

# Operative trauma in low-resource settings: The experience of Médecins Sans Frontières in environments of conflict, postconflict, and disaster

Evan G. Wong, MD, MPH,<sup>a,b</sup> Lynette Dominguez, MD,<sup>c</sup> Miguel Trelles, MD, PhD,<sup>c</sup> Samir Ayobi, MD,<sup>c,d</sup> Khalil Rahman Hazraty, MD,<sup>c,e</sup> Cheride Kasonga, MD,<sup>c,f</sup> Jean-Paul Basimuoneye, MD,<sup>c,g</sup> Lunick Santiago, MD,<sup>c,h</sup> Mustafa Kamal, CRNA,<sup>c,i</sup> Alaa Rahmoun, MD,<sup>c,j</sup> and Adam L. Kushner, MD, MPH,<sup>b,k,l</sup> Montreal, QC, Canada, New York, NY, Brussels, Belgium, Kunduz and Helmand, Afghanistan, Niangara and Masisi, Democratic Republic of the Congo, Tabarre, Port-au-Prince, Haïti, Timurgara, Lower Dir, Pakistan, Jabal-Akkrad, Syria, and Baltimore, MD

**Background.** Conflicts and disasters remain prevalent in low- and middle-income countries, and injury remains a leading cause of death worldwide. The objective of this study was to describe the operative procedures performed for injury-related pathologies at facilities supported by Médecins Sans Frontières (MSF) to guide the planning of future responses.

**Methods.** A retrospective review of a prospectively collected database of all MSF procedures performed between July 2008 and June 2014 for injury-related indications was completed. Individual data points included country of project and date of procedure; age, patient sex, and the American Society of Anesthesiologists' score of each patient; indication for surgery, including mechanism of injury; operative procedure; operative urgency; operative order; type of anesthesia; and intraoperative mortality. Injury severity was stratified according to operative order and urgency.

**Results.** A total of 79,715 procedures were performed in MSF projects that met the inclusion criteria. Of these, 35,756 (44.9%) were performed specifically for traumatic indications across 17 countries. Even after excluding trauma centers, 29.4% (18,329/62,288) of operative cases were for injuries. Operative trauma procedures were performed most commonly for road traffic injuries (29.9%; 10,686/35,756). The most common procedure for acute trauma was extensive wound debridement (31.6%; 3,165/10,022) whereas burn dressings were the most frequent planned reoperation (27.1%; 4,361/16,078).

**Conclusion.** Trauma remains an important component of the operative care provided in humanitarian assistance. This review of procedures performed by MSF in a variety of settings provides valuable insight into demographics of trauma patients, mechanisms of injury, and surgical capabilities required in planning resource allocation for future humanitarian missions in low- and middle-income countries. (Surgery 2015;157:850-6.)

From the Centre for Global Surgery,<sup>a</sup> McGill University Health Centre, Montreal, QC, Canada; Surgeons Over Seas (SOS),<sup>b</sup> New York, NY; Médecins Sans Frontières - Operational Centre Brussels,<sup>c</sup> Surgical Unit, Brussels, Belgium; Trauma Centre,<sup>d</sup> Médecins Sans Frontières, Kunduz, Afghanistan; Hospital Boost,<sup>e</sup> Médecins Sans Frontières, Lashkar-Gah, Helmand, Afghanistan; General Referral Hospital,<sup>f</sup> Médecins Sans Frontières, Niangara, Democratic Republic of the Congo; General Referral Hospital,<sup>g</sup> Médecins Sans Frontières, Masisi, Democratic Republic of the Congo; Surgical and Trauma Centre Nap Kembe,<sup>h</sup> Médecins Sans Frontières, Tabarre, Port-au-Prince, Haïti; District Headquarters Hospital,<sup>i</sup> Médecins Sans Frontières, Timurgara, Lower Dir, Pakistan; Field Hospital,<sup>j</sup> Médecins Sans Frontières, Jabal-Akkrad, Syria; Department of International Health,<sup>k</sup> Johns Hopkins Bloomberg School of Public Health, Baltimore, MD; and Department of Surgery,<sup>l</sup> Columbia University, New York, NY

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Reprint requests: Evan G. Wong, MD, MPH, Department of Surgery, McGill University, 1650 Cedar Avenue, L9 411, Montreal, QC H3G 1A4, Canada. E-mail: [evan.wong@mail.mcgill.ca](mailto:evan.wong@mail.mcgill.ca).

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INJURY REMAINS A LEADING CAUSE OF DEATH WORLDWIDE and deaths from trauma including conflict-related injuries are projected to increase substantially until 2020.<sup>1,2</sup> Most conflicts and disasters occur in low-to middle-income countries (LMICs), where deficiencies in surgical capacity remain prevalent.<sup>3-6</sup> Consequently, these areas often lack the surge capacity to respond to the influx of

injured patients. The resources provided by an external agency are, therefore, often required.

Planning and preparation for a humanitarian response, especially of material and human resources, are essential to the response continuum and rely on reports from previous crises. Collection of data in these settings, however, is particularly difficult and remains anecdotal; a 2012 systematic review of surgical care in humanitarian crises collected studies too heterogeneous to provide actionable quantitative data, although qualitative analyses revealed a preponderance of orthopedic trauma.<sup>5</sup>

Médecins Sans Frontières (MSF), also referred to as “Doctors Without Borders,” has provided operative care in the environments of conflict and disaster for more than 40 years in more than 70 countries.<sup>7</sup> As a global organization, MSF is divided into 5 distinct operational centers, one of which is the MSF Operational Centre Brussels (MSF-OCB). Recognizing the utility of data collection and its ethical responsibility for quality control and improvement, MSF-OCB has recently implemented standard data collection procedures. Thus, the MSF-OCB is ideally suited to fill the gap in knowledge on the state of operative trauma in the settings of low-resource, conflict, and disaster.

The purpose of this study is therefore to review the operative procedures performed for trauma at MSF-OCB facilities from 2008 to 2014 to elucidate the epidemiology of operative trauma in the environments of conflict and disaster, which will guide the development of future programs.

## METHODS

**Data collection.** Detailed methods regarding data collection have already been described.<sup>8</sup> In brief, all operative procedures performed at MSF-OCB facilities are recorded prospectively in a logbook and transferred subsequently to an electronic database every month. Data are collected using a template and guidelines developed specifically by MSF for their operational research needs. Individual data points include country of project and date of procedure; age, patient sex, and American Society of Anesthesiologists’ (ASA) score of each patient; indication for operation, including mechanism of injury; operative procedure; operative urgency; operative order; type of anesthesia; and intraoperative mortality. Degree of urgency is classified as urgent or deferrable. Urgent procedures are defined as acute emergencies, whereas deferrable operations can be postponed for a few days, but the patient is unable to be

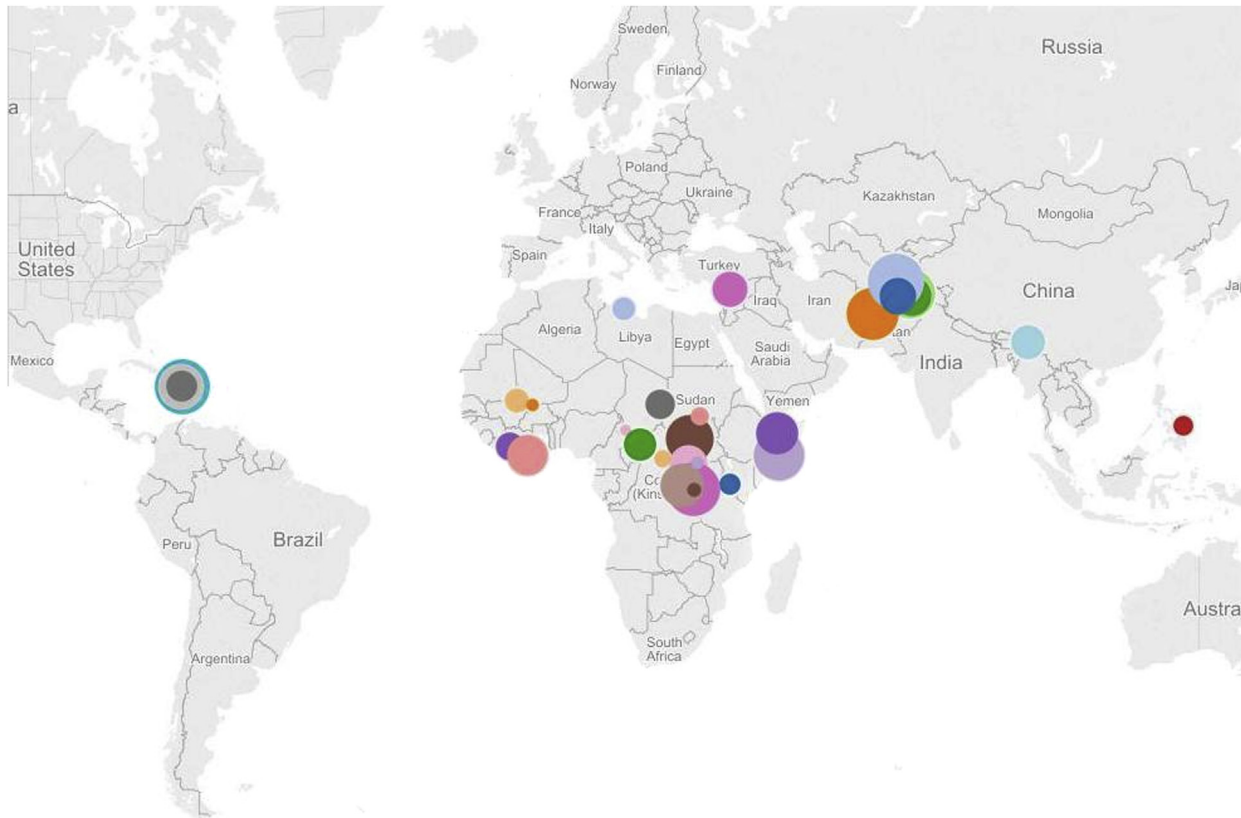
discharged from the hospital. Operative order is classified depending on whether the procedure represents the first operation for that specific patient and pathology or if it is a planned or unplanned reoperation. All collected data are submitted to MSF-OCB headquarters in Brussels for review for completeness and accuracy by the Surgical, Anesthesia, Gynecology, and Emergency Medicine unit. Any discrepancies or missing data are clarified with the data collectors in the field. Annual reports regarding missing data and data validity are also generated for specific projects as further quality control.

**Data analysis.** For this study, a retrospective analysis of all consecutive procedures from MSF-OCB projects between July 2008 and June 2014 was performed. This specific timeframe was chosen, because a standardized template that markedly improved the quality of the data collection was implemented in 2008, and the most recent data stemmed from June 2014. Inclusion criteria included all operative procedures performed for any injury-related indication during this time period. All projects exclusively involving maternity hospitals, subspecialized missions (eg, obstetric fistulae), and indirect support (ie, not directly managed by MSF-OCB) were excluded.

All procedures that met the inclusion criteria were analyzed using descriptive statistics through the electronic database (Excel; Microsoft, Redmond, WA). To obtain the percentages, patient characteristics were divided by the total number of patients, whereas mechanism of injury, procedure, and anesthetic characteristics were divided by the total number of procedures.

Because injury severity scores were not available, an indirect method of stratification of injury severity was used. Operative procedures were classified into the following categories based on their operative urgency and order: (1) Initial urgent; (2) Initial deferrable; (3) Planned reoperation; and (4) Unplanned reoperation. Initial urgent procedures were required presumably for more severely injured patients, whereas initial deferrable operations were for less severely injured patients. Unplanned reoperations were surrogates of morbidity, whereas planned reoperations were follow-up procedures from the initial operative care.

To visualize the geographic distribution of all surgical procedures for trauma, the geographic coordinates of each included MSF-OCB project were plotted using geospatial software (Tableau Public; Tableau Software Inc, Seattle, WA). Project icons were computed to be proportional in size to the number of operative procedures performed.



**Fig.** Geographic distribution of surgical procedures for trauma in MSF-OCB facilities from 2008–2014. Each colored circle represents an individual project. Circle sizes are proportional to the number of surgical procedures. *MSF-OCB*, Médecins Sans Frontières, Operational Centre Brussels. (Color illustration of the figure appears online.)

**Ethical approval.** Ethical Review Board exemption was granted from MSF-OCB because of the retrospective, deidentified nature of this study.

## RESULTS

Between July 2008 and June 2014, a total of 79,715 procedures were performed in MSF-OCB projects, excluding maternity hospitals, subspecialized missions, and indirect support. Of these, 35,756 (44.9%) were performed on 19,527 patients specifically for traumatic indications. The geographic distribution of these procedures across 17 countries is presented in the [Figure](#). Almost half of traumatic cases were performed in 3 exclusive trauma centers: Kunduz (25.9%; 9,243/35,756), in Afghanistan; Sarthe (0.1%; 998/35,756); and Tabarre (20.1%; 7,186/35,756), in Haiti. Even excluding these trauma centers, 29.4% (18,329/62,288) of operative cases in other projects were for injuries.

Basic characteristics of patients, procedures, and anesthesia are presented in [Table I](#). The mean age of these patients was 25.8 years old, with 31.7% (6,203/19,527) of patients younger than 18 years of age. Of

note, 10.1% (1,966/19,527) of patients were older than 50 years of age. Three-quarters of patients were male (75.6%; 14,754/19,527). Mean ASA score was 1.4.

In terms of operative urgency, most operations were qualified as deferrable (69.5%; 24,854/35,756) with the remaining procedures performed on an urgent basis (30.5%; 10,902/35,756). Of all procedures, 28.0% (10,022/35,756) were initial urgent operations (ie, acute trauma), whereas 26.6% (9,505/35,756) were initial deferrable procedures.

Almost half of procedures were repeat operations on the same patient (45.4%; 16,229/35,756) with 0.4% (151/35,756) of all operations being unplanned reoperations (ie, morbidity). Of all reoperations, 99.1% (16,078/16,229) were planned follow-up procedures after the initial intervention.

The majority of procedures (75.5%; 27,005/35,756) were performed under general anesthesia. Intraoperative mortality was 0.3% (109/35,756) with 88.1% (96/109) of deaths occurring during a first urgent operation.

Operative procedures for trauma were performed most commonly for road traffic injuries

**Table I.** Basic patient, procedure, and anesthesia characteristics for procedures performed for trauma at MSF-OCB facilities from 2008 to 2014

	n (%)
Age, y	
<1	106 (0.5)
1–17	6,097 (31.2)
18–49	11,358 (58.2)
≥50	1,966 (10.1)
Sex	
Male	14,754 (75.6)
Female	4,773 (24.4)
ASA	
Mean (SD)	1.4 (0.6)
Operative urgency	
Urgent	10,902 (30.5)
Deferrable	24,854 (69.5)
Operative order	
First	19,527 (54.6)
Planned reoperation	16,078 (45.0)
Unplanned reoperation	151 (0.4)
Anesthesia	
General	27,005 (75.5)
Spinal	4,773 (13.3)
Regional	148 (0.4)
Local	2,977 (8.3)
Combined	566 (1.6)
Other	287 (0.8)
Mortality	
Intraoperative deaths	109 (0.3)

ASA, American Society of Anesthesiologists; MSF-OCB, Médecins Sans Frontières, Operational Centre Brussels.

(29.9%; 10,686/35,756) (Table II). The category of exclusion “other,” which included foreign bodies, natural disasters, work or domestic accidents, and sports injuries, also was common, representing 27.3% (9,778/35,756) of cases. Penetrating injuries, such as gunshot wounds and stabbings, consisted of 20.7% (7,403/35,756) and 4.1% (7,403/35,756) of cases, respectively. Gunshot (25.5%; 2,560/10,022) and stab (8.9%; 891/10,022) wounds disproportionately represented mechanisms of injury for first urgent operations, whereas burns (19.5%; 3,138/16,078) gained importance in the planned repeat procedures. The most common mechanism causing morbidity (ie, unplanned reoperations) was firearm injury (37.7%; 57/151). Least common indications for surgery overall were torture (0.4%; 153/35,756) and rape (0.1%; 28/35,756).

Tables III–V show the most commonly performed operations for trauma during this time period according to the operative urgency and order. For initial urgent operative procedures—or the

most severely injured—procedures for soft-tissue wounds were prominent, including extensive debridements (31.6%; 3,165/10,022) and wound suturing, minor debridements or drainage of abscess (12.7%; 1,275/10,022). Orthopedic procedures also were common, such as fracture reductions (13.5%; 1,354/10,022) and external fixations (5.4%; 545/10,022). Exploratory laparotomies represented 7.5% (751/10,022) of operations for acute trauma. The most common, unplanned reoperations also were for soft-tissue wounds, including extensive debridements (16.6%; 25/151) and wound suturing, minor debridements or abscess drainages (13.2%; 20/151); however, exploratory laparotomies (15.9%; 24/151) and bowel resections (11.3%; 17/151) were also prominent. The most common planned reoperation was for burn dressings (27.1%; 4,361/16,078), although solid viscous resections or repairs (19.6%; 3,151/16,078) and insertion or removal of drains (17.9%; 2,880/16,078) were also frequent.

## DISCUSSION

This study provides one of the largest reviews of surgical trauma care in the settings of conflict and disaster—circumstances in which data collection is particularly difficult. It highlights the importance of trauma in humanitarian crises, as injury-related procedures represented almost half of all operations performed during this time period. This study also provides a comprehensive review of the patient population undergoing surgical care in MSF facilities for injuries and sheds light on the variety of mechanisms of injury occurring during conflicts and disasters. Young males are affected most, and road traffic injuries are most prominent even in times of crises. Operations for soft-tissue wounds and orthopedic procedures are the operations performed most commonly for acute trauma, whereas burn dressings are the most frequent planned reoperations.

Resources available to provide trauma care remain limited in the vast majority of LMICs.<sup>6</sup> Because most conflicts and natural disasters occur in these settings, the sudden surge in injury-afflicted patients often overwhelms systems that are already strained at baseline. The large volume of operative trauma cases required from MSF in 17 countries sheds light on the important need for augmenting baseline trauma capacity in these settings. Only through more sustainable advances in hospital resources, prehospital transport, and trauma referral systems will the resiliency of these communities to crises improve.

**Table II.** Mechanisms of injury for trauma procedures performed in MSF-OCB facilities from 2008 to 2014

<i>Mechanism of injury</i>	<i>Total, n (%)</i>	<i>First urgent, n (%)</i>	<i>First deferrable, n (%)</i>	<i>Planned reoperation, n (%)</i>	<i>Unplanned reoperation, n (%)</i>
Road traffic injury	10,686 (29.9)	2,814 (28.1)	2,899 (30.5)	4,938 (30.7)	35 (23.2)
Other*	9,778 (27.3)	2,719 (27.1)	3,640 (38.3)	3,382 (21.0)	37 (24.5)
Gunshot	7,403 (20.7)	2,560 (25.5)	1,419 (14.9)	3,367 (20.9)	57 (37.7)
Burns	4,413 (12.3)	421 (4.2)	858 (9.0)	3,128 (19.5)	6 (4.0)
Knives	1,469 (4.1)	891 (8.9)	276 (2.9)	293 (1.8)	9 (6.0)
Bombs	1,310 (3.7)	376 (3.8)	237 (2.5)	692 (4.3)	5 (3.3)
Mine	316 (0.9)	64 (0.6)	58 (0.6)	194 (1.2)	0 (0.0)
Assault	200 (0.6)	85 (0.8)	66 (0.7)	47 (0.3)	2 (1.3)
Torture	153 (0.4)	73 (0.7)	45 (0.5)	35 (0.2)	0 (0.0)
Rape	28 (0.1)	19 (0.2)	7 (0.1)	2 (<0.1)	0 (0.0)
Total	35,756 (100.0)	10,022 (100.0)	9,505 (100.0)	16,078 (100.0)	151 (100.0)

\*Foreign body, natural disaster, work or domestic accident, or sport injuries.  
MSF-OCB, Médecins Sans Frontières, Operational Centre Brussels.

**Table III.** Most common initial urgent operative procedures performed for trauma in MSF-OCB facilities from 2008 to 2014 (*n* = 10,022)

<i>Procedure</i>	<i>n (%)</i>
Extensive debridement	3,165 (31.6)
Fracture reduction	1,354 (13.5)
Wound suturing, minor debridement, or abscess drainage	1,275 (12.7)
Exploratory laparotomy	751 (7.5)
External fixation	545 (5.4)
Drain insertion or removal	508 (5.1)
Bowel resection	500 (5.0)
Burn dressing	445 (4.4)
Internal fixation	266 (2.7)
Limb amputation	252 (2.5)
Foreign body removal	198 (2.0)
Orthopedic corrective surgery	170 (1.7)
Solid viscous resection or repair	168 (1.7)
Other general surgery	97 (1.0)
Vascular surgery	68 (0.7)
External genitalia/anal repair	46 (0.5)
Thoracotomy	38 (0.4)
Other gynecologic surgery, including vaginal repair	21 (0.2)
Neurosurgery	21 (0.2)
Otolaryngologic surgery, including tracheotomy	20 (0.2)

MSF-OCB, Médecins Sans Frontières, Operational Centre Brussels.

The findings of this study also highlight an important notion in humanitarian response. Almost 30% of the operations performed for trauma were indicated for road traffic injuries. This finding emphasizes the point that humanitarian agencies must not only have the capabilities of addressing the acute consequences of a conflict or disaster but must also be able to respond to

**Table IV.** Unplanned reoperations performed for trauma in MSF-OCB facilities from 2008 to 2014 (*n* = 151)

<i>Procedure</i>	<i>n (%)</i>
Extensive debridement	25 (16.6)
Exploratory laparotomy	24 (15.9)
Wound suturing, minor debridement, or abscess drainage	20 (13.2)
Bowel resection	17 (11.3)
Drain insertion or removal	14 (9.3)
Limb amputation	10 (6.6)
Fracture reduction	8 (5.3)
External fixation	7 (4.6)
Burn dressing	7 (4.6)
Orthopedic corrective surgery	4 (2.6)
Thoracotomy	4 (2.6)
Urologic surgery	2 (1.3)
Other general surgery	2 (1.3)
Solid viscous resection or repair	2 (1.3)
Other gynecologic surgery, including vaginal repair	1 (0.7)
Internal fixation	1 (0.7)
Vascular surgery	1 (0.7)
External genitalia/anal repair	1 (0.7)
Foreign body removal	1 (0.7)

MSF-OCB, Médecins Sans Frontières, Operational Centre Brussels.

baseline injuries of everyday occurrence. In fact, although this review dealt only with traumatic injuries, evidence suggests that surgical response teams should also be able to manage a wide range of common pathologies, including obstetric emergencies.<sup>8,9</sup>

Of note, the intraoperative mortality rate for trauma patients in our study was 0.3%, which is similar to the previously published rate of 0.2% for all operative indications in MSF facilities.<sup>4</sup> This

**Table V.** Most common planned reoperations performed for trauma in MSF-OCB facilities from 2008 to 2014 ( $n = 16,078$ )

Procedure	n (%)
Burn dressing	4,361 (27.1)
Solid viscous resection or repair	3,151 (19.6)
Drain insertion or removal	2,880 (17.9)
Urologic surgery	1,530 (9.5)
Internal fixation	692 (4.3)
Orthopedic corrective surgery	680 (4.2)
Foreign body removal	660 (4.1)
Orthopedic nerve repair	633 (3.9)
Curettage for osteomyelitis	455 (2.8)
Fracture reduction	276 (1.7)
Wound suturing, minor debridement, or abscess drainage	188 (1.2)
Other specialized surgery	149 (0.9)
Exploratory laparotomy	98 (0.6)
Extensive debridement	72 (0.4)
External genitalia/anal repair	51 (0.3)
Bone graft	42 (0.3)
Limb amputation	30 (0.2)
Other general surgery	27 (0.2)
External fixation	17 (0.1)
Ophthalmic surgery	14 (0.1)

MSF-OCB, Médecins Sans Frontières, Operational Centre Brussels.

remarkably low rate is impressive by any standard and may bring concerns regarding missed deaths in the database. With rigorous mechanisms of quality control in place, this finding reflects more likely a combination of the high quality of care provided by MSF clinicians and an important selection bias. Indeed, MSF selects operative candidates meticulously as to maximize the benefits of limited resources at a population level; patients with a poor probability of survival and injuries that are unlikely to be salvageable are not brought into the operating room.

Furthermore, the low intraoperative mortality also may be a result of severely traumatized patients succumbing to their injuries before their arrival to the hospital, either because of deficiencies in prehospital care, physical barriers common in conflicts such as security checkpoints, and curfews enforced for safety reasons. These hypotheses are corroborated by the low mean ASA score, the high proportion of deferrable operations, and the relatively low proportion of urgent procedures in this study.

The high proportion of planned and unplanned reoperations also merits further comment. In addition to the fact that injuries represent a large proportion of pathologies requiring care during humanitarian crises, it appears that injuries also

disproportionately consume resources. Not only do injuries contribute to almost 45% of all operative procedures, almost half of these operations required a second procedure. Furthermore, although not captured by this study, substantial human and material resources are also required for dressing procedures outside of the operating room. These findings have important implications for resource planning.

Indeed, one of the main implications of this study involves resource allocation and program planning. Given the findings of this review, materials such as blades for debridement, dressings for wounds and burns, and skin sutures, should be prioritized. Surgeons looking to participate in humanitarian missions should be comfortable performing a range of procedures and should train accordingly before deployment, as described previously.<sup>8</sup> Organizations involved in humanitarian emergencies could follow the lead of MSF in stocking material resources near conflict and disaster zones, as shown in the [Figure](#), for rapid distribution. This study also highlights the utility and importance of data collection in these settings; findings may serve as a benchmark for future initiatives in quality improvement.

This study also highlights difficulties in stratification of injury severity in low-resource settings. Although numerous scores such as the Injury Severity Score are used commonly in higher-income settings, these types of scoring systems in LMICs are limited by the scarcity of diagnostic equipment, notably computed tomography scanners. In this study, we attempted to stratify injury severity by the urgency of the initial operation. Although imperfect, the analysis of the initial urgent cohort provides more comparable data to the trauma literature from greater-resource settings and calls for future work on methods of assessment of injury severity that are implementable in LMICs, such as the Kampala Trauma Score, which has been used and validated in sub-Saharan Africa.<sup>10,11</sup>

This study has several limitations. First, despite being a large dataset from a variety of countries, it is a retrospective analysis of the activities of a single organization and is limited to the scope of interventions being performed by MSF. For example, the small proportion of subspecialized operations may reflect a paucity in skilled personnel rather than a lack of need. Furthermore, MSF does not operate in areas in which it cannot guarantee the safety of its personnel; therefore, these areas are not captured in this study, despite likely representing an important need for operative trauma.

Another limitation is the classification system used for the surgical indications and procedures. As seen in the “other” category, it is difficult to pinpoint specific etiologies, and some surgical procedure categories encompass a multitude of operations. This study is also limited because all data were collected in hospital. As alluded to previously, an important proportion of injured patients may succumb prior to arrival to a medical center. Finally, as discussed previously, the lack of an injury severity score is a limitation, although we attempted to address this via indirect stratification methods. Nevertheless, this study provides a broad overview of operative trauma in exceptionally diverse settings and provides actionable quantitative data.

To conclude, trauma is an important component of surgical care provided in humanitarian assistance. This review of procedures performed by MSF in a variety of settings provides valuable insight into trauma patient demographics, mechanisms of injury, and surgical capabilities required in planning resource allocation for future humanitarian missions in LMICs.

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