



Battlefield extremity injuries in Operation Iraqi Freedom

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ABSTRACT

Objective: Extremity injuries account for the majority of wounds incurred during US armed conflicts. Information regarding the severity and short-term outcomes of patients with extremity wounds, however, is limited. The aim of the present study was to describe patients with battlefield extremity injuries in Operation Iraqi Freedom (OIF) and to compare characteristics of extremity injury patients with other combat wounded.

Patients and methods: Data were obtained from the United States Navy-Marine Corps Combat Trauma Registry (CTR) for patients who received treatment for combat wounds at Navy-Marine Corps facilities in Iraq between September 2004 and February 2005. Battlefield extremity injuries were classified according to type, location, and severity; patient demographic, injury-specific, and short-term outcome data were analysed. Upper and lower extremity injuries were also compared.

Results: A total of 935 combat wounded patients were identified; 665 (71%) sustained extremity injury. Overall, multiple wounding was common (an average of 3 wounds per patient), though more prevalent amongst patients with extremity injury than those with other injury (75% vs. 56%, $P < .001$). Amongst the 665 extremity injury patients, 261 (39%) sustained injury to the upper extremities, 223 (34%) to the lower extremities, and 181 (27%) to both the upper and lower extremities. Though the total number of patients with upper extremity injury was higher than lower extremity injury, the total number of extremity wounds ($n = 1654$) was evenly distributed amongst the upper and lower extremities (827 and 827 wounds, respectively). Further, lower extremity injuries were more likely than the upper extremity injuries to be coded as serious to fatal (AIS > 2, $P < .001$).

Conclusions: Extremity injuries continue to account for the majority of combat wounds. Compared with other conflicts, OIF has seen increased prevalence of patients with upper extremity injuries. Wounds to the lower extremities, however, are more serious. Further research on the risks and outcomes associated with extremity injury is necessary to enhance the planning and delivery of combat casualty medical care.

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Introduction

Battlefield extremity injuries account for the majority of combat wounds sustained by United States armed forces during military conflicts of the twentieth century.^{10,12,13,18,19} Extremity wounds, however, account for a relatively small proportion of battlefield and hospital deaths compared with head, chest, and abdominal wounds.^{5,18,19} Overall, more than 65% of the wounded survivors from World War II and the Korean War sustained extremity injuries.^{18,19} Despite the changing nature of warfare, the prevalence of extremity injuries during Operation Enduring

Freedom and Operation Iraqi Freedom (OIF) is comparable to previous US military conflicts.^{11,15,16,22}

The emerging and widespread use of improvised explosive devices (IEDs) has resulted in new injury patterns amongst combat casualties during OIF compared with previous conflicts.^{9,20} In combat, lower extremity injuries (LEIs) are generally more common than upper extremity injuries (UEIs: 37–42% vs. 27–29%).^{18,19} Recent studies from OIF, however, demonstrate equivalent and, in some cases, higher proportion of UEIs to LEIs.^{9,16,17,22} The difference in severity of upper and lower extremity injuries has not been examined.

The objectives of this descriptive study were to characterise the prevalence, types, and severities of battlefield extremity injuries amongst US service members who received treatment for their injuries at Navy-Marine Corps facilities during OIF, and to compare injury-specific and short-term outcomes of (a) patients with extremity injury versus those with other injuries and (b) patients

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with UEI versus those with LEI. This research was conducted in compliance with all applicable United States federal regulations governing the protection of human subjects in research and was approved by the Institutional Review Board of the Naval Health Research Center, San Diego, CA, United States (Protocol NHRC.2003.0025).

Patients and methods

A retrospective review of clinical encounter data in the United States Navy-Marine Corps Combat Trauma Registry (CTR) was performed. The study population consisted of US service members injured in hostile action who presented to forward-deployed US Navy-Marine Corps medical treatment facilities (MTFs) (i.e., medical units that provide immediate triage and stabilisation of patients before sending them on to a higher level of care within the medical chain of evacuation) during a 6-month period of OIF, September 1, 2004, to February 28, 2005.

The Navy-Marine Corps CTR is a deployment health database that consists of medical treatment information abstracted from hard-copy and electronic records of patients treated for battle and nonbattle injury, disease, psychiatric, and routine sick call at forward-deployed Navy-Marine Corps MTFs in Iraq.⁷ The registry is designed to obtain information from multiple levels of care for each patient, starting near the point of injury at Navy-Marine Corps level I (i.e., battalion aid stations) or level II MTFs (i.e., forward resuscitative surgical systems or shock trauma platoons) and continuing through long-term rehabilitative care at military MTFs in the United States.

For the purposes of this study, only medical records from forward-deployed levels of care, and, in the case of evacuated patients, records from combat support hospitals in Iraq and the American hospital in Germany (Landstuhl Regional Medical Center) were analysed. Data were abstracted from these records to obtain the following information for each patient: age; gender; rank; service; mechanism, type, location, and severity of injury; surgical procedures; complications (i.e., any secondary problem that arose following an injury, procedure, or treatment); and disposition.

A diagnosis of extremity injury was indicated by one or more of the extremity *International Classification of Diseases*, 9th Revision, Clinical Modification (ICD-9-CM) codes defined by the Barell injury diagnosis matrix³ (Table 1). Patients without an extremity injury diagnosis were categorised as “other injury.” Patients were also categorised by upper, lower, or both upper and lower extremity injury. Multiple injured casualties with extremity injury were placed in the “extremity injury” category, whereas multiple injured casualties without extremity injury were placed in the “other injury” category.

Injury severity, as indicated by the Abbreviated Injury Scale (AIS) 2005⁸ and the Injury Severity Score (ISS),^{1,2} and ICD-9-CM codes⁶ were retrospectively assessed by clinical research staff at Naval Health Research Center in San Diego, California. The AIS rates the severity of each injury in nine body regions (i.e., head, face, neck, torso, abdomen, spine, upper extremity, lower extremity, and external) and is scored according to the following scale: 0 = no injury, 1 = minor, 2 = moderate, 3 = serious (but not life-threatening injury), 4 = severe (life-threatening injury), 5 = critical (life-threatening injury), and 6 = maximum (fatal injury). The AIS is then used to calculate the ISS (range 0–75), which represents the overall severity of multiple injuries for each patient. Patients with an ISS of 0 were excluded from this analysis; only patients with injuries were included. For the present study, AIS and ISS were categorised as minor to moderate (AIS 1–2; ISS 1–8) and serious to fatal (AIS > 2; ISS > 8).

Disposition was categorised as returned to duty (i.e., wounded in action and fit for full duty, assigned light duty, or sick in quarters), admitted (i.e., wounded in action and admitted for observation to a forward-deployed MTF without further disposition information), evacuated (i.e., wounded in action and medically evacuated to a combat support hospital), and deceased. Patients who were initially evacuated from a level I or II MTF who then subsequently died of their wounds after medical evacuation were categorised as “deceased.” Patients with missing disposition information were included as “unknown.”

Statistical analyses were performed using SPSS version 15.0 (SPSS Inc., Chicago, IL) and SAS version 9.1 (SAS Institute, Inc., Cary, NC). The prevalence of extremity injury was calculated for the entire cohort. Differences across groups by extremity injury status (extremity injury vs. other) and by extremity injury location (upper, lower, or both) were tested using a *t*-test for independent samples for continuous data (i.e., age), and with chi-square (χ^2) and Fisher's exact tests for categorical data and for the Barell matrix analysis; $\alpha = .05$ was used to determine statistical significance. The Barell matrix was used to describe the nature (or type) of extremity injuries; adjusted standardised residuals were used in the nature-of-injury analysis to identify cells from the crosstabs that had the greatest impact on the χ^2 -test statistic (critical values were set at ± 2.0).

Results

A total of 935 combat casualties were identified in the Navy-Marine Corps CTR between September 2004 and February 2005 and sustained a total of 3218 injuries (an average of 3 injuries per patient). Nine patients incurred two separate combat injury events during the study period; each event was counted as one casualty. The mean age was 24 ± 5.2 years (range 18–54 years). All but 8

Table 1
Upper and lower extremity ICD-9-CM codes as defined by the Barell injury diagnosis matrix.

Description	ICD-9-CM Codes
Upper extremity	
Shoulder and upper arm	810–812, 831, 840, 880, 887(.2–.3), 912, 923.0, 927.0, 943(.x3–.x6), 959.2
Forearm and elbow	813, 832, 841, 881(.x0–.x1), 887(.0–.1), 923.1, 927.1, 943(.x1–.x2)
Wrist, hand, and fingers	814–817, 833–834, 842, 881.x2, 882, 883, 885–886, 914–915, 923(.2–.3), 927(.2–.3), 944, 959(.4–.5)
Other and unspecified	818, 884, 887(.4–.7), 903, 913, 923(.8,.9), 927(.8–.9), 943(.x0,x9), 953.4, 955, 959.3
Lower extremity	
Hip	820, 835, 843, 924.01, 928.01
Upper leg and thigh	821, 897(.2–.3), 924.00, 928.00, 945.x6
Knee	822, 836, 844.0–.3, 924.11, 928.11, 945.x5
Lower leg and ankle	823–824, 837, 845.0, 897(.0–.1), 924(.10,.21), 928(.10,.21), 945(.x3–.x4)
Foot and toes	825–826, 838, 845.1, 892–893, 895–896, 917, 924(.3,.20), 928(.3,.20), 945(.x1–.x2)
Other and unspecified	827, 844(.8,.9), 890–891, 894, 897(.4–.7), 904(.0–.8), 916, 924(.4–.5), 928(.8,.9), 945(.x0,x9), 959(.6–.7)

Abbreviation: ICD-9-CM, International Classification of Diseases, 9th Revision, Clinical modification.

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