

Forward Surgical Teams Provide Comparable Outcomes to Combat Support Hospitals During Support and Stabilization Operations on the Battlefield

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Background: Forward Surgical Teams (FST) provide forward deployed surgical care within the battle space. The next level of care in theater, the Combat Support Hospitals (CSH), are distinguished from the FST by advanced resource capabilities including more complex diagnostic imaging, laboratory support with blood banking, and intensive care units. This study was intended to assess the effect of FST capability on the outcome of seriously injured casualties in comparison to the CSH.

Methods: We reviewed all casualty records in the Joint Theater Trauma Registry database from April 2004 to April 2006. The study cohort included all US military battle casualties who

were admitted to either a FST or a CSH and were not returned to duty within 72 hours. Data were tabulated and assessed for basic demographics, mechanism of injury, injury severity score, ventilator and critical care days, and mortality. Statistical inferences were made using Chi square and Student's *t* tests.

Results: As of April 2006, the above information was available in the Joint Theater Trauma Registry on 2,617 US military battle casualties who survived to reach care at a FST and/or CSH. Of this population, 77 subsequently died of wounds and 2,540 survived. We found no significant difference in died of wounds rates between the sample populations or rates of ventilator or critical care days between

the two groups, nor did controlling for injury severity score alter this picture. The most significant predictor of mortality in both these groups was head injury.

Conclusions: The disparity between the availability of the highest level of injury care and the ability to care for injury as soon as possible is an issue of central importance to both the civilian and military trauma care communities. Our analysis demonstrates that despite the operational and logistic challenges that burden the FST, this level of surgical care confers equivalent battlefield injury outcome results compared with the CSH.

Key Words: Injury, Trauma, Forward Surgical Team, Hospital, War, Combat, Battlefield.

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With the development of trauma systems in the civilian sector, during the last 40 years, trauma care has been increasingly concentrated in trauma centers that can mobilize care quickly to mitigate morbidity and mortality in severely injured casualties.^{1–4} Reviews of patient outcomes consistently show that, given the rapidity of evacuation possible with regional coordination and helicopter transport, injured patients have better outcomes when managed in verified trauma centers rather than in facilities without the resources and commitment to trauma care.^{2,4} The development and implementation of the Joint Theater Trauma System has begun to demonstrate similar results on the battlefield.⁵

Rapid evacuation of casualties by helicopter has been the hallmark of military trauma care since the Korean War and is

widely credited as one of the factors contributing to the overall improvement in outcomes for injured soldiers. A new development in the management of battlefield injury has been the deployment of surgeons forward on the battlefield. In the 1990 military action in Panama, the US Army for the first time fielded units designated as Forward Surgical Teams (FST). These were distinguished from lower tiers of medical care by their advanced surgical capabilities, including trauma surgeons, an orthopedic surgeon, anesthesia, and nursing support situated forward of the traditional hospital setting. The next highest level of care, the Combat Support Hospital (CSH) was distinguished from the FST by the additional availability of subspecialty surgical and medical care, advanced imaging, laboratory and blood bank capability, and intensive postoperative care. The primary advantage of the FST is that it is small and mobile, allowing for the projection of resuscitative surgery to locations closer to the point of wounding. This purported advantage is counterbalanced by the relative resource constraints under which the FST must function. On the other hand, the CSH has comparably robust resources but lacks ease of mobility because of these same resources.

At the outset of US involvement in the current conflicts in southwest Asia, the US Army Institute of Surgical Research proposed and established a Joint Theater Trauma Reg-

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istry (JTTR) to track injury outcome data on casualties from all involved US military services. The current analysis was developed to assess the efficacy of the deployment of FSTs in reducing morbidity and mortality in comparison to the more adequately resourced CSH.

METHODS

As of April 2006, using Oracle Structured Query Language (Oracle Corporation, Redwood City, CA), records were obtained from the JTTR on all US military battle casualties admitted to a Level IIb (FST) and/or Level III (CSH) medical treatment facility. Data were gathered and tabulated for basic demographics, first level of care, mechanism of injury, injury severity score (ISS), ventilator and critical care days, and mortality outcomes. For the purposes of our review, those patients recorded as illnesses, nonbattle injuries, return to duty in less than 72 hours, or killed in action were excluded. Once the study cohorts had been identified, collation and analyses were done and statistical inference made using Chi square and Student's *t* tests.

RESULTS

We identified records from 2,617 US military personnel classified as injured in battle who had survived to be admitted to a FST or CSH and not returned to duty within 72 hours. The time period for this study commenced at the end of the maneuver phase of Operation Iraqi Freedom and continued through April 2006. These included 1,936 soldiers, 610 marines, 53 sailors, and 18 airmen. Of these, 77 died of wounds after being admitted to care and 2,540 survived. Of those who died, 15 had entered the military treatment system (MTF) at a FST and 62 had entered care at a CSH. Among those who survived, 649 entered the MTF care at a FST and 1,891 at a CSH. There was no suggestion of statistical significance in mortality between the two groups ($p = \text{NS}$).

To address the possibility that mortality among those going through FSTs was no better than those going straight to the CSH, because the FSTs were receiving worse injuries than the CSH, we examined mean ISS among those who had died of wounds (Table 1). The military ISS developed to take into account the special destructiveness of combat wounds demonstrated no difference in the severity of injury of those entering trauma care at the FST versus the CSH level. As an additional surrogate for injury severity, we examined mean numbers of theater days spent on ventilator support and mean days in the critical care unit (Table 2).

Table 1 Injury Severity and Outcome by Initial Level of Surgical Care

	FST	CSH	<i>p</i>
ISS (military)	35	32	0.14
Mortality	15/659 (2.3%)	62/1929 (3.1%)	NS
Mortality (ISS >25)	9/47 (19.1%)	27/136 (19.9%)	NS

Table 2 ICU Ventilator Days in Theater

	FST	CSH	Student's <i>t</i> Test
μ Ventilator days	1.6	1.3	$p = 0.02$
μ Critical care days	2.9	2.5	$p = 0.09$

Table 3 Outcomes by Mechanism of Injury

	IED, GSW or Grenade	All Others	Total
WIA-DOW	67	10	77
WIA-survived	1902	638	2540
Total	1969	648	2617

IED, improvised explosive device; WIA, wounded in action.
 $p = 0.05$.

Table 4 Outcomes by Anatomic Site of Injury

	Head	Multiple Sites	All Others	Total
WIA-DOW	26	36	15	77
WIA-survived	378	924	1238	2540
Total	404	960	1253	2617

WIA, wounded in action.
 $p < 0.05$.

The only factors significantly influencing outcome in this analysis were mechanism of injury and anatomic site of injury, not the level of MTF providing initial surgical care. Injury by explosive devices and gun shot wounds were more likely to result in death than injury by any other mechanism; this difference approached statistical significance ($p = 0.05$) (Table 3). However, the most significant factor determining risk of death was traumatic brain injury (Table 4).

DISCUSSION

Optimal trauma care must blend the paradox of early therapeutic life-saving intervention versus the need for robust resources for definitive diagnosis, intervention, and intensive supportive care. We attempted to answer the question, does the availability of advanced surgical care on the battlefield improve outcome for seriously injured casualties. In this analysis of samples of similar injury severity, the mortality outcomes were not significantly different for the overall populations. To make sure this result was not an effect of disparity of injury severity between the two groups, we also evaluated mortality of injuries with ISS ≥ 25 and again found the results to be not significantly different. Of note, we did not attempt to stratify our results by age or gender because the active duty military personnel represented here were universally between 18 years and 44 years of age and the majority were male. In addition, it should be recalled that although our cohort includes only 77 deaths for whom the JTTR had complete data and thus our study has relatively low power. Although limited by the available data, our analysis suggests that the clinical outcomes of casualties initially treated at the

FST is comparable to those transported and treated directly at the CSH. It remains to be determined whether this observation is the result of a decrease in time interval from wounding to initial operative treatment for those transported to an FST, or whether in fact there is no demonstrable benefit to forward surgical resuscitative care followed by transport to the CSH for definitive treatment. Of course, there are also many intangible factors which impact both sides of the FST concept utility including operational factors, evacuation doctrine, command ownership, etc., which are beyond the scope of this analysis.

The concept of the deployment of FSTs during maneuver warfare has proven itself consistently.^{6–17} Once the maneuver phase has ceased, the most efficient utilization of battlefield medical treatment facility resources swings in favor of the CSH.¹³ The disparity between the availability of the highest level of injury care and the ability to care for injury as soon as possible after it has occurred is not a new concept. As noted in the introduction, these issues are being confronted in the civilian community by recognition of the need to regionalize advanced level trauma care. Our data suggest that these issues are as important in the resource-constrained environment of the modern battlefield.

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