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International Emergency Medicine

Epidemiology of Patients Treated at the Emergency Department of a Médecins Sans Frontières Field Hospital During the Mosul Offensive: Iraq, 2017

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□ **Abstract— *Background*: Armed conflicts constitute a significant public health problem, and the advent of asymmetric warfare tactics creates unique and new challenges to health care organizations providing trauma care in conflicts. *Objective*: This study aimed to analyze the epidemiology of presentations to a civilian field hospital deployed close to an ongoing conflict. *Methods*: During the 2016-2017 Mosul offensive, the humanitarian organization Médecins Sans Frontières deployed a field hospital 30 km south of Mosul. This study is a retrospective analysis of routinely collected patient data of all presentations to the emergency department (ED) during its period of operation between February 23 and July 18, 2017. Data were collected in Microsoft Excel by health care workers and analyzed in JMP, version 13. Chi-square test was used to compare proportions. A p value < 0.05 was considered significant. *Results*: The analysis included 3946 presentations. Most were due to conflict-related injuries, including explosives (40.4%) and firearms (12.9%), which presented in consecutive waves over time. Approximately one-third of presentations (32.3%) were due to medical issues, which outweighed conflict-related presentations toward the latter half of the operational period. Explosives caused most of the mass casualty events. A total of 20 patients (0.5%) died in the ED. *Conclusions*: The study demonstrated a cyclical burden of conflict-related injuries and extensive medical needs, which increased over time. Among conflict-related injuries, explosive etiology predominated and was likely to result in mass casualty incidents. The low mortality might be due to critical but potentially salvageable patients not reaching the hospital in time, owing to the adverse context. © 2021 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/)**

□ **Keywords—conflict; war; disaster medicine; trauma, surgery; firearm; gun; explosion; humanitarian; Iraq**

Introduction

Armed conflicts are a major cause of morbidity and mortality, due to the direct consequences of battlefield confrontations and, indirectly, as a result of community displacements and disruption of health and social services (1). The Uppsala Conflict Data Program estimates that between 1989 and 2019, the 10 most conflict-affected countries in the world accounted for a total of 2,542,310 conflict-related fatalities (2). However, to date, the effects of armed conflicts on civilian health have received limited attention from the global public health community, in part due to the inherent obstacles associated with conducting studies in high-threat environments (1,3).

On October 16, 2016, the Iraqi government, supported by Kurdish Peshmerga and an international coalition, commenced an offensive to liberate Mosul and its sur-

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rounding areas in Ninewah Governorate, Iraq, from the terrorist group Islamic State of Iraq and Syria (ISIS). The offensive was the world's largest military operation since the U.S. invasion of Iraq in 2003 and formally lasted until July 10, 2017.

The provision of civilian health care during the campaign was divided into two phases (4). Phase one correlated with the period between the start of the offensive and January 2017, and was characterized by limited international medical assistance and a reliance on local health care capacity. Phase two lasted from the taking of West Mosul in January 2017 until the conclusion of the campaign in July 2017, and saw significant medical assistance from the international community. During this time, several international organizations, acting under leadership from the World Health Organization (WHO), set up trauma care pathways and established field hospitals to provide humanitarian health care services close to the conflict.

The conflict in Mosul represented a type of warfare in which regular militaries confronted a technologically rudimentary nonstate actor, which employed a combination of conventional ground forces and terrorist tactics, such as improvised explosive devices and human shields. This type of conflict is termed *asymmetric warfare* and appears to be the defining type of conflict in the early 21st century (5).

This operational environment presents new security, logistical, technical, and ethical, as well as legal, challenges to health care organizations deploying to conflicts. To date there is limited guidance for emergency medical teams (EMTs) deploying to such contexts. In line with the WHO's minimum standards for EMTs deploying to natural disasters, guidance for EMTs deploying to armed conflicts and other complex emergencies is pending publication with WHO support (6). The lack of effective civilian trauma care in contemporary armed conflicts has inspired discussions on ways to improve it (7,8). However, a significant limitation to ensure best practices for this setting has been the lack of robust studies on the epidemiology of health needs generated by this new type of warfare. Such information is essential for developing context-adapted evidence for civilian trauma care. This study, therefore, aims to describe the epidemiology of patients treated at a field hospital that was operational during phase two of the Mosul offensive.

Methods

In early 2017, Médecins Sans Frontières Operational Center Brussels (MSF-OCB) transported a field hospital (equivalent to an EMT type 2) consisting of a mobile unit surgical trailer to Hammam al-Alil, 30 km south of Mosul (6). It included an emergency department (ED), an inpatient department with 20 beds each, as well as two operating rooms. The hospital provided free care to patients from Mosul and its surrounding areas between February 23 and July 18, 2017. Services included trauma surgery, resuscitation prior to referral to other health care resources, as well as emergency medical and nontrauma surgical care. The population served is difficult to estimate; prior to ISIS occupation, the city of Mosul comprised approximately 1.3 million inhabitants. The true population size after the occupation is unknown; however, a 2015 report by the Agency for Technical Cooperation and Development and the United Nations Operational Satellite Applications Programme estimates that approximately 500,000 individuals fled Mosul after its fall (9). The field hospital was part of the larger WHO-led Mosul trauma response, and cooperated with a number of local and international actors that provided prehospital and in-hospital care. This system included Trauma Stabilization Points set up close to the scene of injury, where basic hemostasis and resuscitation was provided prior to transport to higher levels of care, field hospitals with surgical capability provided by a number of organizations, including MSF; Samaritan's Purse; and Aspen Medical, and tertiary referral hospitals located in Erbil, Iraqi Kurdistan some 90 km to the east of Mosul.

The field hospital collected routine programmatic data throughout its operational period. Data from all patients presenting to the ED were extracted from patient files by physicians and nurses and entered into the ED registry (Microsoft Excel), which was a standardized data collection tool developed by the MSF. Due to patient care being the chief focus in this emergency response, formal training in data collection was limited, and there was likewise limited opportunity to assess interobserver reliability. However, data were checked for completeness and validated by senior program managers. Due to the protocol for this study having been finalized after the collection of data, there was no provision for defining inclusion and exclusion criteria, and the data collectors were not aware of the study objectives. The registry was composed of defined variables, including demographic data, triage color (according to the START triage system), exit category (i.e., died, referred, admitted, or discharged), injury mechanism (according to MSF standard code entered according to the etiology of injury), and mass casualty incident (MCI) (i.e., more than 5 people injured in a single incident; however, in practice the threshold was at times set higher due to high numbers of simultaneous casualties occurring frequently) (10). Due to the constraints posed by the adverse environment, there was limited opportunity to collect more detailed clinical information. Cleaning and analysis of data were conducted using JMP, version 13 (SAS Institute). Categorical variables were compared

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using Pearson χ^2 test; $p < 0.05$ was considered significant.

The case definition for this study was any patient presenting with medical or surgical needs to the ED between February 23 and July 18, 2017. No provision was made in the data to determine whether the same individual patient had presented to the ED more than once with different symptoms. To reflect this, the study used the term *presentation* rather than *patient*. However, given the rapidly changing situation in the field, repeat presentations were likely rare events. Because this study aspired to capture the maximum number of patients presenting at the facility, and did not seek to draw conclusions about the larger patient population, sample size calculation was not applicable.

This study fulfilled the exemption criteria set by the MSF Ethical Review Board for a retrospective analysis of routinely collected clinical data. It was approved by the Ethical Review Boards of MSF-OCB and the Directorate of Health, Ninewah, Iraq.

Results

The final analysis included a total of 3946 presentations. Two-thirds (64.2%) were male, and one-third (36.4%) were children or infants (i.e., younger than 15 years). More than one-half of patients (53.3%) presented with conflict-related injuries, of which most were due to explosives (40.4%) and firearms (12.9%). Only 4 individuals (0.1%) presented with injuries due to anti-personnel mines. Medical conditions accounted for almost one-third (32.3%) of presentations. Almost one-fifth (17%) of patients were admitted and one-third (30.6%) were referred. A total of 49.3% of patients required admission to the hospital (Table 1).

Injuries sustained by firearms were more likely than injuries from explosives to be triaged as "red" and require admission. Comparative analysis showed that although the differences were small, they were significant. By contrast, the proportion of explosives-related injuries arising due to an MCI was considerably higher than for firearms. There were, however, no significant differences between the two mechanisms in terms of ED mortality (Table 2).

The burden of patients with conflict-related injuries was greatest during weeks 4 and 5. After this, the burden steadily declined in consecutive waves of decreasing amplitude. Medical and nontrauma surgical needs gradually increased and reached a plateau around week 13. By contrast, the rate of accidental trauma did not vary greatly throughout the study period (Figure 1).

Most of the patients were infants, children, and young adults. The two principal age groups were 0–4 years and 5–9 years, and patients aged between 0 and 24 years constituted more than one-half of total patients. Among male patients, conflict-related injuries accounted for most of the presentations between the ages of 10 and 69 years (Figure 2).

Table 1. Summary of Emergency Department Presentations (n = 3946)

Variable	n (%)
Sex	
Male	2525 (64.2)
Female	1406 (35.8)
Age group	
Adult	2451 (63.5)
Child (1–15 y)	1348 (34.9)
Infant (< 1 y)	61 (1.6)
Etiology of presentation	
Explosives	1595 (40.4)
Medical	1276 (32.3)
Firearm	509 (12.9)
Accidental trauma*	343 (8.7)
Nontrauma surgical†	72 (1.8)
Burns‡	46 (1.2)
Others	43 (1.1)
Antipersonnel mine	4 (0.1)
Outcome	
Discharged	1770 (44.9)
Admitted	669 (17.0)
Referred	1209 (30.6)
Died	20 (0.5)

* All trauma not arising from violent intent, for example, motor vehicle accident.
† Surgical issues not arising due to trauma, for example, appendicitis.
‡ Exposure to flame, hot surfaces, or hot liquids.

Discussion

This study is the first facility-based epidemiological study from the Mosul offensive where the facility has been in close proximity to the battlefield. A similar study has been conducted based on patients being treated at a tertiary referral hospital in Erbil, Iraqi Kurdistan, which was located approximately 90 km from Mosul (11). One of the chief limitations of that study was the inherent survival bias associated with long prehospital transport times, and the results obtained from Hammam al-Alil should therefore be understood in context with the conclusions drawn from Erbil.

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Table 2. Comparison Between Firearm- and Explosives-Related Presentations (n = 3946)

Variable	Firearm, n (%)	Explosives, n (%)	*p* Value
Red triage color	151 (29.7)	354 (22.2)	< 0.05
In-hospital treatment required*	365 (77.8)	1037 (72.0)	< 0.05
Mass casualty incident†	27 (5.3)	141 (8.8)	< 0.05
Died in ED	3 (0.6)	12 (0.8)	0.7

ED = emergency department.
* Includes admission or referral.
† Five or more patients injured in a single incident (in practice, the threshold for mass casualty incident was at times set higher due to a high burden of simultaneous patients).

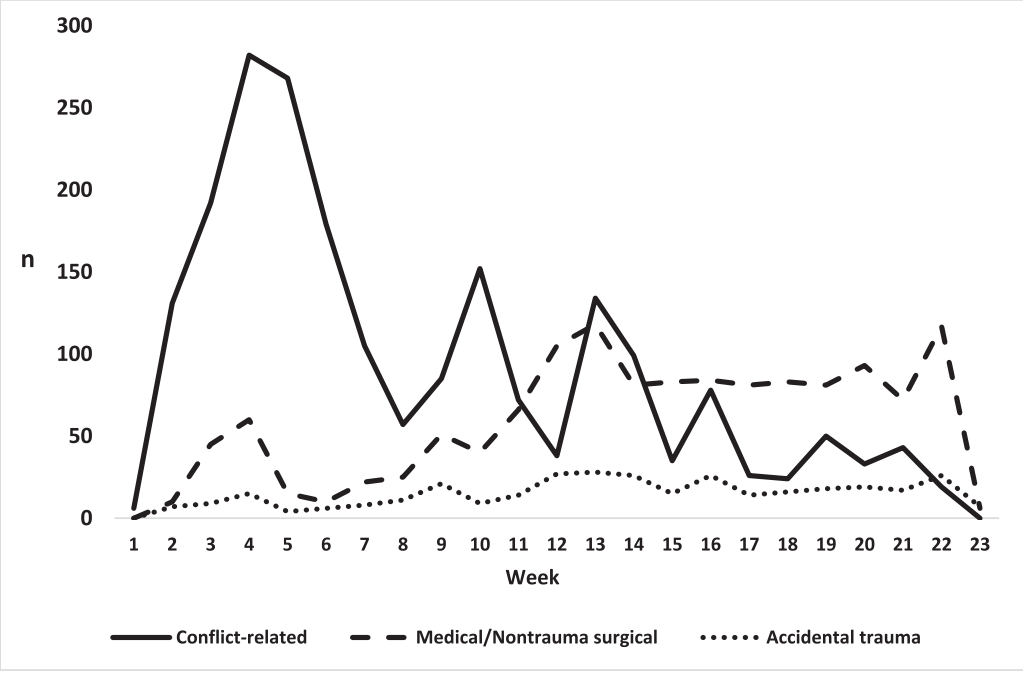

Figure 1. Presentations by operational week (n = 3946). The Mosul offensive commenced on Sunday, October 16, 2016. The first patients arrived to the field hospital on the 7th calendar week of 2017, denoted as week 1 in this figure.

In our study, the predominance of male patients might suggest an overexposure to violence in this group. However, male patients were also overrepresented among non–conflict-related conditions in all age groups, suggesting that there might have been obstacles for women and girls to seek care. After the conclusion of the Mosul offensive, a telephone interview–based survey found that almost one-half of respondents identified security concerns as an important obstacle for seeking care (12). It is possible that the adverse security situation might have been a stronger deterrent for women than for men.

This study found a low immediate mortality rate in the ED. Approximately one-third of patients were referred to other facilities, and the mortality rate in this group remains unknown because there was no provision to track individual patients throughout the referral system. However, results from Erbil also demonstrated a similarly low mortality rate (13). This has was also reported in a study of another MSF facility in Kunduz, Afghanistan, which was a dedicated trauma center serving a conflict-affected region (11,14). Since the advent of the Vietnam war, military trauma care doctrine has focused on the early evacuation of wounded combatants, but similar systems for civilians affected by conflict remain rudimentary (4,15). In low- and middle-income countries, expanding prehospital care, lay first-responder training, integration of professional first responders and vehicles into an emergency care system, and optimizing dispatch coordination have been demonstrated to be areas with significant potential to improve outcomes

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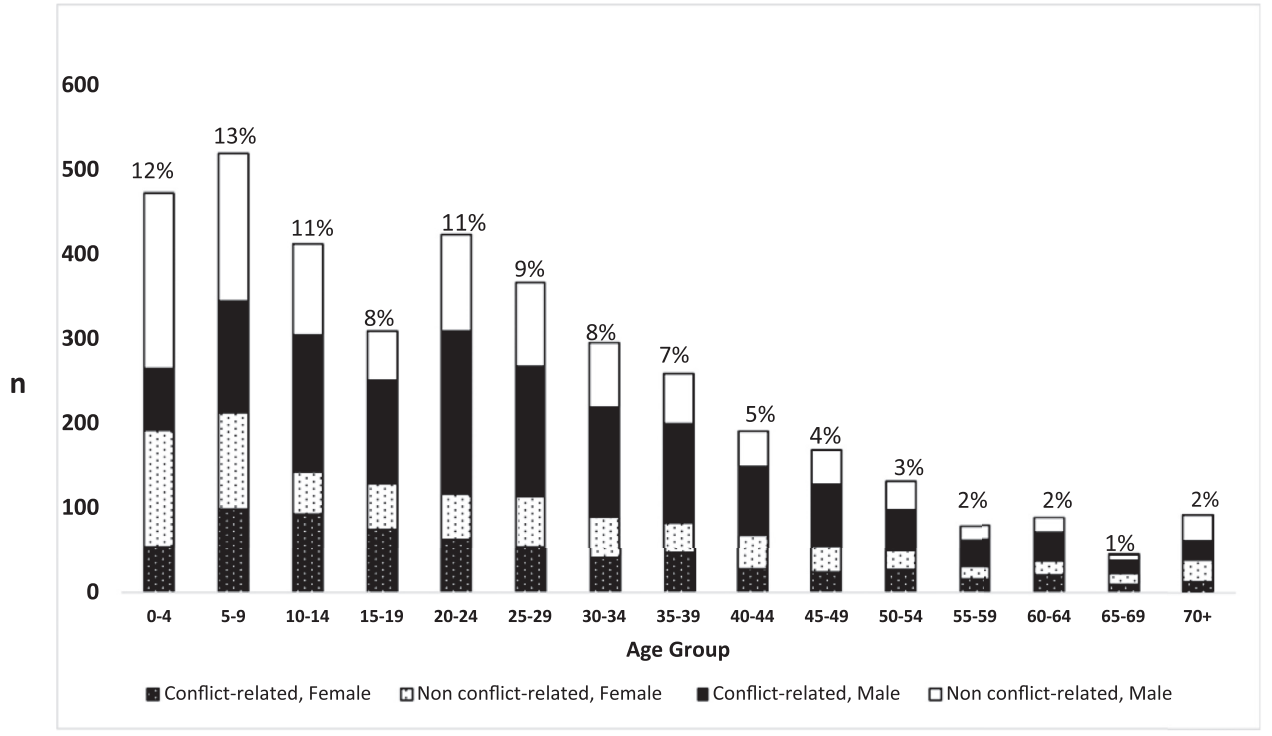

Figure 2. Presentations by age group, sex, and injury, percent of total (n = 3946).

(16–20). Health system deficiencies that are present in resource-poor settings are amplified with the advent of conflict. The low immediate mortality rate might be reflective of the fact that critical but potentially salvageable patients do not reach care in time, owing to the deficiencies in access, quality, and speed of prehospital care exacerbated by the adverse security conditions created by the advent of ISIS' expansion and the conflicts that followed (11,14).

Among patients presenting with conflict-related injuries, approximately four-fifths were due to explosives, in keeping with prior observations from the Mosul offensive (4,11). Similarly, a household survey conducted in Mosul found airstrikes and explosions to be a leading cause of death during the conflict (21). In our study, explosives were more likely than firearms to result in MCIs. These observations are likely due to the area effect of explosives, which is especially pronounced in confined spaces; each event has the potential of injuring several individuals simultaneously. The management of MCIs places a particular burden on health facilities, as several patients might arrive simultaneously, requiring robust triage routines. Although explosives constituted the more common injury, a greater proportion of firearm-related injuries were triaged as "red" and resulted in admission or referral. This might be explained by the wounding potential of explosives compared with firearms; shrapnel from explosives are usually classified as low-velocity, and the small arms typically used in conflicts fire high-velocity projectiles that results in injuries that frequently require debridement and delayed primary closure (22).

The trend of patients presenting with conflict-related injuries was characterized by a series of consecutive surges over time, possibly due to the tendency of combat to occur in waves of engagement. In contrast, this pattern was not seen in Erbil, where civilian patients presented in only two waves, correlating with the taking of east and west Mosul, respectively (11). One-third of presentations were due to medical and nontrauma surgical conditions, and the proportion of presentations in this group increased over time. In this regard, the results from our study were similar to the description of this phenomenon in the upcoming WHO-supported "Red Book," a manual that offers updated guidance to health care response in conflicts and other complex humanitarian emergencies. The gradual increase in needs other than trauma is likely explained by three factors. First, the frontline was a dynamic scene of injury that continually moved away from the MSF facility. Over time, fewer patients with injuries sustained from fighting will present, as other health facilities absorb them. This is also indicated by each consecutive wave being smaller than the previous one. Naturally, decreasing combat intensity can also contribute to this phenomenon. Second, as local inhabitants become aware of there being a health care facility in the area, patients with needs other than conflict-related ones

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might be more likely to present for care. Third, the disruption of the Ninewah health care system, as a consequence of ISIS' expansion, will have created unmet medical and nontrauma surgical needs, which results in patients presenting to whatever health facility was available. This stresses the importance that health care facilities deploying to conflicts, whose chief expectation is to treat trauma patients, must also be equipped and trained to manage presentations of nontrauma conditions.

Limitations

This study was subject to a number of limitations. First, the study is based on retrospective data, offering a description of the activities taking place in a single facility. Therefore, the results should be understood in the wider context of the Mosul offensive. Second, armed conflicts present inherent challenges to data collection and data reporting, leading to reporting bias. In this environment, patient care is naturally prioritized over data collection. Third, although MSF services are available to everyone according to humanitarian principles, the data had no provision to analyze combatants and civilians separately; analysis of patients from Mosul presenting in Erbil suggest that there are important differences in the epidemiology of trauma between the two groups (11). Lastly, because a large proportion of the patients were referred from the ED to other health facilities, it was not possible to capture morbidity and mortality at later stages of care.

Conclusions

This study described the epidemiology of patients from a frontline field hospital providing care close to an ongoing armed conflict with extensive use of asymmetric warfare tactics. Although a cyclical burden of conflict-related injuries was found, the study also revealed extensive medical and nontrauma surgical needs, which increased over time. The study revealed that among patients who presented with conflict-related injuries, explosive etiology predominated, and was more likely to result in MCIs. Furthermore, a very low mortality rate was described, which might be due to gaps in the prehospital system as a consequence of the challenges posed by the conflict environment.

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ARTICLE SUMMARY

1. Why is this topic important?

Modern armed conflicts are defined by asymmetric warfare tactics. As yet, the epidemiology of civilian patients and their care needs are poorly understood in this context.

2. What does this study attempt to show?

This study offers to describe the type and volume of patients presenting to a frontline care facility offering emergency care during an ongoing armed asymmetric conflict.

3. What are the key findings?

Conflict-related injuries presented in a cyclical pattern over time. Medical needs increased over time and outweighed conflict-related needs toward the end of the operational period. A very low immediate mortality rate was found, and may be indicative of a high prehospital mortality rate as critical patients may not reach care in time.

4. How is patient care impacted?

Despite trauma needs often being the focus for medical teams deploying to armed conflicts, clinicians operating in this type of environment must be prepared to meet nontrauma needs as well. Clinicians should be aware that in this context, there may be several obstacles for critical patients to reach care.

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