma system and developing interventions that have been implemented in developed countries and led to significant reductions in both morbidity and mortality.

The challenges of trauma in Africa, particularly sub-Saharan Africa, are highlighted by considering the burden of trauma among populations, the role of sociopolitical will and strategy in addressing the problem, developing high-quality trauma centers in LMICs, staffing these with well-trained personnel, and establishing sustainable funding streams to support their work. Partnerships with public health groups (including Ministries of Health), for an integrated approach, are needed for successful implementation.

Conclusion and issues for discussion

Traditionally, surgical diseases such as broken bones have garnered less attention and support internationally when compared to other medical specialties (infectious diseases). Over the past decade however, health care professionals have increasingly advocated for the need to address the global burden of noncommunicable diseases. Surgical disease, including traumatic injury, is among the top causes of death and disability worldwide, and the subsequent economic burden is substantial, falling disproportionately on LMICs, especially in Africa. The future of global health in these regions depends on a redirection of attention to diseases managed within surgical, anesthesia and emergency specialties. Increasing awareness of these disparities, as well as increasing focus in the realms of policy and advocacy, is crucial. While the barriers to providing quality trauma and emergency care worldwide are not insurmountable, African nations must work together across disciplines and across boundaries in order to negotiate change and reduce the global burden of caring for the injured. The global burden of orthopedic trauma is vast and includes anesthesia services, pre-hospital systems, and physical, human and organizational resource availability.

While the specific problem might somewhat differ from country to country, a more general and conditioned approach is required to address the following major areas:

a) Further defining and measuring the burden of orthopedic diseases at the local/regional/national levels

b) Characterizing and improving the capacity to deliver surgical services (infrastructure, physical resources, and human resources) through technology and education

c) Determining the most appropriate training strategies for orthopedic trauma care providers

d) Exploring mechanisms to enhance funding through private-public partnerships

e) Innovations by working with the private sector to make available affordable implants adapted to local needs to reduce the cost of trauma care

f) Addressing prevention of RTAs at the country level through proven strategies and legislation

g) Advocating and raising awareness of the need to address the neglected burden of orthopedic trauma care and RTAs

h) Unintentional injuries are the cause of death and disability for millions of children every year in LMICs. Because communicable disease and nutritional problems continue to rank higher as causes of child death and disability in most of the developing world, injury is perceived as a less serious problem. There is an urgent need for more to prevent, treat and rehabilitate.

Systems for the delivery of orthopedic trauma care will have to be as diverse as the populations they aim to serve. From building manpower to cost-cutting innovations, each intervention must be made in the context of a country's cultural, socioeconomic, political, demographic and epidemiological environment.

Success depends, however, also crucially on the availability of sufficient funding as was successfully done for contagious diseases. Obviously, this includes always the local governments, but it needs an international coalition and the support of regional and local philanthropists to highlight and support the effort.

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