Global Orthopaedics and Burden of Musculoskeletal Injury

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Learning objectives

1. Global Orthopaedic Issues
2. Estimating Musculoskeletal Burden of Disease
3. Cost effectiveness of Surgery in developing countries
4. How to Improve Surgical Interventions in Developing Countries
5. Current opportunities for orthopaedic surgeons
Global Orthopaedic Issues

• Orthopaedic issues in the developing world usually involve
  – Pediatric deformity
  – Degenerative conditions
  – Musculoskeletal oncology
  – Spinal deformity
  – Trauma
  – Injury
    • Road Traffic Crashes (RTC)
    • Conflict
    • Disaster
Introduction

• In 2001 injuries killed 5.1 million people. Injuries....
  – Accounted for 12% disability-adjusted life years which is greater than that lost because of tuberculosis (2.5%), diarrhea (4.3%) and malaria (2.9%) combined.
  – Resulted in twice as many years lost as that lost to either HIV (6%) or cancer (5.2%).
  – Were the leading cause of death in low and middle income countries between ages 5-45.
  – For each person who dies from trauma, 3-8 more are permanently disabled.

Beveridge et al.  JBJS 2004
Studying the Burden of Disease

- Recognition of its implications:
  - Development of prevention strategies based on the Public Health Model:
    - Surveillance and screening
    - Recognition of risk factors
    - Development of prevention and intervention strategies
    - Progressive evaluation of effects to target population
  - **Policy Implementation and targeted resource allocation for health care**
Background

World Bank: Classifies countries based on per capita gross national income. As of 2005 countries have been classified as:

1. **low income** (< $875 per year)
2. **lower middle income** ($876-$3465)
3. **upper middle income** ($3466-$10,725)
4. **high income** (> $10,726)
### Characteristics of the developing world

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>High</td>
<td>295,734,134</td>
<td>78</td>
<td>41,440</td>
<td>5711</td>
<td>2.56</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>High</td>
<td>60,441,457</td>
<td>79</td>
<td>33,630</td>
<td>2428</td>
<td>2.30</td>
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<tr>
<td>China</td>
<td>Low/Middle</td>
<td>1,306,313,812</td>
<td>72</td>
<td>1500</td>
<td>61</td>
<td>1.06</td>
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<td>Indonesia</td>
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<td>Egypt</td>
<td>Low/Middle</td>
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<td>68</td>
<td>1250</td>
<td>55</td>
<td>0.54</td>
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<tr>
<td>Philippines</td>
<td>Low/Middle</td>
<td>87,857,473</td>
<td>68</td>
<td>1170</td>
<td>31</td>
<td>0.58</td>
</tr>
<tr>
<td>Peru</td>
<td>Low/Middle</td>
<td>28,302,603</td>
<td>71</td>
<td>2360</td>
<td>98</td>
<td>1.17</td>
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<tr>
<td>Brazil</td>
<td>Low/Middle</td>
<td>188,078,227</td>
<td>70</td>
<td>3300</td>
<td>212</td>
<td>1.15</td>
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<tr>
<td>Kenya</td>
<td>Low</td>
<td>33,829,590</td>
<td>51</td>
<td>480</td>
<td>20</td>
<td>0.14</td>
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<tr>
<td>Sierra Leone</td>
<td>Low</td>
<td>5,867,426</td>
<td>39</td>
<td>210</td>
<td>7</td>
<td>0.03</td>
</tr>
<tr>
<td>Mozambique</td>
<td>Low</td>
<td>19,406,703</td>
<td>45</td>
<td>270</td>
<td>12</td>
<td>0.03</td>
</tr>
<tr>
<td>Uganda</td>
<td>Low</td>
<td>27,269,482</td>
<td>49</td>
<td>250</td>
<td>18</td>
<td>0.08</td>
</tr>
<tr>
<td>Nigeria</td>
<td>Low</td>
<td>128,765,768</td>
<td>46</td>
<td>430</td>
<td>22</td>
<td>0.28</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>Low</td>
<td>70,053,286</td>
<td>50</td>
<td>110</td>
<td>5</td>
<td>0.03</td>
</tr>
<tr>
<td>Malawi</td>
<td>Low</td>
<td>12,707,464</td>
<td>41</td>
<td>160</td>
<td>13</td>
<td>0.02</td>
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<tr>
<td>Ghana</td>
<td>Low</td>
<td>21,946,247</td>
<td>57</td>
<td>380</td>
<td>16</td>
<td>0.15</td>
</tr>
<tr>
<td>India</td>
<td>Low</td>
<td>1,080,264,388</td>
<td>62</td>
<td>620</td>
<td>27</td>
<td>0.60</td>
</tr>
<tr>
<td>Nepal</td>
<td>Low</td>
<td>27,676,547</td>
<td>61</td>
<td>250</td>
<td>12</td>
<td>0.21</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>Low</td>
<td>144,319,628</td>
<td>62</td>
<td>440</td>
<td>14</td>
<td>0.26</td>
</tr>
<tr>
<td>Pakistan</td>
<td>Low</td>
<td>162,419,946</td>
<td>42</td>
<td>600</td>
<td>13</td>
<td>0.74</td>
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<tr>
<td>Afghanistan</td>
<td>Low</td>
<td>29,928,987</td>
<td>62</td>
<td>?</td>
<td>11</td>
<td>0.19</td>
</tr>
<tr>
<td>Cambodia</td>
<td>Low</td>
<td>13,636,398</td>
<td>54</td>
<td>350</td>
<td>33</td>
<td>0.16</td>
</tr>
<tr>
<td>Vietnam</td>
<td>Low</td>
<td>83,535,576</td>
<td>71</td>
<td>540</td>
<td>26</td>
<td>0.53</td>
</tr>
</tbody>
</table>

Speigel et al. In Press
Learning objectives

1. Global Orthopaedic Issues
2. **Estimating Musculoskeletal Burden of Disease**
3. Cost effectiveness of Surgery in Developing Countries
4. How to Improve Surgical Interventions in Developing Countries
5. Current opportunities for orthopaedic surgeons
Estimating Global Burden of Disease

• 135 specific diseases and injuries
• 3 major groups:
  – **Group I** (communicable diseases, maternal and perinatal conditions, and nutritional deficiencies)
  – **Group II** (noncommunicable diseases)
  – **Group III** (injuries)
    • Injuries are further divided into *intentional* (self inflicted violence, interpersonal violence, war, other) and *unintentional* (road traffic injuries, poisoning, falls, fires, drowning, other).
Estimating Global Burden of Disease

Quantifying the Burden of Disease: *The “DALY”*

- Traditional measures of population health have focused on mortality
- But, what about the *contribution of non-fatal outcomes* to the world’s disease burden?
- In response, the DALY (Disability Adjusted Life Year) was developed as a component of the Global Burden of Disease Study
- The DALY was designed to measure the *combined impact of morbidity and mortality*
  - quantify the burden of disease and disability in a population
  - inform resource allocation in prevention and treatment programs
DALY (Disability-Adjusted Life-Year)

• One DALY = Loss of 1 year of healthy life
• Composite metric that tries to capture two different dimensions of health:
  – Mortality → QUANTITY OF LIFE (YLL)
  – Morbidity → QUALITY OF LIFE (YLD)
• DALY = YLL + YLD
• Controversial, but widely used
Age weighting:
assumes a societal preference to value a year of life for a young adult more than for a child or an elderly person.

- DALY (0,1) means the range from perfect health (zero) to death (one).

Murray and Lopez in 1996

As with other summary measures of population health, social value choices are incorporated. More weight is given to patients with disabilities in young adulthood. The rationale behind this weighting is that young adults contribute more to the economic well being of a country than the young and elderly.
Examples of disability weights for traumatic musculoskeletal conditions

<table>
<thead>
<tr>
<th>Non-musculoskeletal conditions</th>
<th>Musculoskeletal Injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>cataracts</td>
<td>dislocations</td>
</tr>
<tr>
<td>0.600</td>
<td>0.074</td>
</tr>
<tr>
<td>acute myocardial infarction</td>
<td>femur</td>
</tr>
<tr>
<td>0.491</td>
<td>0.372</td>
</tr>
<tr>
<td>major depression</td>
<td>pelvis</td>
</tr>
<tr>
<td>0.600</td>
<td>0.247</td>
</tr>
<tr>
<td>birth asphyxia/trauma</td>
<td>ankle</td>
</tr>
<tr>
<td>0.381</td>
<td>0.196</td>
</tr>
<tr>
<td>leprosy</td>
<td>tibia/fibula</td>
</tr>
<tr>
<td>0.153</td>
<td>0.271</td>
</tr>
<tr>
<td>tuberculosis</td>
<td>amputations</td>
</tr>
<tr>
<td>0.294</td>
<td>0.300</td>
</tr>
<tr>
<td>spinal cord injury</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.725</td>
</tr>
</tbody>
</table>

The values for a selected group of conditions were determined by a panel of experts using a Person Trade Off (PTO) method, and lie along a continuum from 0 (complete health) to 1 (death).
Estimating Global Burden of Disease

Critique of the DALY

• The DALY assumes a “global social milieu”
  – The disability weights do not take into account the context in which the condition occurs.

• Weights for the same condition *might vary significantly based upon the local infrastructure and the availability of support from family members and the society.*
  – Paraplegics in Cameroon rated their health as significantly worse than those in Australia.

Bottom Line…

INJURY is the leading cause of death and disability worldwide in people under 60 years of age.

Chart 1. Global burden of disease attributable to injuries, 1998 estimates

## Composition of Burden of Disease (% DALYS)

<table>
<thead>
<tr>
<th></th>
<th>Low-Income</th>
<th>High-Income</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td><strong>Communicable</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HIV</td>
<td>5</td>
<td>0.4</td>
<td>5</td>
</tr>
<tr>
<td>Perinatal</td>
<td>6</td>
<td>0.9</td>
<td>6</td>
</tr>
<tr>
<td>Respiratory</td>
<td>6</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td><strong>Non-communicable</strong></td>
<td>49</td>
<td>87</td>
<td>53</td>
</tr>
<tr>
<td>Cancer</td>
<td>5</td>
<td>17</td>
<td>7</td>
</tr>
<tr>
<td>Psychiatric</td>
<td>10</td>
<td>21</td>
<td>11</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>13</td>
<td>20</td>
<td>14</td>
</tr>
<tr>
<td><strong>Injuries</strong></td>
<td><strong>11</strong></td>
<td><strong>8</strong></td>
<td><strong>11</strong></td>
</tr>
<tr>
<td>TOTAL</td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Note: “Communicable” also includes perinatal and nutrient deficiencies.

Estimating Global Burden of Disease

Chart 2. Leading causes of death, both sexes, 1998. Low and middle-income countries, by age.

- 0-4 Years
- 5-14 Years
- 15-44 Years
- 45-59 Years
- >60 Years

Communicable diseases, maternal & perinatal conditions and nutritional deficiencies
Noncommunicable conditions
Injuries
Orthopaedic Injury: RTCs

RTCs = Road Traffic Crashes
# Predicted Changes in Rank Order of DALYs

<table>
<thead>
<tr>
<th>Rank</th>
<th>1990</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LRI</td>
<td>IHD</td>
</tr>
<tr>
<td>2</td>
<td>Diarrhea</td>
<td>Depression</td>
</tr>
<tr>
<td>3</td>
<td>Perinatal</td>
<td>RTC</td>
</tr>
<tr>
<td>4</td>
<td>Depression</td>
<td>CVD</td>
</tr>
<tr>
<td>5</td>
<td>IHD</td>
<td>COPD</td>
</tr>
<tr>
<td>6</td>
<td>CVD</td>
<td>LRI</td>
</tr>
<tr>
<td>7</td>
<td>TB</td>
<td>TB</td>
</tr>
<tr>
<td>8</td>
<td>Measles</td>
<td>War</td>
</tr>
<tr>
<td>9</td>
<td>RTA</td>
<td>Diarrhea</td>
</tr>
<tr>
<td>10</td>
<td>Congenital</td>
<td>HIV</td>
</tr>
</tbody>
</table>
Road Traffic Crashes

• Road Traffic Crashes – an emerging epidemic?
  – The number of motorized vehicles in China increased from 60,000 to more than 50 million over the past 50 years.
  – In Thailand the number has increased from 4.9 million in 1987 to 17.7 million in 1997.

• While only 32% of the world’s vehicles are found in low-income countries, they account for 85% of the deaths and 90% of the DALYs attributed to road traffic crashes.

Road Traffic Crashes

- 28% reduction in fatalities is expected in high-income countries
- 92% and 147% rise in fatalities are anticipated in China and India, respectively
Road Traffic Crashes

- Road traffic crashes are the most common cause of death from injury worldwide

- Road traffic crashes are responsible for approximately 1.2 million deaths per year

- The estimated costs for low and middle income countries are equivalent to 1-2% of their gross domestic product, which for many countries exceeds yearly developmental aid given to them.
Road Traffic Crashes

• **1.2 million deaths** a year or an average of 3,242 every day.
• **Disables between 20 million and 50 million people** each year.
• The majority of injuries affect people in low- and middle-income countries, especially young males and vulnerable road users:
  – 90% of road traffic deaths occur in low- and middle-income countries.
  – More than half of all road traffic deaths occur among young adults between 15 and 44 years of age; 73% of all fatalities are male.
Estimating Musculoskeletal Burden of Disease

- What we know:
  - closed head injuries and visceral injuries are the predominant cause of death
- What can be assumed:
  - the effect of non-fatal injuries is likely much greater than that of fatal injuries
  - musculoskeletal injuries are a common source of morbidity
Estimating Musculoskeletal Burden of Disease

We need to quantify:

1. **Incidence** of musculoskeletal injury.
2. **Long term impact** of traumatic injuries on the family, community, and society*.

*In addition to the loss of the productivity of the individual, these injuries can drain significant resources from family and community. There may be permanent job loss, and the family often has to allocate significant resources (savings, belongings, cattle, land) to cover the costs of treatment. So far there is little information pertaining to either incidence of musculoskeletal injury or its long term impact. A few studies do have interesting implications worth noting.
Estimating Musculoskeletal Burden of Disease

Bach et al. Distribution of fractures and surgical cases according to general category
Estimating Musculoskeletal Burden of Disease

Conclusions, Bach et al:

• Musculoskeletal injury is very common in Africa

• “Most surgeons working in Africa are trained in Anglo-French parts of Europe and North America, where in contrast to Germany, Austria and Switzerland, musculoskeletal trauma is not included under the general surgical umbrella”

• Recommends establishing the profile of the “district surgeon” who is trained in knowledge and abilities of all surgical specialties relevant to the area in which they are working.
Injury and Musculoskeletal Burden of Disease

What does this mean for Orthopaedic Surgeons?
• Global burden of musculoskeletal injuries is in low and middle income countries
• Extremity injuries are an important cause of permanent disability
• The impact of traumatic conditions treated by orthopaedic surgeons has yet to be quantified on a global basis.
Estimating Musculoskeletal Burden of Disease

Orthopaedic surgeons have the opportunity to work with public health colleagues to better characterize the burden of musculoskeletal disease, and to design more effective strategies to decrease this burden. Their roles are to:

– Quantify the contribution of musculoskeletal injury to the Global Burden of Disease.

– Design effective strategies for decreasing the burden.
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Surgeons and Global Health

SURGERY:
• “Curative”
• Focus is on the Individual
• High-tech, high-skills
• Not Cost-effective

PUBLIC HEALTH:
• Prevention approach
• Focuses on Populations
• Low-tech, variable skills
• More cost-effective
• Equity

Surgery has not been perceived as part of “public health”, particularly in low and middle income countries. In recent years research expenditures per DALY have been: for HIV, $85; for injuries, $0.43

Surgeons and Global Health

• Recent challenges to this perception:
  – Is it possible to prevent traumatic surgical emergencies?
• Evidence that certain surgical treatments “avert DALYs” is beginning to emerge.
• Need for studies focusing on the ability of specific treatments to avert DALYs.
Surgery and Global Health

*Disease Control Priorities in Developing Countries: Surgery Chapter (2006)*

• Estimates of cost-effectiveness of interventions:
  – Measles Vaccines: $4-15/DALY averted
  – AntiRetroVirals for HIV: $300-500/DALY averted
  – **Surgery: $7-200/DALY averted**

Calculating DALYs Averted

- 11,282 DALYs averted during 3-month period
- Cost/DALY averted = $32.78
  - Non-surgical interventions:
    - Vitamin A distribution = $9
    - Measles immunization = $15
    - Oral rehydration for diarrhea = $35

**Conclusions:** At $7-200/DALY averted, surgical treatment of common pathologies in developing countries may be more cost effective than previously thought.
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How to Improve Surgical Interventions in Developing Countries

- Prevention
- Improvements in delivery of, and access to, health care
- Increased health care personnel
- Education

- Synergy of mission statements
- Academic partnering through departments
- Teaching/Training/Research model
Road Traffic Crash Prevention

• Improve road safety
  – Improved road engineering
  – Introduction of sidewalks – lack of pedestrian walkways associated with two-fold increased risk of pedestrian fatality.
  – Enforcement of speed limits
    • Rumble strips installed on the main Accra-Kumasi highway in Ghana reduced crashes by about 35% and fatalities by about 55%.
  – Vehicle design and maintenance
  – Human behavior
    • Speed control, seat belt use, ethanol consumption

Among all road traffic crashes, 26% involve children and adolescents. Measures which address speed and alcohol use among all road users would save many of these children's lives (3).
Prevention

- United Nations Road Safety Commission:
  - 42 agencies committed to addressing road safety.
  - Compile available evidence and examine scientific evidence for road-traffic injury prevention.
Access to Medical Care

Ensuring Universal Quality of Care for the Injured

• Barriers to the provision of care:
  – Deficient infrastructure – both pre-hospital and hospital-based services
  – Lack of trained health professionals
  – Inadequate access to health information
Access to Medical Care: Pre-hospital

- Up to 50% of those injured in low and middle income countries receive no medical care.
- A significant number will receive services at a non-doctor staffed primary health facility.

Mock et al. Journal of Trauma 1997
Access to Care: Pre-hospital

Low Utilization of Formal Medical Services by Injured Persons in a Developing Nation

• Mock et al. *JOT* 1997:
  – Epidemiologic study of trauma in Ghana
  – Survey involving 21,105 persons living in rural and urban sights using the Abbreviated Injury Score
  – 1 year period: 13 fatal injuries, 1,597 nonfatal injuries
  – Of fatally injured, 31% received formal medical care
  – Overall hospital use 27%
## Access to Care: Pre-hospital

![Image](https://via.placeholder.com/150)

Figure 1: distribution of injury, urban versus rural.

<table>
<thead>
<tr>
<th></th>
<th>All Injured$^a$</th>
<th></th>
<th></th>
<th>Severe Injured$^a$</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number (n = 1597)</td>
<td>No Care (%)</td>
<td>Hospital (%)</td>
<td>Clinic (%)</td>
<td>Number (n = 445)</td>
<td>No Care (%)</td>
</tr>
<tr>
<td>Urban</td>
<td>673</td>
<td>32</td>
<td>38</td>
<td>30</td>
<td>200</td>
<td>17</td>
</tr>
<tr>
<td>Rural</td>
<td>924</td>
<td>49</td>
<td>20</td>
<td>31</td>
<td>245</td>
<td>26</td>
</tr>
</tbody>
</table>

$^a p < 0.001$ for urban versus rural. Hospital indicates inpatient or outpatient. Severely injured indicates $\geq 1$ month of disability.
Conclusion: Utilization of formal medical services for nonfatal injuries correlates strongly with transportation access.
Access to Care: Pre-hospital

<table>
<thead>
<tr>
<th>Body part</th>
<th>All Injured</th>
<th></th>
<th></th>
<th></th>
<th>Severely Injured</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number (n = 869)</td>
<td>No Care (%)</td>
<td>Hospital (%)</td>
<td>Clinic (%)</td>
<td>Number (n = 225)</td>
<td>No Care (%)</td>
<td>Hospital (%)</td>
<td>Clinic (%)</td>
</tr>
<tr>
<td>Head</td>
<td>119</td>
<td>36</td>
<td>35</td>
<td>29</td>
<td>29</td>
<td>10</td>
<td>69</td>
<td>21</td>
</tr>
<tr>
<td>Torso</td>
<td>40</td>
<td>33</td>
<td>53</td>
<td>15</td>
<td>16</td>
<td>0</td>
<td>94</td>
<td>6</td>
</tr>
<tr>
<td>Upper extremity</td>
<td>230</td>
<td>48</td>
<td>22</td>
<td>30</td>
<td>80</td>
<td>31</td>
<td>35</td>
<td>27</td>
</tr>
<tr>
<td>Lower extremity</td>
<td>467</td>
<td>52</td>
<td>14</td>
<td>34</td>
<td>103</td>
<td>29</td>
<td>30</td>
<td>41</td>
</tr>
<tr>
<td>Skin/burn</td>
<td>46</td>
<td>67</td>
<td>9</td>
<td>24</td>
<td>10</td>
<td>20</td>
<td>10</td>
<td>70</td>
</tr>
</tbody>
</table>

a Sum of number of individual sites of injuries equals more than total number of injuries, as some injured persons had more than one body part injured. Snakebites excluded from this analysis.

b p ≤ 0.05 (df = 2) for differences in medical care for presence vs absence of injury to this body part for all injured persons.

c p ≤ 0.05 (df = 2) for differences in medical care for presence vs absence of injury to this body part for severely injured persons. Head includes face and neck. Hospital indicates inpatient or outpatient. Severely injured indicates ≥ 1 month of disability.

**Conclusion**: current estimates of Injury as a cause of morbidity and mortality likely underestimate the true problem given that these data are often obtained from hospital records. As we can see here, a number of patients never make it to the hospital. Also, the upper extremity and lower extremity were frequently involved and often in individuals who did not receive any formal care.
Access to Care: Pre-hospital

Pre-hospital Care Solutions:
• Informal emergency response system
• Public transport vehicles
• Lay people may be trained in basic first aid
• Mock et al. *Journal of Trauma* 2001:
  – 335 commercial drivers trained using a 6-hour basic first aid course.
  – 61% interviewed at a mean follow up of 10 months had provided 1st aid since participating in the course.
WHO guidelines for development of effective pre-hospital trauma care systems:

- Goal to identify:
  - Core strategies
  - Equipment
  - Supplies
  - Organizational structures, which are needed to create effective and adaptable pre-hospital care systems for injured persons worldwide


For countries that are looking for more comprehensive measures to combat this problem, the World Health Organization has established some guidelines to assist developing countries with establishing prehospital trauma care systems. Without adequate access to hospital care, many patients with orthopaedic injuries have delayed presentations. This leads to increased incidence of chronic bone infections, non-reduced dislocations, malunions and nonunions making definitive treatment more costly and difficult.
Access to Care: Pre-hospital

Three tier pre-hospital care system:

1. **Basic First Aid.** Community members with minimal training. Recognize an emergency, call for help and provide treatment until formally trained health-care personnel arrive to give additional care.

2. **Basic Life Support.** Extensive formal training in prehospital care, scene management, rescue, stabilization and the transport of injured people.

3. **Advanced life support.** MD or EMT staffed with extensive referral network.

WHO stresses that expensive systems should not supplant more basic measures of developing prehospital care systems.
Essential Trauma Care Project:
- Partnership between the International Association for the Surgery of Trauma and Intensive Care (IATSIC) and the WHO.
- This collaboration led to the “Guidelines for Essential Trauma Care” publication:
  - Guidelines for determining which trauma services should be provided at various facilities, the resources needed for such services, and the staffing.

What about when the patient arrives at the hospital? In such a resource deprived setting, how can we improve the quality of trauma care at various health care facilities? More importantly, how can governments determine which trauma services are to be provided, which resources are needed to deliver these services and which individuals will provide the services?
Access to Medical Care

Essential Trauma Care Project

• Based upon four levels of health care facility
  1. *Basic* (village health post)
  2. *GP* (general practitioner, has surgical capability)
  3. *Specialist* (has a general surgeon with or without an orthopaedic surgeon)
  4. *Tertiary* (has an orthopaedic surgeon)

These services are outlined in the ETC resource matrix, based upon four levels of health care facility [*Basic* (village health post), *GP* (general practitioner, has surgical capability), *Specialist* (has a general surgeon with or without an orthopaedic surgeon), and *Tertiary* (has an orthopaedic surgeon)].
Access to Medical Care

- What does this mean for musculoskeletal injury:
  - Basic immobilization is essential at all levels.
  - Closed reduction is essential at the tertiary and specialty levels, and desirable at the basic and GP levels.
“Global Human Resource Crisis”

- Global shortage of 4 million health care workers worldwide
- Inadequacies in the distribution of workers both between and within countries

Chen et al. *Lancet* 2004

What about the workforce? We’ve talked about infrastructure that needs to be in place to advance trauma care. How does the workforce factor in? Current estimates suggest that there is a global shortage of 4 million health care workers, and this global “human resource crisis” is defined not only by deficiencies in the absolute number of workers, but also by inadequacies in the distribution of workers both between and within countries.
Health Workforce

• **24% of the world’s disease burden** is found in Africa
  – 3% of the world’s health workers
  – 1% of the world’s resources for health

• **10% of the world’s disease burden** is found in the region of the Americas (including the United States and Canada),
  – This region accounts for 37% of the world’s health workforce and more than 50% of the world’s health spending.

Chen et al. *Lancet* 2004

When one looks at the distribution of health care workers compared to regional burden of disease, we see how significant this problem is in the developing world. This is particularly pronounced in Africa where 24% of the world’s disease burden is found in Africa, this continent has only 3% of the world’s health workers, and only 1% of the world’s resources for health96. In contrast, while only 10% of the world’s disease burden is found in the region of the Americas (including the United States and Canada), this region accounts for 37% of the world’s health workforce and more than 50% of the world’s health spending.
Health Workforce

What about orthopaedic surgery?

• 80% of trained orthopaedic surgeons in the world live and practice in the 26 developed nations.
• If the United States had the same orthopaedist-to-population ratio as Malawi, we would have 30 orthopaedic surgeons. Ratios between different countries vary widely

Teaching/Training of Health Care Professionals

• Most injured patients worldwide have no access to an orthopaedic surgeon.
• Majority of treatment is provided by:
  – traditional practitioners (bonesetters)
  – general medical doctors
  – general surgeons
  – other health care workers
• Impact through teaching/training
Teaching/Training of Health Care Professionals

Bone Setter’s Gangrene

- Volkmann’s ischemia and compartment syndrome: type of forearm ischemic contracture resulting from brachial artery injury usually associated with supracondylar fracture of humerus
- May see loss of motor & sensory function, however, classic involvement is with anterior interosseous branch of median nerve;
- Method – apply tourniquet bamboo stick splint over injured limb.
- Often left in place for 2-3 days before it is intermittently released for treatment with herbs and massage.
Notes on: Teaching/Training of Health Care Professionals

One area in which there has been some effort to educate traditional practitioners is in fracture care. In a large portion of the developing world, fractures continue to be treated by traditional bonesetters. While many fractures heal properly with traditional treatment, bone setters often do not appreciate the dangers of tight splintage and compartment syndrome. Although the rate of complications following treatment by traditional bonesetters remains unknown, catastrophic consequences such as gangrene and Volkmann’s ischemic contracture have been the focus of numerous articles.
Performance of a trained traditional bonesetter in primary fracture care

Background: In rural areas of Africa about 70% of patients with closed fractures are treated by traditional bonesetters.

Study Design:

2 year prospective study comparing results of fracture care at two primary care centers in rural Nigeria

Center A received 1 day course in fracture care

Center B received no training
Performance of a trained traditional bonesetter in primary fracture care

John E Onuminya

Results:

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Centre A</th>
<th>Centre B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acceptable union</td>
<td>19 (47.5)</td>
<td>5 (12.5)</td>
</tr>
<tr>
<td>Malunion</td>
<td>8 (20.0)</td>
<td>12 (30.0)</td>
</tr>
<tr>
<td>Non-union</td>
<td>3 (7.5)</td>
<td>6 (15.0)</td>
</tr>
<tr>
<td>Delayed union</td>
<td>7 (17.5)</td>
<td>8 (20.0)</td>
</tr>
<tr>
<td>Post-traumatic osteomyelitis</td>
<td>2 (5.0)</td>
<td>5 (12.5)</td>
</tr>
<tr>
<td>Limb gangrene</td>
<td>1 (2.5)</td>
<td>4 (10.0)</td>
</tr>
<tr>
<td>Total</td>
<td>40 (100)</td>
<td>40 (100)</td>
</tr>
</tbody>
</table>

Conclusions:

1. Traditional bonesetters (Centre A) are amenable to formal training
2. Training of TBS is requires little effort and can significantly reduce morbidity associated with traditional management of closed fractures
Tindal et al. *Journal of Pediatric Orthopaedics* 2005:

- 3-day course on how to recognize and manage idiopathic club feet for orthopaedic clinical officers.
- 100 consecutive cases of uncomplicated idiopathic clubfeet in newborn babies were manipulated by OCOs (orthopaedic clinical officers)
Notes on: Results of Manipulation

Another area in which orthopaedic surgeons can train traditional caregivers is in the treatment of club feet. Malawi has 12 million people, 85% of whom live in rural areas. There are only 4 orthopaedic surgeons in the country. 70 orthopaedic clinical officers are employed in government district hospitals and missions throughout the country. OCOs provide majority of orthopaedic care and usually work in isolation.
FIGURE 1. Algorithm for the treatment of clubfoot. POP, plaster of Paris cast.
Results of Manipulation of Idiopathic Clubfoot Deformity in Malawi by Orthopaedic Clinical Officers Using the Ponseti Method

A Realistic Alternative for the Developing World?

Alistair J. Tindall, MRCS (Eng.), Colin W. B. Steinlechner, FRCS (Tr.&Orth.), Christopher B. D. Lavy, MCh, FRCS, Steve Mannion, FRCS (Tr.&Orth.), and Nyengo Mkandawire, MCh (Orth)

Results:

– 57 = fully corrected to a plantigrade position by Ponseti manipulation alone.
– 41 = manipulation + simple percutaneous tenotomy.
– Orthopaedic clinical officers corrected 98 out of 100 feet; the remaining 2 feet were referred for surgical correction.
– No complications
Mozambique: the Assistant Medical Officers Program

- 2 years didactic training in a variety of surgical specialties, 1 year practical internship. Trained in management of open fractures, external fixation, traction reduction and amputation.

In addition to the need to train non-physician medical personnel, efforts must be made to improve the quality of care provided by physicians. One problem facing physicians who are practicing in the developing world is that much of their training may not be relevant to what they see in practice.
Teaching/Training of Health Care Professionals

Region Specific Training
- In a review from Pakistan, only 37% of the general surgical procedures performed were taught in training programs from high income countries.*

“Rural” Surgeons
- Proficient in a selected group of essential procedures drawn from all of the surgical subspecialties.
- Ethiopia: training program for surgical care in rural hospitals
  - 1 out of 8 teaching modules is orthopaedics: management of closed fractures, dislocations, open fractures, tendon lacerations, amputations and use of traction**

**Rennie et al. Trauma Q 1999

In addition to the need to train non-physician medical personnel, efforts must be made to improve the quality of care provided by physicians. One problem facing physicians who are practicing in the developing world is that much of their training my not be relevant to what they see in practice.
Information Transfer

Problems:
1. Access
2. Relevant information

Access:
• In 2002, 56% of low income countries could not access through the web or hard copy journals
• 21% had access to an average of two journals

Katikireddi et al. BMJ 2004:
Information Transfer

Solutions:

• Ptolemy Project – University of Toronto and Association of Surgeons of East Africa

• The World Health Organization launched HINARI (Health Internetwork Access to Research Initiative) in 2002
  – Providing access to medline and full text articles through more than 2400 journals via a web portal.
  – As of 2004, >1100 nonprofit institutions from 103 of 113 eligible countries had subscribed to the service, which is free in countries with a GNP per capita of less than $1000.
Information Transfer

Likelihood of research impacting practice

  - Performed a cross-sectional questionnaire in different countries (China, Thailand, India, Egypt, Kenya) and found that research published in local journals had the highest likelihood of changing practice.
  - Reported on role of orthopaedic surgeons as “information brokers”.
Surgery and Global Health

- Past Models of Surgery and International Health
  - Volunteerism and Service
  - Short-term Missions
  - Resource Intensive
  - Limited Follow-up
  - Complications Left Behind
  - Impact Local Health Delivery System
  - Minimal Teaching

New Model of Surgery and Global Health

Sustainable Partnerships
Role of academic institutions:
Research, Training, and Capacity Building
Learning objectives

1. Global Orthopaedic Issues
2. Estimating Musculoskeletal Burden of Disease
3. Cost effectiveness of Surgery in developing countries
4. How to Improve Surgical Interventions in Developing Countries
5. **Current opportunities for orthopaedic surgeons**
Specific International Orthopaedic Organizations

- SICOT - the Société Internationale de Chirurgie Orthopédique et de Traumatologie
- HVO and Orthopaedics Overseas
- ICOE – International Center for Orthopaedic Education
- Operation Rainbow
- World Orthopaedic Concern, International
- Institute for Global Orthopedics and Traumatology (IGOT)
- Surgical Implant Generation Network
The International Society of Orthopaedic Surgery and Traumatology (SICOT) has developed a web portal, active in eighteen countries, to facilitate the exchange of ideas and educational materials. One component of this program is a telediagnostic web site, in which consultation can be obtained.

3000 members representing 100 countries with one delegate from each country. World portal: lectures given by world experts, discussion boards for interaction. Telediagnostic web site: Files with clinical information of patients are sent to medical centers for consultation.
Health Volunteers Overseas and Orthopaedics Overseas

• Private non-profit organization dedicated to improving the availability and quality of health care in developing countries through the training and education of local health care providers.

• HVO promotes health care in the least developed nations of the world through training and education in 11 specialty areas: Anesthesia, Burn Management, Dentistry, Dermatology, Hand Surgery, Internal Medicine, Nursing, Nursing Anesthesia, Oral & Maxillofacial Surgery, Orthopaedics, Pediatrics, Physical Therapy
HVO (Health Volunteers Overseas)

- **Program Locations:** More than 65 clinical education programs in 25 developing countries in the Americas, Asia, Africa and Eastern Europe.
- Seeks trained health workers in many disciplines
- **Annual Budget:** $5.5 million
- **Funding:** 92.6% from private sources, including individuals, foundations, associations and corporations; 7.4% from U.S. government funds. They help residents locate funding
- **Website:** [www.hvousa.org](http://www.hvousa.org)
ICOE – International Center for Orthopaedic Education

- Clearing house for worldwide educational activities.
- Sponsored by the AAOS, OREF, JBJS
- Matches institutions offering educational opportunities with applicants seeking educational or service experiences globally
- Includes 2300 institutions in 78 countries on 6 continents
- Website: www.icoe.aoassn.org
Operation Rainbow

Twofold mission:

1. Providing free Plastic and Orthopedic surgery to children who do not have access to care, in the United States and across the globe.
2. Providing continuing education to international health care providers to encourage medical self-sufficiency.
   • Website: www.operationrainbow.org

Operation Rainbow focuses its mission work within two specialties or divisions: Orthopedic Surgery (since 1988) and Plastic Surgery (since 1978). Since the mission goals always include addressing needs specific to a given location, specialties other than these two are often invited to join the Rainbow Team for the specified needs. The list of team member categories represents the minimum requirements for participation on a Rainbow Team.
World Orthopaedic Concern, International

An international society for orthopaedic education and care in developing countries, the World Orthopaedic Concern (WOC) is dedicated to improving the standard of orthopaedic and reconstructive surgery in all developing countries — in the tropics, subtropics, and anywhere where there is a need. We do this by educating Orthopaedic Surgeons, Orthopaedic Residents, Registrars, General Surgeons, General Surgery Residents, Medical Students, and paramedical personnel and technicians.

Website: http://www.worldorthopaedicconcern.org/
Institute for Global Orthopaedics and Traumatology

Goals

• 1. To analyze the determinants of inequity in the burden of musculoskeletal injuries and other musculoskeletal conditions amongst underserved populations.

• 2. To develop recommendations and strategic action plans that will decrease the inequities of musculoskeletal injuries and other musculoskeletal conditions amongst underserved populations.

• 3. To promote collaborative approaches in underserved areas for evidence-based research, education and capacity building for the management of musculoskeletal injuries and other musculoskeletal conditions

Website: www.globalorthopedics.com
Surgical Implant Generation Network

• SIGN was officially incorporated in January of 1999. The processes were set in place to begin projects.
• SIGN IM Nail system, which includes an intramedullary nail, interlocking screws and instrumentation. The system is specifically designed for use in hospitals in developing countries where real time imaging and power equipment are not available. Currently, SIGN engineers are designing new implants to address a broader range of fractures in the femur and tibia.

Website: http://www.sign-post.org/
Summary

• Long term impact of musculoskeletal injury
• Identify those conditions that contribute most significantly to each region of need
• Provide better estimates of the cost effectiveness of surgical intervention
• Establish partnerships between training programs in the developing world and institutions in the developed world.
  – Indonesian orthopaedic training program. Co-operative effort between Indonesians, the Australian Orthopaedic Association, and OO.
• Direct intervention efforts at prevention, improving access to care, education of traditional care givers, and access to relevant information through the internet.
Credits

David Spain, MD
Richard Gosselin, MD
Alexander Disston, MD

Institute for Global Orthopedics and Traumatology (IGOT)
UCSF/SFGH Orthopedic Trauma Center
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