Identification of Procedures and Capabilities Required to Ensure Survival of Prolonged Field Care and Medical Evacuation

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FINAL REPORT

Date: 16 January 2024

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DECLARATION OF INTEREST

The views expressed are those of the authors and do not reflect the official views or policy of the Department of Defense or its Components. The voluntary, fully informed consent of the subjects used in this research was obtained as required by 32 CFR 219 and DODI 3216.02. This work was funded by Project Code Number J917EC02. Authors are military service members, employees, or contractors of the U.S. Government. This work was prepared as part of their official duties. Title 17 USC §105 provides that 'copyright protection under this title is not available for any work of the U.S. Government.' Title 17 USC §101 defines a US Government work as a work prepared by a military service member, employee, or contractor of the U.S. Government as part of that person's official duties.

NOTICE AND SIGNATURE PAGE

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE	**2. REPORT TYPE**	**3. DATES COVERED**
16 Jan 2024	Final Report	October 2017 – January 2023

4. TITLE AND SUBTITLE

Identification of procedures and capabilities required to ensure survival following prolonged field care

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
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5d. PROJECT NUMBER
J917EC02

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
59MDW/ECRC
3698 Chambers Pass, San Antonio TX 78234

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
Distribution A: Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT-

Introduction: Emergent clinical care and patient movement through the military evacuation system improves survival. Patient management differs when transporting from the point-of-injury (POI) to the first medical treatment facility (MTF) versus transporting from the Role 2 to the Role 3 (R2-R3) MTF secondary to care rendered within the MTF, including surgery and advanced resuscitation. The objective of this study was to describe care provided to patients during in theater inter-facility transports and compare with pre-hospital transports (POI to first MTF). **Methods:** We performed a retrospective chart review of patients with R2-R3 transports from 2007 to 2016. Data collected included procedures and events at the MTF and during transport. We compared the intra-theater transports data (R2-R3) to data from a previous study evaluating prehospital transports (POI to first MTF). **Results:** We reviewed records of 869 R2-R3 transport patients. R2-R3 transports were longer in duration compared to POI transports and were more likely to be staffed by advanced personnel. Survival rates were slightly higher among R2-R3 transports. **Conclusions:** Inter-facility transports (R2-R3) are longer in duration, transport more complex patients, and are staffed by more advanced level provider types compared to transports from POI.

15. SUBJECT TERMS- intra-theater transports, Role 2, Role 3, military evacuation

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT:**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
			UU	8	Col Joseph Maddry, MD
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			**19b. TELEPHONE NUMBER** *(include area code)*
U	U	U			210-539-2834

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1.0 EXECUTIVE SUMMARY

Emergent clinical care and patient movements through the military evacuation system improves survival. Patient management differs when transporting from the point-of-injury (POI) to the first medical treatment facility (MTF) versus transporting from the Role 2 to the Role 3 (R2-R3) MTF secondary to care rendered within the MTF, including surgery and advanced resuscitation. The objective of this study was to describe care provided to patients during in theater inter-facility transports and compare with pre-hospital transports (POI to first MTF).

2.0 INTRODUCTION

The Department of Defense (DoD) medical personnel are tasked with determining how to stabilize combat casualties when a Military Treatment Facility (MTF) with surgical capabilities are not available for up to 72 hours after the time of injury.[1,2] To address this challenge, it is necessary to understand the capabilities, such as damage control and stabilization interventions, required to ensure the survival of a patient long enough to reach a definitive level of care. In combat operations, patients with traumatic injuries require urgent clinical care and expeditious evacuation to improve survival.[3] Ground medics deployed in the field are often the first responders but have limited capabilities and supplies. Aeromedical evacuation platforms such as US Army Medical Evacuation (MEDEVAC) allow for urgent evacuation to Role 2 or Role 3 facilities that provide higher levels of care. MEDEVAC transport times may vary depending on environmental factors and the ability to land in combatant locations.[4] Previous data has shown that longer transport times are associated with increased morbidity and mortality.[5,6,7]

During the conflicts in Iraq and Afghanistan, the implementation of Secretary Gates' "golden hour" policy resulted in the establishment of multiple dispersed Role 2 military treatment facilities. [7] This policy enforced the rapid transport of combat casualties to damage control surgery and resuscitation.[7] With this forward surgical capability came the need to transport post-operative combat casualties from the Role 2 MTFs to the more advanced Role 3 MTFs. The MEDEVAC system was designed predominately for the evacuation of casualties from the field of combat and pre-surgical trauma management.[8] Those patients transported from a Role 2 to a Role 3 following damage control surgery and/or resuscitation are significantly different from those transferred from the point of injury. To address this difference, the US Army has intermittently supplemented the standard paramedic based MEDEVAC with critical care flight nurses though not consistently.[9] Conversely, the Air Force Critical Care Air Transport Team (CCATT) consisting of an emergency medicine or critical care physician, an emergency or critical care nurse, and a respiratory therapist functions as a "flying ICU" and has been employed in Role 2 to Role 3 inter-facility transports.[10] However, CCATT predominately functions within fixed-wing aircraft, so they are usually limited to transport from Role 2s possessing an airfield.

Staudt et al. evaluated data from the Joint Trauma System (JTS) database and described patients treated at a Role 2 and subsequently evacuated to a Role 3 in Afghanistan.[11] This study provided a description of patient characteristics and the en route care personnel but did not abstract data from the individual flight medical records or evaluate patient outcome data. The authors advocated for future studies to evaluate the care provided during Role 2 to Role 3 MTF transports as well as short- and long-term outcomes based on en route care provider skill level. Accordingly, we conducted a study describing the interventions performed during aeromedical

evacuation from a Role 2 to a Role 3, the aeromedical evacuation team performing the transport, and the association with 30-day patient outcomes.

3.0 METHODS, ASSUMPTIONS, PROCEDURES

We performed a retrospective chart review of patients with R2-R3 transports from 2007 to 2016. Data collected included procedures and events at the MTF and during transport. We compared the intra-theater transports data (R2-R3) to data from a previous study evaluating prehospital transports (POI to first MTF).

4.0 MAJOR EVENTS/MILESTONES/SUCCESS

We successfully met the following milestones:

- Received IRB approval January 2018
- Identified patient populations from Department of Defense Trauma Registry (DoDTR) in September 2018
- Collected, extracted and cleaned CCATT data from Pilot Unit and MEDEVAC data from JTS by September 2019
- Linked 30 day outcomes with DoDTR by December 2019
- Completed analysis December 2020
- Manuscript written and accepted to Military Medicine in September 2023, published 7 November 2023.

5.0 RISK ASSESSMENT

5.1 Risk Analysis:

Inadvertent breach of confidentiality was a risk for conducting this study. This risk was no greater than minimal and was similar to any other risk incurred during the delivery of medical care rendered prior to study enrollment. These risks were mitigated by strict adherence to regulatory, study, and ECRC policies ensuring safeguards for protecting PHI. Comprehensive, master, study dataset was de-identified prior to analysis.

5.2 Technical Challenges

First, this is a retrospective chart review and our findings may be limited as a result of incomplete or missing data. Specifically, the task demands on transport providers vary by phase of transport and may result in different documentation practices for Role 2 to 3 transports compared to transports from POI. The use of data abstractors has the potential for subjectivity; however, thorough chart abstraction, substantive abstractor training and quality review procedures were implemented to limit subjectivity. Second, variations in documentation practices between MEDEVAC and CCATT units may impact consistency of the data within the Role 2 to 3 cohort. Third, while this study found significant differences between the transports from POI and the transports between facilities, we cannot assert any causality with regards to outcomes. With regards to external validity, this study focused on military trauma patients during Operation Iraqi Freedom/Operation Enduring Freedom (OIF/OEF) and our results may not be generalizable to the civilian community or other conflicts. Civilian patients and casualties in future military conflicts may have significantly different traumatic injuries and medical ailments than those discussed in our study.

6.0 TRANSITION PLAN

6.1 Military Relevance

Identifying these therapies will enable the DoD to establish what capabilities will be required to provide effective prolonged field care (PFC) and damage control resuscitation (DCR).

6.2 Transition Strategy

Knowledge gained from this study will inform the improvement and development of clinical practice guidelines. Findings have the potential to identify strengths and weaknesses of previous evacuation platforms and providers and inform tactical/medical planning for future conflicts.

7.0 RESULTS

We reviewed the records of 869 R2-R3 transport patients. R2-R3 transports were longer in duration compared to POI transports (39 minutes vs. 23 minutes) and were more likely to be staffed by advanced personnel (nurses, physician assistants, and physicians) (57% vs. 3%). The sample primarily consisted of military aged males (mean age 27 years) who suffered from explosive or blunt force injuries. Procedures performed during each phase of care reflected the capabilities of the teams and locations. Pain and cardiac events were more common in POI evacuations compared to the R2-R3 transports, but documentation of respiratory events, hemodynamic events, neurologic events, and equipment failure was more common during the R2-R3 transports. Survival rates were slightly higher among the R2-R3 cohort (98% vs. 95%, difference 3% [95% CI of the difference 1% to 5%]).

8.0 CONCLUSION/DISCUSSION

When compared to MEDEVAC transports from the POI, inter-facility transports within theater (Role 2 to Role 3) are longer in duration and utilize more advanced level provider types to transport patients of higher complexity. Military medical planning, training and resource allocation should consider these factors when preparing for future military operations.

9.0 DELIVERABLES

9.1 Publications

Maddry, JK, Arana, AA, et al. Management of Combat Casualties during Aeromedical Evacuation from a Role 2 to Role 3 Medical Facility. *Mil Med*. 2023; https://doi.org/10.1093/milmed/usad404

9.2 Presentations

Maddry JK, et al. Management of Combat Casualties During Aeromedical Evacuation From Role 2 to Role 3 Medical Facility. Poster.

- *Special Operations Medical Association Scientific Assembly*, 2022
- *Military Health System Research Symposium*, 2022
- *San Antonio Military Health System and Universities Research Forum*, 2023

10.0 COST

This project was funded by DHA (J9) in the amount of $376,000. All funds were expended.

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TABLES & FIGURES

Table 1. Definitions of events

Event Type	Definition
Pain	Increase in rate or dose of existing analgesia Start of new analgesia A documented complaint of pain As determined by medical provider to include: Headache, chest, abdominal, back, hip, leg/knee, arm/shoulder, muscle pain
Respiratory	As documented by medical provider to include: SpO2 ≤ 90% FiO2 increase >10% O2 L/min increase >4 ≥5 increase in PEEP
Hemodynamic	As documented by medical provider to include: SBP ≤90 or ≥180 or 20% change from baseline MAP ≤65 or ≥120 or 20% change from baseline CVP change from baseline of 5 HR <60 bpm or >120 bpm or 20% change from baseline
Cardiac	As determined by medical provider to include: Cardiac arrest Notable findings on electrocardiogram
Neurological	As determined by medical provider to include: Agitation, seizures, change in mental status, motor, cognitive, or sensory ability
Renal/urinary	As determined by medical provider to include: Oliguria (low urine output), dark urine, renal calculus
Temperature	Fever (body temperature ≥ 100.5 F or 38 C) Hypothermia (body temperature < 95 F or 35 C)
Equipment failure	As determined by medical provider to include: Propaq failure, battery failure, ventilator failure
Abnormal lab	Glucose (<70 or >105) Potassium (<3.5 or >5) Sodium (<136 or >145) PTT (>35)

Definitions from Maddry et al.[10]

Table 2. Patient and provider characteristics

Variable	Role 2 to Role 3 (n=869)	POI to 1st MTF† (n=1237)	Difference (95% CI)
Age, years	27 (7)	24 (5)	-3 (-4 to -2)*
Male gender	97%	99%	-2% (-3% to -1%)*
Highest provider type			
Paramedic	8%	21%	-13% (-16% to -10%)*
Medic	14%	76%	-62% (-58% to -65%)*
Advanced**	57%	3%	54% (51% to 58%)*
Not specified	20%	-	-
Injury severity score	13 (13)	14 (14)	-1 (-35 to 2)
ISS ≤10	57%	50%	-7% (-11% to -3%)*
ISS 11-19	21%	25%	-4% (-8% to -1%)*
ISS 20-29	12%	14%	-2% (-5% to 1%)
ISS 30-75	11%	12%	-1% (-4% to 2%)
Injury type			
Blast	42%	69%	-27% (-32% to -23%)*
Blunt	29%	2%	27% (24% to 30%)*
Penetrating	27%	28%	-1% (-4% to 4%)
Burn	2%	1%	1% (0% to 2%)
Flight time, minutes	39 (20)	23 (56)	-16 (-19 to -13)*

Values are mean (standard deviation) or percent of sample.
*Differences are statistically significant if the 95% confidence interval of the difference does not include zero.
**Advanced provider category included registered nurses, physician assistants, and physicians.
†POI to 1st MTF data are from Maddry et al.

Table 3. Procedures and in-flight medications during each phase of care

Transport from POI to first MTF (n=1237)†	At Role 2 (n=869)	Transport from Role 2 to Role 3 (n=869)
Supplementary oxygen (49%)	X-ray (89%)	Hypothermia prevention (53%)
Any medications (30%)	Intravenous access (78%)	Any medications (51%)
Analgesia (28%)	Fluids (70%)	Analgesia (44%)
Fluids (28%)	Hypothermia prevention (64%)	Supplementary oxygen (40%)
Intravenous access (22%)	Wound dressing/packing (61%)	Fluids (30%)
Pressure packing (13%)	Ultrasound (60%)	Mechanical ventilation (29%)
Hypothermia prevention (11%)	Stabilization/immobilization (52%)	Stabilization/immobilization (26%)
Spinal stabilization (6%)	Drains (43%)	Sedation (24%)
Intraosseous access (5%)	Supplementary oxygen (39%)	Paralytic (15%)
Tourniquet (5%)	Mechanical ventilation (30%)	Chest tube (7%)
Blood products (4%)	Intubation (29%)	Antiemetic (6%)
Nasal/oral airway (3%)	Blood products (26%)	Blood products (4%)
CPR (3%)	Tubes (23%)	Vasopressors (3%)
Splint/sling (2%)	Arterial line (16%)	Tourniquet (1%)
Chest needle (2%)	Central line (15%)	Wound dressing/packing (1%)
Intubation (2%)	Laparotomy (9%)	Parenteral access (1%)
Sedation (1%)	External fixator (9%)	Antibiotics (<1%)
Hemostatic agent (1%)	Fasciotomy (9%)	
Chest seal (1%)	Chest tube (8%)	
Defibrillation (1%)	Amputation (6%)	
Cricothyrotomy (1%)		
Chest tube (<1%)		

†POI to 1st MTF data are from Maddry et al.[8]

12.0 List of Symbols, Abbreviations and Acronyms

CCATT – Critical Care Air Transport Team
DCR - damage control resuscitation
DoD – Department of Defense
DoDTR – Department of Defense Trauma Registry
JTS – Joint Trauma System
MEDEVAC – Medical Evacuation
MTF – Medical Treatment Facility
OIF/OEF – Operation Iraqi Freedom/ Operation Enduring Freedom
PFC – Prolonged Field Care
POI – point-of-injury
R2-R3 – Role 2 to the Role 3