# Current Status of Musculoskeletal Trauma Care Systems Worldwide

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Abstract: BACKGROUND AND RATIONALE Although general trauma care systems and their effects on mortality reduction have been studied, little is known of the current state of musculoskeletal trauma delivery globally, particularly in low-income (LI) and low middle-income (LMI) countries. The goal of this study is to assess and describe the development and availability of musculoskeletal trauma care delivery worldwide. MATERIALS METHODS A questionnaire was developed to evaluate different characteristics of general and musculoskeletal trauma care systems, including general aspects of systems, education, access to care and pre- and posthospital care. Surgical leaders involved with musculoskeletal trauma care were contacted to participate in the survey. RESULTS Of the 170 surveys sent, 95 were returned for use for the study. Nearly 30 percent of surgeons reported a formalized and coordinated trauma system in their countries. Estimates for the number of surgeons providing musculoskeletal trauma per one million inhabitants varied from 2.6 in LI countries to 58.8 in high-income countries. Worldwide, 15% of those caring for musculoskeletal trauma are fellowship trained. The survey results indicate a lack of implemented musculoskeletal trauma care guidelines across countries, with even high-income countries reporting less than 50% availability in most categories. Seventy-nine percent of the populations from LI countries were estimated to have no form of health care insurance. Formalized emergency medical services were reportedly available in only 33% and 50% of LI and LMI countries, respectively. Surgeons from LI and LMI countries responded that improvements in the availability of equipment (100%), number and locations of trauma-designated hospitals (90%), and physician training programs (88%) were necessary in their countries. The survey also revealed a general lack of resources for postoperative and rehabilitation care, irrespective of the country's income level. CONCLUSION This study addresses the current state of musculoskeletal trauma care delivery worldwide. These results indicate a greater need for trauma system development and support, from prehospital through posthospital care. Optimization of these systems can lead to better outcomes for patients after trauma. This study represents a critical first step toward better understanding the state of musculoskeletal trauma care in countries with different levels of resources, developing strategies to address deficiencies, and forming regional and international collaborations to develop musculoskeletal trauma care guidelines.

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# Current Status of Musculoskeletal Trauma Care Systems Worldwide

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**Background and Rationale:** Although general trauma care systems and their effects on mortality reduction have been studied, little is known of the current state of musculoskeletal trauma delivery globally, particularly in low-income (LI) and low middle-income (LMI) countries. The goal of this study is to assess and describe the development and availability of musculoskeletal trauma care delivery worldwide.

**Materials & Methods:** A questionnaire was developed to evaluate different characteristics of general and musculoskeletal trauma care systems, including general aspects of systems, education, access to care and pre- and posthospital care. Surgical leaders involved with musculoskeletal trauma care were contacted to participate in the survey.

**Results:** Of the 170 surveys sent, 95 were returned for use for the study. Nearly 30 percent of surgeons reported a formalized and coordinated trauma system in their countries. Estimates for the number of surgeons providing musculoskeletal trauma per one million inhabitants varied from 2.6 in LI countries to 58.8 in high-income countries. Worldwide, 15% of those caring for musculoskeletal trauma are fellowship trained. The survey results indicate a lack of implemented musculoskeletal trauma care guidelines across countries, with even high-income countries reporting less than 50% availability in most categories. Seventy-nine percent of the populations from LI countries were estimated to have no form of health care insurance. Formalized emergency medical services were reportedly available in only 33% and 50% of LI and LMI countries, respectively. Surgeons from LI and LMI countries responded that improvements in the availability of equipment (100%), number and locations of trauma-designated hospitals (90%), and physician training programs (88%) were necessary in their countries. The survey also revealed a general lack of resources for postoperative and rehabilitation care, irrespective of the country's income level.

**Conclusion:** This study addresses the current state of musculoskeletal trauma care delivery worldwide. These results indicate a greater need for trauma system development and support, from prehospital through posthospital care. Optimization of these systems can lead to better outcomes for patients after trauma. This study represents a critical first step toward better understanding the state of musculoskeletal trauma care in countries with different levels of resources, developing strategies to address deficiencies, and forming regional and international collaborations to develop musculoskeletal trauma care guidelines.

**Key Words:** injury, burden, trauma, musculoskeletal, trauma systems

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## BACKGROUND AND RATIONALE

A trauma system is an organized, coordinated effort in a defined geographic area that delivers the full range of care to all injured patients.[1] The system includes injury prevention programs, implementation and optimization of prehospital care, acute care resources and facilities, and posthospital care. The American College of Surgeons-Committee on Trauma identified that education and resources are crucial for optimal trauma care.[2]

Mortality due to traumatic injuries is the leading cause of death in people aged younger than 45 years worldwide,[3] and 90 percent of these deaths occur in low-income (LI) and low middle-income (LMI) countries.[4] In 2004, the World Health Organization (WHO) published recommendations on how to improve essential trauma care to reduce trauma-related mortality.[5] In subsequent years, there has been an increased interest in evidence-based implementation of and evaluation of trauma systems worldwide.

Musculoskeletal injury is an important subset of overall trauma that is a major source of long-term disability. Little has been written about what constitutes an effective musculoskeletal trauma care system or the current state of musculoskeletal trauma care delivery worldwide, especially in LI, LMI, and upper middle-income (UMI) countries. The goal of

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this study is to assess the current state of musculoskeletal trauma care delivery in countries worldwide. This effort will serve as a foundation for future research aiming to identify similarities and opportunities to improve musculoskeletal trauma care throughout all the phases of the trauma system, make recommendations on adequately allocating future funding, and establish guidelines for local, national and regional policies.

## MATERIALS AND METHODS

A questionnaire was developed and conducted through support from the AOTrauma International Board, AO Alliance, International Orthopaedic Trauma Association (IOTA), the Asociación de Cirujanos Traumatólogos de las Américas (Association of Trauma Surgeons of the Americas; ACTUAR), and the University of California, San Francisco Orthopaedic Trauma Institute/Institute of Global Orthopaedics and Traumatology.

The questionnaire consisted of 54 items in 7 categories. The categories included general information, availability of a trauma system, education and research, health care insurance, triage and transfer, operative care and resources, and posthospital care and rehabilitation (Appendix 1). The questionnaire was sent to a single surgeon per country who was proficient in English, specialized in musculoskeletal trauma care, and either was:

1. a current or former leader of a national or regional orthopaedic organization or
2. a current chair of a department of orthopaedic or general surgery at an academic institution

Participants were identified through existing relationships in the AO, AO-Alliance, IOTA, ACTUAR, and Institute of Global Orthopaedics and Traumatology (IGOT) networks. Surgeon leaders from 170 countries were identified and invited to complete the survey. If an invitee failed to respond after multiple reminders, an alternative respondent was identified. Only one respondent was sought for each country. The study was Institutional Review Board exempt based on the criteria of the University of California, San Francisco (UCSF) Committee for Human Research.

The questionnaire was administered via RedCap, a secure web-based application for building and managing online surveys and databases. Data were analyzed according to the country's WHO income designation: (LI; $1005 per capita or less), (LMI; $1006–$3955), (UMI; $3956–$12,235), or high-income (HI; $12,236 or more) countries. Geographic regions were allocated according to the 7 WHO World bank regions (East Asia and Pacific, Europe and Central Asia, Latin America and Caribbean, Middle East and North Africa, North America, South Asia, and sub-Saharan Africa).

STATA (StataCorp. 2015, College Station, TX) was used for data analysis including descriptive statistics on all items. Continuous variables were converted to categorical for presentation. For questions that asked for an absolute number of hospitals or providers available, the data were normalized to the country's population. The qualitative data were inductively coded, and the frequency of coded responses were presented.

## RESULTS

### General

Of the invited surgeons from the 170 countries, a total of 93 surgeons completed the survey for a response rate of 54% (93/170). Available data from two partially completed questionnaires that had addressed most of the questions were also included, bringing the number of surveys to 95. All four WHO income designations and all seven World Bank regions were represented (Table 1). The highest response rates were from Europe (28%), sub-Saharan Africa (28%), North America, and Latin America, whereas the Middle East and North Africa were relatively under-represented (4%). Most respondents (97%) reported an Interagency Language Roundtable scale of three or higher, indicating professional working proficiency (average 4.6, SD 1.1). The most common surgical specialty was orthopaedic surgery (91.4%), followed by general surgery (6.5%). The average working experience as an independent surgeon was 18.3 years (SD 8.6, range 2–45).

### Trauma Systems

Only 29.0% of countries were reported to have a formalized trauma system in place. Although the presence of a trauma system was associated with higher income level, one was present in just 48.4% of HI countries. Designated trauma centers were reported available in 59.1% of countries, ranging from 27.8% in LI countries to 71.0% in HI countries. The absence of designated trauma centers was highest in sub-Saharan Africa (57.7%). Coverage of the trauma centers was deemed adequate by the respondents in 11.7% of LI countries as compared to 70.0% of HI countries. The highest level of trauma-designated hospitals (eg, Level 1 or tertiary referral centers) cover an average of 21 million inhabitants in LI and LMI countries compared with 2.6 million inhabitants in UMI and HI countries.

The number of surgeons caring for musculoskeletal trauma per one million inhabitants is presented in Table 2. Responses from LI and LMI countries in the South Asian and sub-Saharan African regions noted that nonphysician providers provide musculoskeletal trauma care, such as orthopaedic clinical officers in Malawi and osteopaths in India. Such providers were not reported in UMI or HI countries.

**TABLE 1.** Participating Countries According to WHO Income Designation and Worldbank Region

| | Income Designation WHO | | | | |
|---|---|---|---|---|---|
| **World Bank Region** | **LIC** | **LMIC** | **UMIC** | **HIC** | **Total** |
| East Asia and the Pacific | 0 | 5 | 3 | 5 | 13 |
| Europe and Central Asia | 0 | 2 | 5 | 19 | 26 |
| Latin America and the Carribean | 1 | 4 | 10 | 2 | 17 |
| The Middle East and North Africa | 0 | 1 | 0 | 3 | 4 |
| North America | 0 | 0 | 0 | 2 | 2 |
| South Asia | 1 | 4 | 0 | 0 | 5 |
| Sub-Saharan Africa | 16 | 6 | 4 | 0 | 26 |
| Total | 18 | 22 | 22 | 31 | 93 |

**TABLE 2.** Number of Surgeons per One Million Inhabitants According to WHO Income Designation and Worldbank Region

| | Number of Surgeons per 1 Million Inhabitants | |
|---|---|---|
| | **Mean** | **SD** |
| WHO income designation | | |
| LI | 2.6 | 2.7 |
| LMI | 15.2 | 17.7 |
| UMI | 31.3 | 22.0 |
| HI | 58.8 | 52.9 |
| Worldbank region | | |
| East Asia and the Pacific | 28.8 | 28.8 |
| Europe and Central Asia | 61.7 | 56.2 |
| Latin America and the Carribean | 36.5 | 20.5 |
| The Middle East and North Africa | 26.4 | 21.1 |
| North America | 51.3 | 41.3 |
| South Asia | 8.2 | 3.5 |
| Sub-Saharan Africa | 2.8 | 2.5 |

Other features of trauma systems included in the survey were trauma guidelines and trauma registries. In general, few countries reported having published guidelines related to musculoskeletal trauma care (Table 3). Even in HI countries, the availability of guidelines focused on in-hospital care was only 58.1%. National trauma registries were similarly lacking in 77.2% of countries, irrespective of their WHO income designation, including in 58.1% of HI countries. Given its use as a common bellwether procedure, surgical treatment of open tibia fractures was assessed as a measure of trauma care coverage.[6] In LI countries, survey respondents estimated that 9.9% of hospitals are equipped to treat this injury within 6 hours and 17.0% can do so within 24 hours. In HI countries, these percentages rise to 38.3% and 50.5%, respectively. In sub-Saharan Africa, Northern Africa, and the Middle East, respondents estimated that the percentage of hospitals that can treat an open tibia fracture varies between 13% and 16% compared with 24% and 42% among the remaining countries.

## Education

There was little variation in the duration of medical school or postgraduate training to treat musculoskeletal trauma with a mean duration of 6.3 years (SD, 1.3) and 5.4 years (SD, 1.9), respectively. No significant differences were identified between WHO income designations or World Bank Regions. However, in 84.9% of UMI and HI countries, training is funded by the government, whereas the trainee pays for the surgical education in about 67.5% of LI and LMI countries. The number of musculoskeletal residents trained per one million inhabitants was reported at 1.0, 1.8, 2.7, and 9.9 for LI, LMI, UMI, and HI countries, respectively. By World Bank designation, this number is the lowest in sub-Saharan Africa (0.8, SD, 1.6) and the highest in the European and Central Asian regions (11, SD, 19). Official accrediting bodies are available in 67.5% of LI and LMI countries and 84.6% of UMI and HI countries. Musculoskeletal trauma fellowship training is available in 22.5% of LI and LMI countries and 59.6% of UMI and HI countries. Worldwide, 15% of providers taking care of musculoskeletal trauma are fellowship trained (14% in LI and LMI countries and 17% in UMI and HI countries).

## Prehospital Care

The questionnaire also focused on identifying the current status of prehospital care and transfer. A formalized

**TABLE 3.** Availability of Musculoskeletal Injury–Related Guidelines According to WHO Income Designation

| Guidelines Available | Pre-hospitalization and Triage guidelines | Trauma Designation | Residency Education | Research | Management of Open Fractures | Damage Control Surgery | Management of Mangled Extremity | Management of Compartment Syndrome | Management of Joint Dislocations | Management of Pelvic Ring Injuries | Management of Geriatric Hip Fractures | Management of Spinal Injury | Pain Management | Rehabilitation of Multi-trauma Patients |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LI | | | | | | | | | | | | | | |
| LMI | | | | | | | | | | | | | | |
| UMI | | | | | | | | | | | | | | |
| HI | | | | | | | | | | | | | | |

| | |
|---|---|
| | 0-25% |
| | 26-50% |
| | 51-75% |
| | 76-100% |

emergency medical service (EMS) was available in all of the HI countries and 91% of the UMI countries. This number dropped to 50% and 33% in LMICs and LICs, respectively. The lack of an EMS was most pronounced in South Asia, Latin America, and sub-Saharan Africa.

For an open tibia fracture, it was estimated that, in LI and LMI countries, these injuries present to a hospital within 6 hours in 25.0% of cases and within 24 hours in 73.3% of cases. In UMI and HI countries, these times were estimated to be 76.9% and 83.3%, respectively. In South Asia and sub-Saharan Africa, the probability of being hospitalized within 6 hours after injury was the lowest (0%–19%) of all regions.

## Hospital Care and Resources

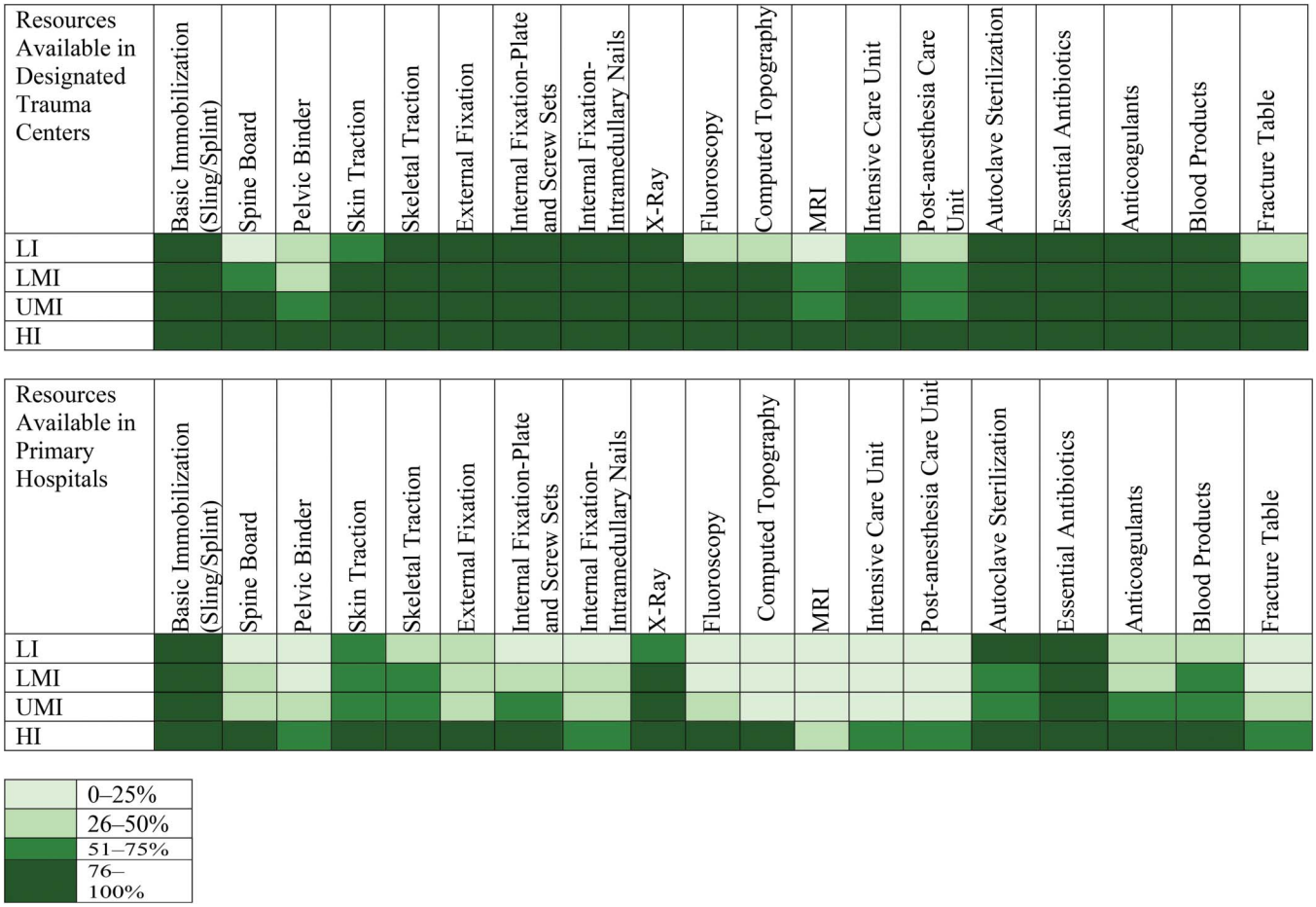
Operating room facilities were deemed inadequate in 94.1% of LI countries, 86.4% of LMI countries, 72.7% of UMI countries, and 36.7% of HI countries. For HI countries, improving the number of surgeons (48.4%) and designated trauma centers (48.4%) were noted to be the highest priorities, followed by increasing the number and training of support staff (43.3%). For LI and LMI countries, increasing the availability of equipment was universally identified to be important (100%), followed by improving the number and locations of trauma-designated hospitals (90.0%), and training of physicians (87.5%).

Available resources in both trauma-designated and non–trauma-designated settings were evaluated, and the results are shown in Table 4. Of note, in LI countries, spine boards, fluoroscopy, computed tomography, magnetic resonance imaging, and fracture tables were available in a minority of hospitals even at the highest-level trauma centers.

## Posthospital Care

Questions evaluating the availability of postoperative and rehabilitation care revealed a universal lack in resources for these phases of care, irrespective of the nations' WHO income designations. In more than 50% of HI countries, prosthetic care and psychological counseling are unavailable in most hospitals. Physical therapy is readily available in most HI countries in contrast to LI and LMI countries. A more

**TABLE 4.** Availability of Musculoskeletal Injury–Related Resources in Both the Trauma-Designated and Primary Hospitals According to WHO Income Designation



detailed account of the reported available services in the posthospital phase is shown in Figure 1.

## DISCUSSION

We conducted an exploratory research survey to better characterize the current state of musculoskeletal trauma care globally that included 95 countries across broad-income and geographic distributions. There are clear disparities identified based on income levels and geographic regions. Common findings across all levels include a need for more formalized trauma systems, improved guidelines for musculoskeletal trauma care, registries to monitor quality, and greater resources for posthospital care. LI countries had deficiencies in virtually all aspects of the trauma system, but the most immediate needs relate to the lack of emergency medical systems for prehospital care, surgical workforce shortages, and the lack of equipment necessary to provide musculoskeletal trauma care. These data may help develop guidelines that can subsequently inform country-specific efforts to improve musculoskeletal trauma care.

The WHO has promoted the concept of trauma systems by means of the Emergency and Essential Surgical Care and WHO Global Initiative for Emergency and Essential Surgical Care programs. The implementation of trauma systems has contributed to a reduction in worldwide mortality due to high-energy musculoskeletal trauma.[3,7] However, overall implementation of these systems remains low. In 2017, Dijkink et al.[8] reviewed the recent literature on the state of general trauma systems in 32, mostly HI, countries. Their group identified that, despite the presence of seemingly sufficient resources and the evidence-based benefits of trauma systems, only 9 of the 23 HI countries have well-defined and documented national trauma systems. This finding is consistent with our study, which found that only 29.0% of countries have a formalized trauma system in place, ranging from 16.7% in LI countries to just 48.4% in HI countries. A key step in the improvement of musculoskeletal trauma care will be the more widespread adoption of well-coordinated systems for general trauma care.

Our study identified large disparities in the surgical workforce available to provide musculoskeletal trauma care. This is consistent with other publications that have shown shortages in the surgical workforce globally.[9–11] It is closely tied to educational systems, which varied substantially across income levels. In general, the rate of residency training per capita was lower in LI countries, which may be in part related to the fact that funding was the responsibility of the trainee rather than the government. Fellowship training in musculoskeletal trauma care was not widely available. Increasing funding for training programs through programs such as the College of Surgeons of East, Central, and South Africa is one method to address this need.[12] Not surprisingly, nonphysician alternative provider training programs, such as the Orthopaedic Clinical Officer Program in Malawi, were more common in low-resource settings.

National trauma registries, which are important for quality assurance and monitoring, were reported as being

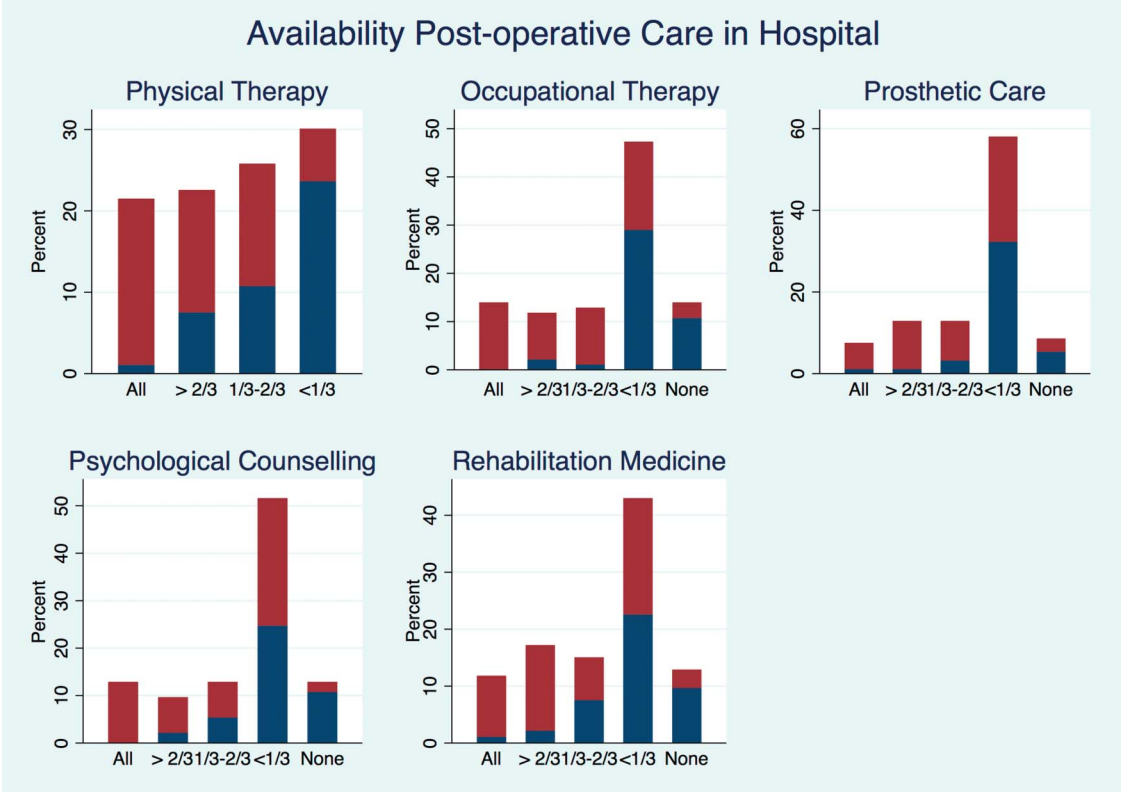



**FIGURE 1.** Availability of postoperative care specialties according to WHO income designation.

infrequently available, regardless of the income level or region. This is consistent with other studies.[13,14] Trauma registries require a central organization, trained staff, and financial resources, which may make them cost prohibitive in resource-constrained countries. However, these are an achievable goal for HI countries if registries were made a priority. Further, the development and propagation of evidence-based guidelines for musculoskeletal trauma would be a straightforward quality improvement initiative across all income levels.

Although prehospital care and transfer systems are generally adequate in HI countries, they remain deficient in LI settings. Efforts to invest in a formalized EMS system ought to be a focus for most LI countries in South Asia, Latin America, and sub-Saharan Africa. A universal comment from the LI country survey participants was that the basic infrastructure and equipment needed for fracture surgery are significantly lacking, even at the tertiary hospital level.

Our data show a uniform underdevelopment of the postacute and posthospital phase throughout different regions and income designations. There has been a justified focus on reducing mortality in the acute phase, but to further decrease the economic burden of trauma and alleviate morbidity, it will be important to invest in the postacute phase of rehabilitation and psychological counseling. It is estimated that 45% of societal costs due to injury can be attributed to lost productivity from disability.[15] Psychosocial dysfunction is extremely common and persists for a long term after trauma.[16] These may be targets of a comprehensive trauma system, particularly in HI countries.

There are several limitations of this study. Our response rate of 54% was fair, with a relatively even distribution across income levels and geographic regions, although some areas are notably under-represented, particularly in Eastern Europe and the Middle East. The questionnaire was administered to a single individual in each country who possessed knowledge of that country's trauma and musculoskeletal care systems. We aimed to ask questions that had a single, objective answer that is likely to be known, particularly by a surgeon in a leadership role. However, some questions had elements of subjectivity that would be better addressed with larger sample sizes for each country. Similarly, we could not assess hospital-level trauma system issues, such as infrastructure and equipment-related conditions, which are also critically pertinent factors in trauma care. A more in-depth study at a hospital-level may be a target for future investigation.

## CONCLUSION

This study broadly describes the current state of musculoskeletal trauma care delivery worldwide. Better defining optimal musculoskeletal trauma care systems and achieving their more widespread adoption could contribute to improved patient outcomes and substantial reductions in the global burden of musculoskeletal injuries. This work represents an essential first step toward better understanding the state of musculoskeletal trauma care in countries from different geographic regions and income levels, creating approaches to address needed improvements and fostering collaborative stakeholder networks to develop musculoskeletal trauma care guidelines.

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## APPENDIX 1. CORPORATE AUTHORSHIP INTERNATIONAL ORTHOPAEDIC TRAUMA STUDY CONSORTIUM

### AOTrauma

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