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*C. G. Blood
G. J. Walker
R. Bias
E. Kay
E. J. Carlson
R. P. Brackett
J. Sonderman*

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NAVAL HEALTH RESEARCH CENTER
P. O. BOX 85122
SAN DIEGO, CA 92186-5122

BUREAU OF MEDICINE AND SURGERY (MED-02)
2300 E ST. NW
WASHINGTON, DC 20372-5300



**An Assessment of the Potential for Increasing the Salvageability of
Critical Combat Traumas Through First Responder Interventions**

Christopher G. Blood, M.A., J.D.
G. Jay Walker, B.A.*
Ray Bias, CAPT, USNR¹
Edmond Kay, M.D.²
Edward J. Carlson, M.Ed.³
Richard P. Brackett, PA⁴
Joseph Sonderman, B.A.⁵

Naval Health Research Center
P.O. Box 85122
San Diego, CA 92186-5122

*GEO-CENTERS, Inc.
4640 Forbes Blvd., Ste. 120
Lanham, MD 20706

¹Acadian Ambulance Service, Inc.

²University of Washington, Seattle, WA

³Transocean, Inc., Houston, TX

⁴Harbor Medical, LLC Urgent Care Clinic, Boothbay Harbor, ME

⁵Symphony Mobilex, Columbus, OH

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SUMMARY

Introduction

Studies have shown that the immediate medical response to serious battlefield injuries can have a critical impact on the survivability of the casualty and on possible long-term impairments. Deployment of new medical equipment and/or training of medical first responders may yield reductions in combat deaths and improvements in quality of life.

Objective

The objective of this study was to examine clinical records of wounded military combatants who initially survived but later died at a medical treatment facility to assess whether interventions by first responders utilizing present-day technologies or training might yield a difference in the salvageability of the casualty.

Methods

Former corpsmen/medics with combat experience were recruited to review the clinical records of 100 combat trauma cases that died of wounds, and to assess the preventability of death if the traumas were sustained today. The former first responders were also asked to provide judgments as to which currently available medical technologies and/or training might make a lifesaving difference.

Results

On average, in 84% of the cases, the former first responders felt that no present-day actions on the part of a corpsmen/medic would even marginally increase salvageability. In 4% of the cases, a majority of the former corpsmen/medics judged the casualty as possibly salvageable with present-day technologies and training. The technologies most frequently cited as likely to yield gains in salvageability included medical anti-shock trousers, sufficient blood replacement fluids, bag valve masks, and hemorrhage control devices. Training most prominently mentioned included endotracheal or chest intubation, advanced trauma life support and intravenous fluid therapy.

Conclusions

The former first responders reviewing the clinical records indicated that only a small percentage of the "died of wound" cases reviewed in this study might be salvageable with specific technologies and training in the hands of present-day first responders.

An Assessment of the Potential for Increasing the Salvageability of Critical Combat Traumas Through First Responder Interventions

INTRODUCTION

Studies of soldiers wounded on the battlefield have highlighted the importance of treating trauma injuries within a relatively narrow time frame after wound sustainment.^{1,2} The medical responses that occur between the time an injury is sustained and the expiration of the “Golden Hour”¹ can have a critical impact on whether the life is saved and/or whether long-term impairments are incurred. Typically, the “first responder” to reach a wounded Marine or soldier on the battlefield is the hospital corpsman or medic organic to the combat unit. For the Marines, Fleet Marine Force (FMF) corpsmen are considered the first echelon of battlefield medical care, and their medical training typically includes skills such as intravenous (IV) therapy, emergency cricothyroidotomies, hemorrhage control, endotracheal intubation, suture application, and needle thoracentesis.^{3,4} The FMF corpsman will typically do all he can for the wounded Marine, and then evacuate the patient to the next level of care, which will usually be a facility that has higher-level surgical and stabilization capabilities. Army medics largely have similar training and approaches to care.

Even with corpsmen or medics in close proximity, access to a wounded soldier in the heat of battle can be challenging.⁵ More difficult yet may be rapid evacuation of the wounded individual to a medical treatment facility. Because access to the wounded and evacuation options can be limited, it is crucial that first responders have optimum training and equipment at their disposal for treating the wounded individual. Toward that end, the objective of the present study was to survey first responders who have combat experience to determine their perceptions as to whether certain equipment or training might make a life-saving difference on the battlefield if it were available in future combat operations.

METHODS

A Naval Health Research Center inpatient database⁶ identified 960 U.S. Marines serving in Vietnam who died of battle wounds after reaching a medical treatment facility. These medical facilities consisted of combat zone hospitals, communications zone hospitals, casualty receiving and treatment ships, and in a few instances, hospitals in the continental United States. One hundred of the 960 died-of-wound (DOW) casualties were randomly selected for inclusion in the study's sample. Diagnoses, dates of admission, hospitalizations, and service numbers of these 100 DOW casualties were then extracted from the inpatient database. Clinical records for these casualties were then requested and obtained from the National Personnel Records Center in St. Louis, Missouri. The degree of detail within each clinical record varied. Most obtained clinical records included documentation regarding courses of treatment and autopsy findings; some records, however, were limited to nurse's and/or doctor's notes, or relatively brief descriptions of wounds and causative agents.

Four former FMF corpsmen and one Army medic were recruited to participate in the examination of the DOW clinical records. Each of these first responders had to meet two requirements for participation in the study: (1) they must have had combat experience, and (2) they must have remained at least peripherally involved in a medical field subsequent to separation from service. All five of the former corpsmen/medics chosen served in Vietnam and continued on with their medical education and career following their combat deployment. One of the first responders went on to become a physician and worked directly in emergency medicine for 10 years; a second became certified as a physician's assistant and has continued to work in emergency medicine and urgent care to the present time; a third obtained a bachelor's of science in nursing and became a certified Emergency Medical Technician (EMT)-Paramedic, serving as a trauma nurse aboard the *USS Comfort* during Desert Storm/Shield; the fourth and fifth selected corpsmen also became EMTs after their service ended and stayed involved in

emergency medicine – one was a reservist who later became a paramedic and served as a corpsman in Operation Desert Shield.

Prior to forwarding the 100 clinical records to the former first responders, personal identifying information of both patient and medical staff were removed. A separate electronic questionnaire for each of the 100 trauma cases was provided to each first responder. This questionnaire is displayed as Figure 1. The first responders were asked to examine the clinical record for each trauma case and then complete a survey to assess the likelihood that a first responder's actions would increase the chance of survival if the trauma were sustained today and present-day technologies and training were available to the first responder. The five reviewers evaluated records independently without any interactions with the other first responders. In addition to completing the survey for each of the 100 trauma cases, a second survey queried the first responders about their own combat experience. This survey is seen as Figure 2.

Figure 1. Surveys completed by first responders for each of 100 trauma cases.

RECORD 002

- Do you believe there are actions that could be taken by the first responder that would increase the patient's chance of survival if this trauma were to occur today?
 Yes No Can't determine
 If "yes", what actions would increase the probability of salvageability and explain why you believe so? If "no", please explain why you believe no actions would improve salvageability chances
- If the actions cited above would increase the patient's chances of survival if taken by a first responder, how much of an effect do you believe these actions would have?
 Life definitely salvageable
 Life possibly salvageable; subsequent 'quality of life' expected to be okay
 Life possibly salvageable; subsequent 'quality of life' questionable
 Only a marginal increase in salvageability
 No actions taken by a first responder would increase this patient's survivability.
- What, if any, medical equipment, medicine, or technologies that could now be deployed with corpsmen do you believe would reduce the probability of death if such a trauma case were sustained today? Please explain.
- What training that can be given to corpsmen do you believe would reduce the probability of death if such a trauma were to be sustained today?

Figure 2. Survey examining personal battlefield experiences of first responders

TRAUMA CORPSMAN EXPERIENCE SURVEY
(Fill out after completing all record reviews)

Please answer the following general questions without regard to a specific trauma case.

- From your experience, what were the average and maximum distances between a deployed corpsman and a Marine wounded on the battlefield?
 Average Distance:
 Maximum Distance:
- From your experience, what are typical lengths of time for a corpsman to reach a wounded Marine?
- From your experience, what are the major obstacles to reaching a wounded soldier?
- From your experience, what are the typical constraints to battlefield treatment of the wounded?
- What suggestions would you offer for the improvement of combat casualty care prior to the wounded individual's arrival at an Echelon II or III medical treatment facility?

RESULTS

Cause of Death and Wounding Agents

Over half of the 100 casualties examined died as a result of gunshot wounds, while another 22% died of wounds related to injuries from unspecified explosive devices. The wounding agents, along with their respective percentage distributions, are listed below in Table 1.

Table 1. Wounding Agent in Fatal Battlefield Traumas

Weapon	Percent
Gunshot	55%
Explosive device	22%
Booby trap	6%
Mortar	5%
Mine	5%
Shrapnel	4%
Gasoline fire	1%
Grenade	1%
Downed helicopter	1%
Total	100%

The distribution of the causes of death, as extracted from the patients' hospital records, are displayed in Table 2. Nearly half of the casualties succumbed to head injuries: intracranial injury; cerebral edema, hematoma, and hemorrhage; cerebral anoxia; and brain stem injury. Hemorrhage, sepsis, severe burns and pulmonary edema were also noted as the cause of death in the clinical records for multiple casualties.

First Responder Actions and Salvageability

When asked whether first responder actions would increase the patient's chance of survival if the injury were sustained present-day, in an average of 83.8% of the trauma cases reviewed, the reviewers felt no present-day actions would make a difference in salvageability. For 7.6% of the cases reviewed, the first responders believed that actions might be taken that would increase the chance of salvageability – but that

the increase in salvageability would only be marginal or the subsequent quality of life would be questionable. There were an additional 4.6% of the cases where first responders believed that present day actions by a corpsman/medic would either make the life definitely salvageable, or would make the life possibly salvageable with the subsequent quality of life expected to be okay. Table 3 displays the distribution of responses of the individual medic/corpsmen by perceived change in salvageability and expected subsequent quality of life if the trauma were to be sustained present-day with available technologies/training. The kappa statistic,⁷ a traditional measure on inter-rater reliability, yielded a value of 0.228 when the level of agreement was analyzed. This level represents “fair” agreement.⁷

Table 2. Recorded Causes of Death in Fatal Battlefield Traumas

Cause of Death	Percent
Intracranial injury	31%
Hemorrhage	22%
Cerebral Edema, hematoma, and hemorrhage	12%
Sepsis	6%
Severe burns	6%
Brain stem injury	5%
Pulmonary edema	5%
Severe full body trauma	2%
Atelectasis	1%
Cerebral anoxia	1%
Flail chest	1%
Hemopneumothorax	1%
Hemothorax	1%
Hepatic trauma	1%
Laceration to major blood vessel	1%
Necrotizing bronchopneumonia	1%
Pneumothorax	1%
Severe lung contusion	1%
Spinal cord injury	1%
Total	100%

Table 3. Responses to Question of Degree of Increase in Salvageability if Trauma Were Sustained Today

	First Responder					Average
	A	B	C	D	E	
No – no increase in salvageability if sustained today	72%	70%	92%	94%	91%	83.8%
Yes, trauma is possibly salvageable with questionable QOL,* or there is but marginal increase in salvageability	10%	24%	0%	3%	1%	7.6%
Yes, trauma is either definitely salvageable, or trauma is possibly salvageable with QOL* expected to be okay	13%	3%	2%	3%	2%	4.6%
Can't Tell – not enough information in clinical record	5%	3%	6%	0%	6%	4.0%
TOTAL	100%	100%	100%	100%	100%	100%

*QOL = Quality of Life

Among the 100 reviewed trauma cases, there were 62 cases where the five reviewers were unanimous in their belief that the victim would still be unsalvageable if the trauma were sustained today. Among the remaining 38 trauma cases, there were a total of 61 instances where a first responder believed that some increase in potential salvageability existed present-day through available technologies/training in the hands of corpsmen/medics. Table 4 indicates that in 17 of these 38 cases, two or more first responders were in agreement that an increase in salvageability was possible with presently available technologies/training.

Table 4. Agreement Levels in 38 Trauma Cases Where at Least One First Responder Thought Present-Day Salvageability Increased

No. of Responders Believing Increase in Salvageability Possible	Number of cases
1 responder	21
2 responders	13
3 responders	3
4 responders	0
5 responders	1
Total	38

Among the 38 casualties where at least one first responder believed the salvageability could be increased, 19 died of hemorrhages. This number represents 86% of the 22 traumas reviewed in which the cause of death was listed as hemorrhage. Of the 5 cases in which pulmonary edema was the cause of death, 3 were judged by at least one first responder to have a potential increase in salvageability with present-day technologies in the hands of corpsmen/medics. Similarly, 3 of the 6 trauma cases that ultimately died of sepsis were believed by at least one first responder to have potential increases in salvageability. Conversely, of the casualties reviewed that ultimately succumbed to burns, intracranial injuries, and cerebral hematomas, none were judged to have even a marginal increase in salvageability if the trauma were sustained today.

The one DOW casualty believed by all five former first responders to have an increase in salvageability died of cerebral anoxia. Three other traumas in which three of the first responders were in agreement that an increase in salvageability was possible indicated the cause of death as hemorrhage. Of the 13 trauma cases with two first responders in agreement, eight died of hemorrhage and the other five cases listed the causes of death as atelectasis, spinal cord injury, flail chest, hepatic trauma, and laceration of major blood vessels.

Technologies and Training

Tables 5 and 6 indicate the numbers of times among the 38 potentially salvageable traumas that the reviewers indicated specific technologies or training that might yield an increase in salvageability if made available to today's first responders.

Table 5. Equipment/Supplies Most Prominently Mentioned to Yield Increased Salvageability of Critically Wounded Soldiers

Supplies/Technologies	Number of Mentions
Medical anti-shock trousers (MAST)	24
Replacement intravenous fluids	16
Bag valve masks (BVM)	10
Tourniquets/arterial clamps/hemostats	10
Needle chest decompression devices	3

As can be seen in Table 5, medical anti-shock trousers (MAST) and sufficient intravenous fluids were the most frequently mentioned supplies/technologies likely to increase salvageability among critically wounded soldiers if in the hands of today's first responders. Other supplies prominently cited as potentially leading to increased salvageability included bag valve masks and hemorrhage control equipment.

Table 6 indicates that the first responder training the reviewers thought most likely to effect an increase in salvageability among critically injured soldiers included training provided in various methods of intubation (endotracheal, chest, rapid sequence) and in advanced trauma life support (ATLS). Intensive training in IV fluids administration and in hemorrhage control also were cited multiple times.

Table 6. Training Most Prominently Mentioned to Yield Increased Salvageability of Critically Wounded Soldiers

Training	Number of Mentions
Endotracheal/Chest/Rapid Sequence Intubation	30
Advanced Trauma Life Support (ATLS)	23
IV fluid therapy	19
Hemorrhage control	5

Former First Responder Experiences

After reviewing the trauma records and completing the corresponding surveys, the former corpsmen/medics responded to questions about their own experiences during combat operations. Topics ranged from distance and time estimates of reaching and treating wounded soldiers to typical constraints and major obstacles encountered in the treatment process. All five reviewers reported the average distance between a deployed corpsman/medic and the wounded soldier in their experience was under 100 meters — two stated it averaged no more than several meters, while the remaining three estimated ranges between 50 and 100 meters. Maximum distance estimates were more dispersed. Two responders reported a maximum of a quarter mile, while the other three reported maximum distances between several yards and 150 yards. When asked about the typical length of time it took for a first responder to reach a wounded soldier, one

reviewer reported less than one minute, three reviewers estimated between one and two minutes, and the fifth respondent estimated a span of five to ten minutes.

Major Obstacles and Constraints

When asked about the major obstacles in reaching a wounded soldier, all five former first responders cited hostile enemy fire. The difficulties of administering to injuries at night, the terrain, the danger of traps, and communication difficulties were also cited as primary impediments.

Multiple simultaneous traumas, and the often-accompanying insufficient supply stock, was cited in three surveys as a leading constraint to battlefield treatment of the wounded. Other combat conditions – unsecured locations, noise, dirt and contamination, terrain and evacuation delays – were indicated as additional complications. These conditions were generally stated to have hampered the processes of administering fluids, intubation, and general wound treatment. Lack of oxygen, bag valve masks and spinal immobilization equipment were also cited as constraints by the first responders based on their own battlefield experiences.

Suggestions for Improved Care

Finally, the former first responders were queried as to possible mechanisms for improving combat casualty care prior to arrival at an echelon II or III medical treatment facility. As was indicated previously, the area of IV therapy/techniques was frequently cited for potential improvement in prehospital combat casualty care. In addition, improved evacuation and ATLS training were cited by three of the first responders as ways of improving battlefield care. Further, training in advanced cardiac life support, cervical collar spinal control, and endotracheal intubation were each recommended by two of the first responders, while each of the following were cited once as technologies/supplies that would improve pre-hospital care: compact cardiac monitor and defibrillator, cardiac drugs in the field, extended spectrum antibiotics, and portable vital sign monitors and equipment. Finally, one reviewer suggested that first responders be formed into two-person units that would remain together to provide care on the battlefield.

SUMMARY

Five former first responders with battlefield experience as a corpsman/medic and subsequent medical experience after discharge each reviewed 100 clinical records of soldiers wounded in combat who subsequently died of their wounds. The former first responders were surveyed as to which, if any, present-day technologies and/or training, if made available to today's first responders, would make a difference in the salvageability of each trauma case reviewed. In an average of 83.8% of the cases, the first responders thought no intervention by a corpsman or medic could make a difference in salvageability; in another 7.6% of cases it was believed that any difference would be marginal or that the subsequent quality of life would be questionable. However, in 4.6% of the trauma cases, the first responders indicated that the actions of a present-day corpsman/medic might increase the salvageability of the casualty with the subsequent quality of life expected to be okay. The equipment and supplies most frequently cited to yield gains in salvageability included medical anti-shock trousers, sufficient blood replacement fluids, bag valve masks, and hemorrhage control devices. Training most prominently cited by the first responders as potentially affecting increases in salvageability included endotracheal or chest intubation, advanced trauma life support, and intravenous fluid therapy.

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13. SUPPLEMENTARY NOTES

14. ABSTRACT (maximum 200 words)

Five former first responders with battlefield experience as a corpsman/medic and subsequent medical experience after discharge each reviewed 100 clinical records of soldiers wounded in combat who subsequently died of their wounds. The former first responders were surveyed as to which, if any, present-day technologies and/or training, if made available to today's first responders, would make a difference in the salvageability of each trauma case reviewed. In an average of 83.8% of the cases, the first responders thought no intervention by a corpsman or medic could make a difference in salvageability; in another 7.6% of cases it was believed that any difference would be marginal or that the subsequent quality of life would be questionable. However, in 4.6% of the trauma cases, the first responders indicated that the actions of a present-day corpsman/medic might increase the salvageability of the casualty with the subsequent quality of life expected to be okay. The equipment and supplies most frequently cited to yield gains in salvageability included medical anti-shock trousers, sufficient blood replacement fluids, bag valve masks, and hemorrhage control devices. Training most prominently cited by the first responders as potentially effecting increases in salvageability included endotracheal or chest intubation, advanced trauma life support, and intravenous fluid therapy.

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