



Pediatric trauma: experience of a combat support hospital in Iraq[☆]

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Abstract

Background/Purpose: The mission of the combat support hospital (CSH) is to evaluate and treat combatants injured during war operations. The 31st CSH in Balad and Baghdad, Iraq, during Operation Iraqi Freedom 2 also treated many injured civilians, including children. The purpose of this article is to report the experience of the 31st CSH treating pediatric trauma patients.

Methods: A retrospective review of a comprehensive patient database collected in theater was conducted.

Results: From January 1 to December 31, 2004, we treated 99 patients 17 years and younger. The average age of these patients was 10.6 years. Nine died of their wounds. The mean injury severity score was 11.6. Forty-one sustained gunshot wounds, 13 acquired fragment wounds (55% penetrating), and 22 were injured by improvised explosive devices (22%). Seventy-three patients required a total of 191 operations: 18 celiotomies, 8 craniotomies, 23 skeletal fixations, and 75 wound washout/debridements, among others. Predictors of mortality included admission Glasgow Coma Score less than 4 and admission pH less than 7.1.

Conclusions: The primary mission of the CSH in theater remains unchanged, but its role is evolving. With this study, we can begin to understand the needs of wounded children in urban conflict and help guide training and resource allocation in the future.

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The mission of the combat support hospital (CSH) is to provide corps-level health service support. (A corps is a deployable/operational unit with 20,000-40,000 troops.)

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This support includes evaluation, resuscitation, initial wound surgery, and postoperative treatment of American, coalition, and enemy soldiers. In 2004, the 31st CSH was deployed to Balad and Baghdad, Iraq, in support of Operation Iraqi Freedom 2.

Combat support hospitals are the third echelon (Echelon III) of wartime health service support. Echelon I consists of a unit-level health care, including immediate life-saving measures and evacuation. Echelon II provides initial resuscitative treatment and includes medical companies

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14. ABSTRACT Background/Purpose: The mission of the combat support hospital (CSH) is to evaluate and treat combatants injured during war operations. The 31st CSH in Balad and Baghdad, Iraq, during Operation Iraqi Freedom 2 also treated many injured civilians, including children. The purpose of this article is to report the experience of the 31st CSH treating pediatric trauma patients. Methods: A retrospective review of a comprehensive patient database collected in theater was conducted. Results: From January 1 to December 31, 2004, we treated 99 patients 17 years and younger. The average age of these patients was 10.6 years. Nine died of their wounds. The mean injury severity score was 11.6. Forty-one sustained gunshot wounds, 13 acquired fragment wounds (55% penetrating), and 22 were injured by improvised explosive devices (22%). Seventy-three patients required a total of 191 operations: 18 celiotomies, 8 craniotomies, 23 skeletal fixations, and 75 wound washout/debridements, among others. Predictors of mortality included admission Glasgow Coma Score less than 4 and admission pH less than 7.1. Conclusions: The primary mission of the CSH in theater remains unchanged, but its role is evolving. With this study, we can begin to understand the needs of wounded children in urban conflict and help guide training and resource allocation in the future.					
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Table 1 Number and percentage of injuries by mechanism

Mechanism	No.	Percentage (%)
Gunshot wound	41	42
IED (blast)	22	22
Motor vehicle crash	19	19
Fragmentation wounds	13	13
Burn	7	7
Fall	3	3
Crush	1	1

and forward surgical teams. Echelon III provides in-theater hospital care and consists of mobile army surgical hospitals, evacuation hospitals, and CSH. After stabilization and treatment, soldiers are returned to duty or transferred to echelons IV (field hospitals and general hospitals outside the continental United States) and V (medical centers/hospitals located in the continental United States) for definitive management and rehabilitation.

Although the mission of the CSH is to evaluate and treat combatants, recent conflicts in Afghanistan and Iraq have realized an evolving role for the CSH, to include treatment of ill and injured civilians. Since the invasion of Iraq, many civilians, including children, have been injured or killed, largely as a result of collateral damage and terrorist acts. In addition, children acting as human shields or recruited by insurgents to transport and place improvised explosive devices (IEDs) are injured in the crossfire or by accidental detonation. If their injuries are life, limb, or eyesight threatening, they are stabilized at the nearest American/coalition medical facility (often echelon I or II). These patients are referred to the nearest level III facility, such as the 31st CSH.

Pediatric injuries during combat operations have not been extensively reported, although recent reports have documented large pediatric casualties during Operation Iraqi Freedom I [1]. The British 34 Field Hospital Accident and Emergency (A and E) Department recently reported their experience treating 78 children during OP TELIC, the United Kingdom military operation in Iraq, in March to May 2003 [2].

1. Methods

This study is an institutional review board approved retrospective review of a comprehensive database of all patients, both military and civilian, treated at the 31st CSH from January 1 to December 31, 2004. The subset of patients younger than 18 years was extracted from this larger database. In a number of patients, the age was not known or not recorded in the database. For the purposes of this study, these patients were presumed to be adults.

As mentioned in the introduction, the CSH is the third echelon of wartime medical care. Many patients received care at lower echelons before arrival at our facility. The data

that we have from these lower echelons are incomplete. The data that we present here consist of physiologic condition and injuries documented upon arrival at the 31st CSH.

We calculated mortality (percentage of those who died of wounds) and tabulated causes of death; abbreviated injury scale (AIS); injury severity score (ISS); nature and location of injuries; number, type, and length of operations performed; intensive care unit (ICU) length of stay; and need for blood products. We also compared admission data between survivors and nonsurvivors using Student's *t* test of unpaired samples with unequal variance, accepting $P < .05$ as statistically significant. Glasgow Coma Score with a "T" such as 3T were included in this data set.

2. Results

From January to December 2004, we cared for 3293 patients. Ninety-nine patients, approximately 3%, were younger than 18 years. Fifty-four of these were younger than 13 years. The average age was 10.5 years, ranging from ages 1.6 to 17 years. Seventy-six were male and 23 female. Seventy-nine (79%) were battle or crossfire injuries and 20 (20%) were nonbattle injuries. Most of the injuries were caused by penetrating and/or blast trauma: gunshot wounds, fragmentation wounds, and IEDs. There were also a significant number of children injured in motor vehicle crashes (Table 1). None of the injured children were known to be wearing any sort of body armor or other protective equipment.

The nature of the injuries ranged from minor to life threatening. The anatomical location of injuries is shown in Table 2. Most patients had multiple injuries. Blast victims suffered a combination of blunt, penetrating, and thermal trauma. There were multiple facial (18) and extremity (92) injuries owing to being thrown a distance and missiles or fragments in the eye/brain/torso/extremities. In addition, there were 26 head injuries, 13 spine injuries, 11 vascular injuries, 9 eye injuries, and 6 burns. There were also 11 patients with either pulmonary contusion or inhalation injury.

A total of 191 operations were performed on 73 patients. The average operating time was 139 minutes (range, 45-351 minutes). We performed 75 extremity washouts, 23 skeletal fixations, 21 oral/facial operations, 19 soft tissue repairs, 18 celiotomies, 11 ocular operations, and 8 craniotomies, among others. Nine patients died of their wounds for a mortality rate of 9%. Sixty-four children were discharged

Table 2 Number of deaths by mechanism

Mechanism	No.
Gunshot wound	3
IED (blast)	3
Motor vehicle crash	2
Motor vehicle crash + burn	1

Table 3 Number of deaths by physiologic cause

Cause of death (physiologic)	No.
Neurologic/brain death	6
Hemorrhage	2
Multiorgan failure	1
Loss of airway	1

and 24 were transferred to Iraqi hospitals after stabilization. We do not have follow-up information on these children. The number of deaths by mechanism is listed in Table 2. The causes of death are listed in Table 3. Three of the 9 deaths occurred as a result of blast trauma. Six were owing to devastating brain injury.

We calculated the AIS and ISS in all of the injured children (Table 4). The mean ISS was 11.6. The mean ISS in the children who died was 23.4 and in those who lived was 10.4. Not surprisingly, the children who died had significantly higher AIS of the head/neck.

Upon arrival to the 31st CSH, the average systolic blood pressure was 115 mm Hg; diastolic blood pressure, 63 mm Hg; heart rate, 111 beats/min; and temperature, 98.2°F. The mean hematocrit was 32.1%, pH 7.27, and the base deficit, 6.27. We compared these data in the survivors vs the nonsurvivors (Table 5). Glasgow Coma Score was significantly lower in nonsurvivors, as was the pH on arrival at the CSH. Nonsurvivors were transfused more packed red blood cells (pRBCs) and fresh frozen plasma (FFP) than survivors. There was a trend toward significance in temperature difference between the survivors and nonsurvivors.

A total of 35 patients received blood transfusions (pRBC or whole blood). Sixteen received FFP as well. The median pRBC transfusion was 2 U (range, 1-15 U). The median FFP transfusion was 3 U (range, 1-12 U). Three patients received a total of 10 U of whole blood. One dose of activated factor VII (recombinant factor VIIa) was given to a patient with a gunshot wound on the head who died of his wounds. Forty-five patients were required to stay in the ICU for a total of 406 ICU days. The median ICU length of stay was 9 days (range, 1-92 days). The median hospital length of stay was 4 days (range, 1-110 days). When compared with adult ICU/hospital days, children (although represent-

Table 4 Abbreviated injury scale/ISS

	Mean	Survivors	Nonsurvivors	P
AIS—head/neck	0.99	0.78	3.11	.01*
AIS—face	0.23	0.20	0.56	.19
AIS—thorax	0.49	0.46	0.78	.29
AIS—abdomen	0.37	0.40	0	<.01*
AIS—pelvis	1.11	1.16	0.67	.12
AIS—external	0.49	0.48	0.56	.45
ISS	11.6	10.4	23.4	<.01*

* P value significant at <.05.

Table 5 Admission data of survivors vs nonsurvivors

	Survivors	Nonsurvivors	P
SBP (mm Hg)	116	103	.16
DBP (mm Hg)	64	54	.21
Heart rate (beats/min)	110	117	.31
Temperature (°F)	98.4	95.9	.06
Glasgow Coma Score	13.5	4.1	<.01*
Hematocrit (%)	32.7	28.5	.15
pH	7.3	7.1	.028*
Base deficit	5.1	10.9	.088
Units pRBC (n = 35)	.98	3.11	<.01*
Units FFP (n = 16)	.58	2.22	.02*

SBP indicates systolic blood pressure; DBP, diastolic blood pressure.

* P value significant at <.05.

ing only 3% of the total patients) required 10.5% and 6.8% of the total ICU and hospital bed days, respectively.

3. Discussion

This report is the first to describe pediatric injuries during modern combat operations presenting to an American level III facility for care. This and other data coming from the Joint Theater Trauma Registry are important to medical commanders and planners to gauge the personnel, training, and equipment that are necessary for future conflicts fought in urbanized areas.

Interestingly, the British 34 Field Hospital report, which covered the war-fighting phase of OP TELIC from March to May 2003, noted a very different distribution of injury mechanism than we did: 56% burns as the primary injury, 9% fragmentation wounds, and only 1 gunshot wound [2]. The authors note that most of the pediatric casualties at that time were owing to collateral damage from shelling/bombing or unexploded ordinance. The war and climate in Iraq have changed a great deal since early 2003, now with children being caught in crossfire and victimized by terrorist-detonated IEDs. There are several recent reports of experience with terror-related injury in Israeli children. A study during the period from October 2000 to December 2001 reported data on 138 children hospitalized for traumatic injury caused by terrorist acts. The mechanism of injury was blast or explosion in 67%, gunshot wounds in 25%, and burns in 8%. As in our report, there was a high percentage of penetrating cranial trauma (13%). Most of these victims were multiply injured [3]. Not surprisingly, our experience falls somewhere between these 2, because children in Iraq today are injured both in crossfire and in terrorist acts.

Others have also reported on injured children during wartime. As we observed, a high percentage suffer penetrating injuries (gunshot wounds and fragmentation wounds), burns, and blast injuries [2,4-6]. These injuries tend to be associated with a higher ISS and worse functional outcome than other types of injuries [6]. Victims of gunshot

wounds are 6 times more likely to die than victims of a car crash [7].

Blast/explosion injury victims are particularly complex. They sustain blunt and penetrating wounds as well as burns and inhalation injury [8]. Injury patterns include a high rate of cranial injuries, amputations, extensive cutaneous/soft tissue damage, burns, and intra-abdominal and thoracic injuries [9]. All physicians should be prepared to evaluate and treat these patients, because accidental and terrorist-detonated explosions now occur all over the world.

The types of injuries that we saw and operations that were required should help guide the allocation of resources to this and other regions in the future. More than half of our patients required ICU admission. Because of the fact that Iraqi civilians could not be evacuated to American/military higher levels of care, many were managed longer term at the CSH. Thus, there is a need for physicians with experience and training in pediatric critical care (ie, pediatricians, pediatric intensivists, and pediatric surgeons). Historically, pediatricians have been deployed as general medical officers or Battalion Surgeons [10]. As a result of recent experience, pediatricians were recently added to the personnel inventory of certain CSHs. In addition, there is now a Triservice telemedicine system that provides level II and level III facilities with immediate access to a pediatric intensivist whenever needed, either by telephone or email.

Physicians returning from war abroad in the 1960s applied the lessons learned in their military experiences to civilian trauma, and over the next several decades, developed trauma centers and trauma systems. A great deal of progress has been made in recent years with the development of pediatric trauma systems and a National Pediatric Trauma Registry [11-13]. Data from this registry have been studied and used to educate physicians/surgeons,

improve facilities, and develop resources. This article is the first in recent conflicts to report and analyze pediatric trauma and to detail the needs of pediatric patients in urban combat. In addition to aiding preparation for future deployments, these data add to the ongoing effort to improve pediatric trauma care at home.

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