Ten years of military pediatric care in Afghanistan and Iraq

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BACKGROUND:	Besides care for injured US military personnel, doctrine also requires life-, limb-, and eyesight-saving care to all injured casualties, including children. This study's objective was to evaluate the burden and epidemiology of pediatric medical care during the past decade of military operations in Iraq and Afghanistan.
METHODS:	Retrospective review of two military registries of all patients admitted to combat support hospitals and forward surgical teams from 2001 through 2011 was conducted. Pediatric (PED) patients were defined as younger than 18 years. Adult patients were divided into local civilian/noncoalition military (LOCAL) and coalition (COALITION) soldiers.
RESULTS:	A total of 7,505 PED patients, 25,459 LOCAL adults, and 95,618 COALITION soldiers were analyzed in the primary registry. Children represented 5.8% of all admissions (11% bed days), LOCAL adults represented 20% (36% bed days), and COALITION soldiers represented 74% (53% bed days). PED median (interquartile range) length of stay was 3 days (1 7 days), longer than LOCAL with 2 days (1 6 days), and COALITION with 1 day (1 2 days) ($p < 0.001$). PED Injury Severity Score (ISS) was 9 (4 16), similar to LOCAL with 9 (4 16) but higher than COALITION with 5 (2 10) ($p < 0.001$). Mortality in trauma patients was highest in PED (8.5%) compared with LOCAL (7.1%) and COALITION (3%) ($p < 0.01$). Mechanisms of injury for PED trauma were blast (37%), penetrating (27%), blunt (23%), and burn (13%). Factors independently associated with PED mortality included ISS (odds ratio, 95% confidence interval) (1.08, 1.06 1.09), Glasgow Coma Scale (GCS) score (0.85, 0.82 0.88), base excess (0.87, 0.85 0.90), female sex (1.73, 1.18 2.52), age less than 8 years (1.43, 1.00 2.04), and burns (3.17, 1.89 5.32).
CONCLUSION:	Deployed medical facilities not staffed or equipped to typical civilian standards have a high burden of pediatric casualties requiring care. The cause of increased mortality in pediatric versus adult populations despite similar severity of injury is potentially multifactorial. Military medical planners need to consider pediatric resources and training to improve outcomes for children injured during combat. (*J Trauma Acute Care Surg*. 2012;73: S509 S513. Copyright © 2012 by Lippincott Williams & Wilkins)
LEVEL OF EVIDENCE:	Epidemiologic study, level III.
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Whenever wars are fought, children are caught in the crossfire. The past decade of war in Afghanistan/Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF), is no exception. The military medical policy of the United States dictates the provision of care for injured soldiers, as well as life-, limb-, and eyesight-saving care to injured civilians, including children. Furthermore, the stated military mission in both operations includes winning the "hearts and minds" of the population. Providing care to injured or ill children certainly affects this mission.

Military trauma for both adult and pediatric (PED) patients is different from that of the civilian setting, as has been previously described.[1,2] Civilian trauma generally is caused by more than 90% blunt mechanism,[3] whereas most military trauma is caused by penetrating injury.[1,4] Furthermore, penetrating injury in the civilian setting is mostly caused by gunshot wounds, whereas in modern warfare, it is necessary to distinguish blast trauma as a mechanism distinct from gunshots. Previous studies on pediatric casualties in OEF and OIF analyzed smaller numbers (the largest number being 2,060 patients) of the initial PED patients cared for at military facilities.[5–9] Now that OIF has concluded, the objective of this study was to describe the epidemiology of pediatric care by US military medical personnel for the past 10 years in both Afghanistan and Iraq and to analyze the burden of care in pediatric versus adult patients.

PATIENTS AND METHODS

A retrospective review of the Patient Administrative Systems and Biostatistics Activity (PASBA) database and the Joint Theater Trauma Registry (JTTR) was performed of patients admitted to combat support hospitals and forward surgical teams from 2001 through 2011. The PASBA database contains all admissions from Afghanistan and Iraq and is maintained at Fort Sam Houston, Texas. Data queried included admission type (battle injury, nonbattle, and medical), year, age, patient category, mechanism of injury, diagnoses, procedures, length of stay (LOS), and in-hospital mortality. The JTTR, maintained at the US Army

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TABLE 1. Comparison of Pediatric Versus Adult Local and Coalition Personnel in OEF and OIF

	Type of Patient		
Variable	**PED**	**Local Adult**	**Coalition Adult**
Number	7,505	25,459	95,618
OEF	3,634	6,357	34,923
OIF	3,871	19,102	60,695
Male	75	94*	91*†
OEF	75	90*	91*†
OIF	78	91*	95*†
Trauma	79	65*	46*†
ISS	9 (4 16)	9 (4 16)	5 (2 10)*†
OEF	9 (4 16)	9 (4 14)	5 (2 10)*†
OIF	10 (4 17)	9 (4 17)*	5 (2 10)*†
LOS	3 (1 7)	2 (1 6)*	1 (1 2)*†
OEF	3 (1 7)	3 (1 7)	1 (1 2)*†
OIF	2 (1 6)	2 (1 6)	1 (1 2)*†
Trauma mortality	8.5	7.1*	3.0*†
OEF	8.1	6.3*	1.6*†
OIF	9.1	7.6*	3.7*†

*$p < 0.05$ significantly different from PED group.
†$p < 0.05$ significantly different from LOCAL adult group.
Data are presented as percentage or median (interquartile range).

Institute of Surgical Research, Fort Sam Houston, Texas, was established by the Department of Defense to collect comprehensive data on all personnel, military and civilian, admitted for trauma in Afghanistan and Iraq. Data queried from the JTTR included basic patient demographics, mechanism and cause of injury, Injury Severity Score (ISS), Glasgow Coma Scale (GCS) score, base excess, use of transfusion and mechanical ventilation, and in-hospital mortality. The JTTR was used for all comparisons with ISS, transfusions, or ventilation. Pediatric (PED) patients were defined as local children younger than 18 years. No distinction was made whether the child was a combatant or a noncombatant. PED patients were also analyzed based on age less than or at least 8 years as has been done in previous analyses.[7] Adults were divided into two groups: local civilian and noncoalition military personnel (LOCAL) and coalition soldiers (COALITION). Blast injuries were defined as those occurring from any explosive device and were distinguished from burn, blunt injury, and penetrating injury. For both databases, in-hospital mortality was the primary end point. For PED and LOCAL patients, it occurred at the deployed combat support hospital facility, whereas for COALITION soldiers, this included hospital admission through referral centers in Germany and the United States. Length of stay was limited to the combat support hospitals for all patients. Univariate analyses, to include Kruskal-Wallis, Mann-Whitney, and χ^2 tests as appropriate, were used to compare these three groups. Univariate comparisons and logistic regression were also conducted to identify individual factors associated with mortality within the PED population using the JTTR database. Differences between OEF/Afghanistan and OIF were also noted. Statistical analyses were performed using SPSS version 16.0 (IBM, Armonk, NY). This study was approved by the institutional review board at Brooke Army Medical Center, Fort Sam Houston, Texas.

RESULTS

Pediatric Versus Adult Comparisons

Overall, the PASBA database contained 7,505 PED admissions, 25,459 LOCAL, and 95,618 COALITION between July 2002 and October 2011. Children represented 5.8% of all admissions and 11% of all bed days, LOCAL adults accounted for 20% of admissions and 36% bed days, and COALITION soldiers accounted for 74% of admissions and 53% bed days (Table 1). Overall median (interquartile range) LOS was 3 days (1–7 days) for PED, longer than LOCAL adults with 2 days (1–6 days) ($p < 0.001$), and COALITION soldiers with 1 day (1–2 days) ($p < 0.001$). Trauma accounted for 79% PED, compared to 65% of LOCAL ($p < 0.05$) and 46% of COALITION admissions ($p < 0.05$). The JTTR database contained 4,743 PED trauma admissions, 16,292 LOCAL adults, and 22,995 COALITION soldiers. PED median (interquartile range) ISS was 9 (4–16), similar to LOCAL with 9 (4–16) but higher than COALITION with 5 (2–10) ($p < 0.001$). The 8.5% mortality for PED trauma was the highest compared with 7.1% LOCAL ($p < 0.01$) and 3% COALITION ($p < 0.01$). Table 1 notes ISS, LOS, and mortality differences between patient groups and theater of war. The PED population had a higher mortality and longer stay compared with both adult groups in OEF and OIF. The ISS was similar in the LOCAL and PED populations but higher than that of the COALITION soldiers in both theaters.

Pediatric Population

Pediatric admissions peaked in 2007 in OIF, whereas numbers have been steadily increasing over time in OEF (Fig. 1). A plot of pediatric ISS and mortality over time is noted in Figure 2. Within the PED trauma admissions, mechanisms of injury were blast with 37%, penetrating with 27%, blunt with 23%, and burn with 13%. This is consistent with the most common specific injury causes as follows: explosive device with 38%, gunshot wounds with 22%, motor vehicle crash with 11%, and burn injury with 5%. Differences between OEF and OIF are noted on Table 2. The most common surgical procedures performed were wound debridement and skin grafting. The mortality was significantly higher in OIF (8.6% compared with 6.1%, $p > 0.001$); however, the LOS was longer in OEF (3 days [1–7 days] vs. 2 days [1–6 days], $p < 0.001$). Within the trauma (JTTR) PED admissions, the ISS score was also significantly higher in OIF (10 [4–17] vs. 9 [4–16], $p < 0.05$). There were

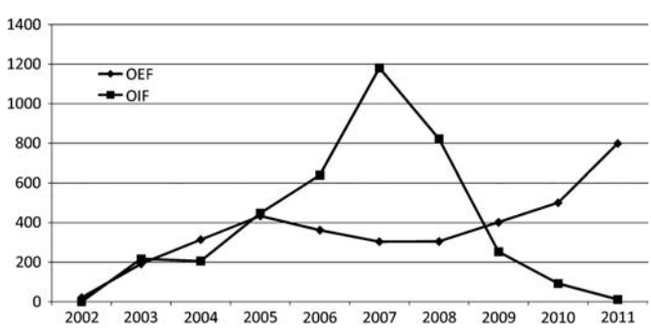

Figure 1. Pediatric admissions over time in OEF and OIF.

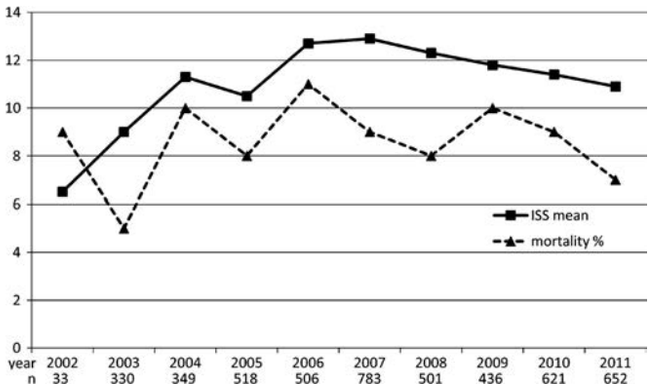

Figure 2. Combined pediatric ISSs and percent mortality over time.

similar proportions of patients transfused (9.7% and 9.6%) and ventilated (16.1% and 17.8%) in both OEF and OIF, respectively.

Children younger than 8 years, compared with older children, had a higher mortality for both trauma and medical admissions. This remained true within OEF and OIF (Table 3). The LOS was significantly shorter for younger children (2 days [1–6] days vs. 3 days [1–8] days, $p < 0.001$). There were significantly more females younger than 8 years and more males older than 8 years in both countries ($p < 0.001$) (Table 3). Younger children were also more likely to be admitted for a medical etiology, blunt or burn injury, while older children were more likely to be admitted for a penetrating or blast injury. There were no significant differences in ISS scores (9 [4–16] vs. 9 [4–17]) according to age (Table 3).

TABLE 2. OEF and OIF Comparison of Pediatric Patients

Variable	OEF	OIF
No. patients	3,634	3,871
Male*	75	80
Battle injury trauma*	34	55
Nonbattle trauma*	41	28
Disease*	26	17
ISS*	9 (4 16)	10 (4 17)
Overall mortality*	6.1	8.6
Trauma mortality	8.1	9.1
Bed days*	3 (1 7)	2 (1 6)
Blast*	40	35
Blunt*	29	17
Burn*	10	14
Penetrating*	23	33
Explosive device*	40	35.3
Gunshot wound*	16.2	29.4
Motor vehicle crash*	12.3	9.1
Ventilated	16.1	17.8
Transfused	9.7	9.6
Age <1 year*	3.7	5.3
Age 1 5 y*	26	21
Age 6 11 y	36	36
Age 11 17 y*	34	38

*$p < 0.05$ significant difference between OEF and OIF.
Data are presented as percentage or median (interquartile range).

TABLE 3. PED Patients Based on Age Group

Variable	<8 y	≥8 y
Overall mortality*	9.9	5.3
Trauma mortality*	10.3	7.3
OEF mortality*	8.4	4.4
OIF mortality*	11.2	6.2
OEF blast*	24	39
OEF penetrating*	5.3	16
OEF blunt*	19	15
OEF burn*	11	4.8
OEF medical*	38	21
OIF blast*	31	35
OIF penetrating*	22	34
OIF blunt*	10	7.9
OIF burn*	12	5.3
OIF medical*	21	14
Blast*	28	37
Penetrating*	15	25
Blunt*	14	12
Burn*	12	5.1
Medical*	29	18
Female*	58	43
OEF female*	58	42
OIF female*	57	43
OEF ISS	9 (4 16)	9 (4 16)
OIF ISS	9 (4 16)	9 (4 17)
Overall ISS	9 (4 16)	9 (4 17)
Bed days*	2 (1 6)	3 (1 8)
OEF bed days*	3 (1 7)	3 (1 8)
OIF bed days*	2 (1 5)	3 (1 7)

*$p < 0.05$ significant difference between OEF and OIF.
Data are presented as percentage or median (interquartile range).

Overall, 77% of children were male. Females had a significantly higher mortality in OEF (8.5% vs. 5.3%, $p < 0.001$) and nonsignificantly higher in OIF (9.6% vs. 8.2%, $p = 0.2$). Females were also more likely to be admitted for a burn or a medical reason as compared with males. There were no significant differences in ISS scores or LOS based on sex. After regression analysis of the JTTR database, factors that were independently associated with trauma mortality were ISS, GCS score, base excess, burn injury, age less than 8 years, and female sex (Table 4).

DISCUSSION

To date, this review of 7,505 PED patients is the largest review of pediatric casualties cared for in Afghanistan and Iraq. PED patients constituted 5.8% of all admissions and 11% of all bed days, indicating the significant pediatric workload within combat support hospitals and forward surgical teams. These results may also be underestimated because initially, data collecting resources focused on military personnel, potentially resulting in falsely lower pediatric numbers. These percentages are similar to earlier reports by Burnett et al.[5] (n = 1,012) and Spinella et al.[9] (n = 1,305), who reported that children made up 12% and 10% of total bed days, respectively.

TABLE 4. Logistic Regression for Pediatric Trauma Mortality

Variable	β Coefficient	Odds Ratio (95% Confidence Interval)	*p*
ISS	0.073	1.08 (1.06 1.09)	<0.001
GCS score	0.168	0.85 (0.82 0.88)	<0.001
Base excess	0.134	0.87 (0.85 0.90)	<0.001
Age <8 y	0.359	1.43 (1.00 2.04)	0.047
Burn injury	1.15	3.17 (1.89 5.32)	<0.001
Female sex	0.546	1.73 (1.18 2.52)	0.005

Given that the COALITION soldiers are generally well armored and are quickly evacuated out of theater in less than 24 hours, it is not surprising that children had a longer stay and higher mortality. As noted earlier, life-, limb-, or eyesight-saving care is triaged in the same way for all patients, regardless of background or age. In less severe cases, while all COALITION troops are cared for, LOCAL and PED patients are generally referred to local civilian medical facilities but are sometimes cared for if the situation allows. This leads to a more severely injured population of LOCAL casualties who are ultimately seen in the military facility. Interestingly, the children cared for had a longer stay and higher mortality than the LOCAL adult population, despite having similar ISS scores. A pediatric population with a trauma mortality of 8.5%, a median ISS score of 9 (4–16), and predominantly blast and penetrating mechanisms of injury is a population vastly different from children admitted to any civilian institution. A 2007 study of US pediatric trauma reports a mortality of 2.9% and 93% blunt injury, although neither ISS nor any other measure of injury severity was noted.[3] Arguably, this severity of injury seen in OEF and OIF would stress any major pediatric trauma center, let alone a deployed military medical unit that is primarily resourced for, and most experienced with, adult patients, and generally without pediatric-trained surgeons or subspecialists trained in caring for critically ill children. Joint Theater Trauma System's clinical practice guidelines and protocols are also primarily written and rehearsed for adult patients, although over time, some additions have been made for PED patients. This lack of pediatric expertise, training, resources, or system-based practices may account for some of the higher pediatric mortality and LOS that was observed. However, given the resources available, the care provided to these local children is a testament to the motivation of deployed medical personnel fighting for the best outcome for each individual child.

Previously, Creamer et al.[6] reviewed 2,060 PED patients from the PASBA database. The results of this study confirmed several of their interesting findings; specifically, that female sex was associated with higher mortality and a younger age. When adjusted for ISS, admission base excess, GCS score, and burn injuries, both female sex and age of less than 8 years remained independently associated with death. We further noted that females were more likely to be admitted for a burn or for a medical reason. It is unclear why these differences exist, although one could hypothesize that a variety of cultural and societal influences may play a part along with other unmeasured preexisting medical conditions. It is unclear why females predominate the younger age groups, although one could hypothesize that the increased numbers of males in older children occur because boys congregate around soldiers, are combatants themselves, or are involved in accidental trauma to a higher degree as is true in the developed world. The findings of Creamer et al. that the incidence of gunshot wounds and penetrating injuries were more common in Iraq than in Afghanistan were also confirmed in this study and were potentially caused by differences in weapons and fighting techniques. In this larger population, we also noted that burn injury was more common in Iraq (unlike in the analysis of Creamer et al.), whereas blast and blunt injury was more common in Afghanistan.

In a population of 1,132 patients, Matos et al.[7] previously found that children younger than 8 years had an independent risk of death compared with older children and adults (without body armor), after adjusting for multiple factors. Similar results were confirmed in this larger pediatric population, even excluding adults.

Limitations in this study are similar to those inherent to retrospective reviews, particularly with missing and incorrect data. Furthermore, filling out data collection sheets within a battlefield environment creates a greater potential for data inaccuracies. There is also the potential for overlap when classifying mechanisms of injury, given the nature of battlefield trauma. For instance, a blast injury could also result in penetrating trauma from shrapnel, blunt injury from being thrown, and a burn injury from a resulting fire. An additional limitation of the trauma registries in this environment is that given communication barriers and lack of birth data among Afghan and Iraqi children, it is difficult to accurately assess patient ages in the PED and LOCAL population; so there may have been older teenagers misclassified as young adults and vice versa.

During the past 10 years, the military has adjusted to caring for critically ill pediatric trauma patients in OIF and OEF. Early on, a consultation network was established to give deployed medical providers access via the Internet or telephone to a pediatric intensivist. A pediatric trauma curriculum was added to the Joint Forces Combat Trauma Management Course (a week-long intensive class designed for doctors, nurses, and physician assistants deploying to combat support hospitals), and pediatric supplies were added to combat support hospital deployment packages. The US Navy has also had a pediatric intensivist deployed to the combat support hospital in Kandahar, Afghanistan, for a large portion of OEF. Similarly, the US Air Force has had a pediatric intensivist or pediatrician present in the combat support hospital at Bagram Airfield, Afghanistan. It is unclear whether these specific interventions resulted in reduced pediatric mortality. As noted in Figure 2, while mortality, as expected, increases and decreases with ISS over time, there was no significant evidence that mortality rates were improving during the course of the decade. Furthermore, we were not able to evaluate any effect from the presence of pediatric intensivists, surgeons, or pediatricians.

CONCLUSION

War cannot be fought without the consequence of injuring children. The modern battlefield creates a deadlier spectrum of injuries that is not commonly seen in civilian trauma. In OEF and OIF, children are often more severely injured, have a longer median stay, and can require significant resources. The US military medical infrastructure has adapted to this reality, which has

potentially saved children's lives, although it is impossible to quantify this effect. Further improvements in the best use of pediatric intensivists, other pediatric specialized services, and predeployment training logistical preparation could certainly be implemented. This past decade of pediatric experience dictates that pediatric trauma care is an integral part of the wartime medical mission. Military medical planners must consider this in current and future military operations.

AUTHORSHIP

M.B. designed this study. M.B., R.I.M., and P.C.S. contributed to the data analysis. All authors participated in writing and reviewing the article for publication.

DISCLOSURE

The authors declare no conflicts of interest.

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