COMBAT CASUALTY MORTALITY: Survivability of Injury, Preventability of Death and their Implications to t Trauma System and the Warfighter

Combat Trauma Care Workshop
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Disclosure / Disclaimer

Nothing to disclose

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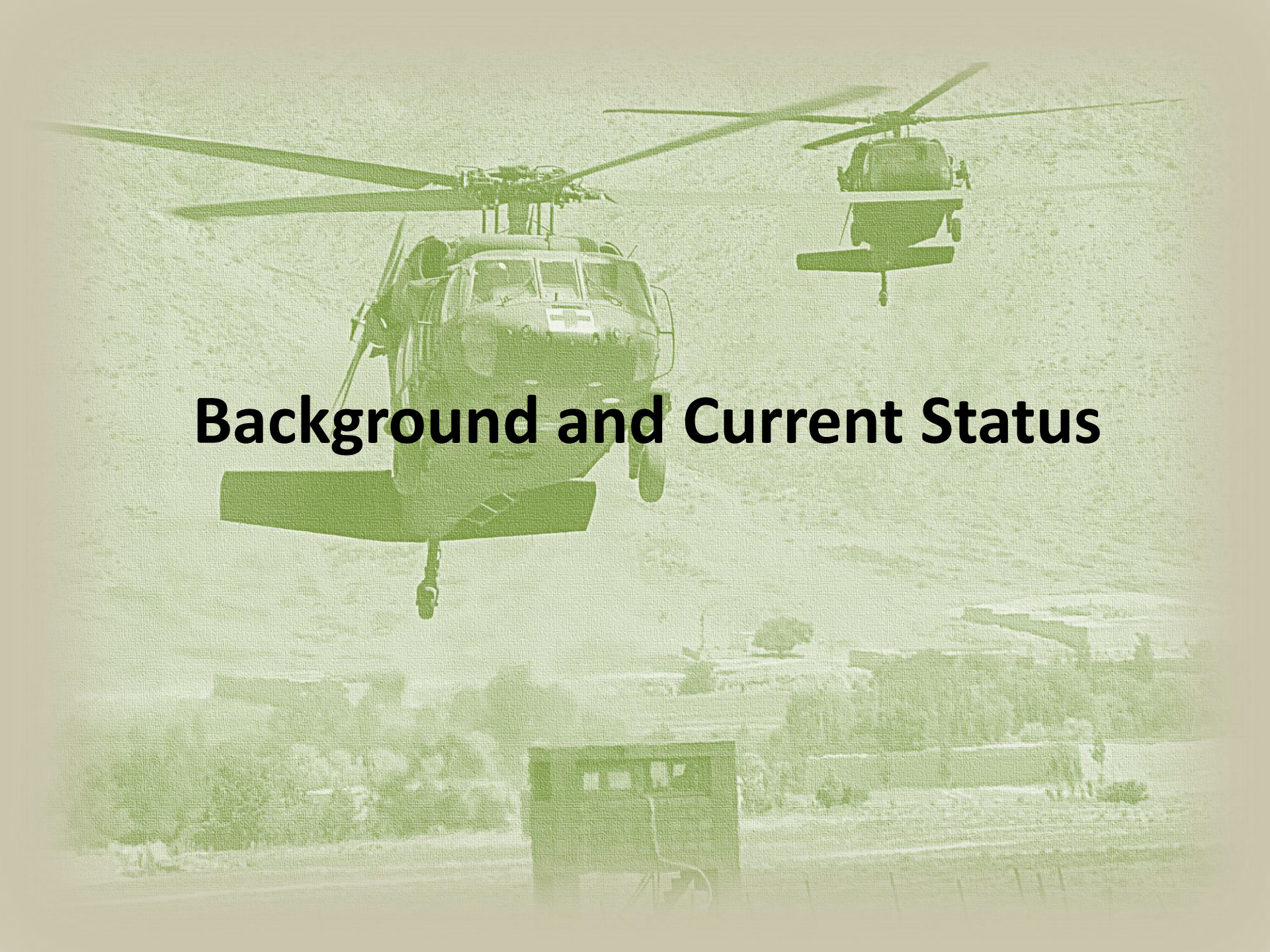
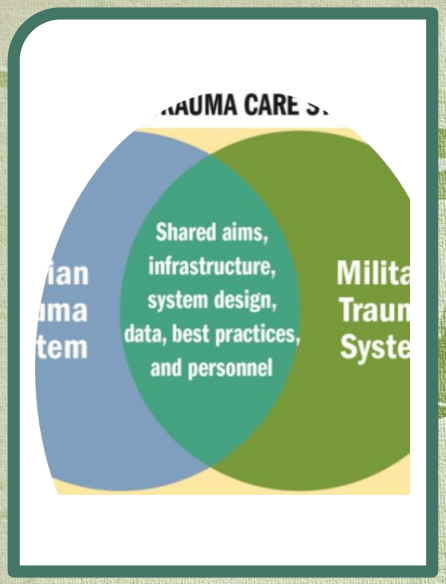
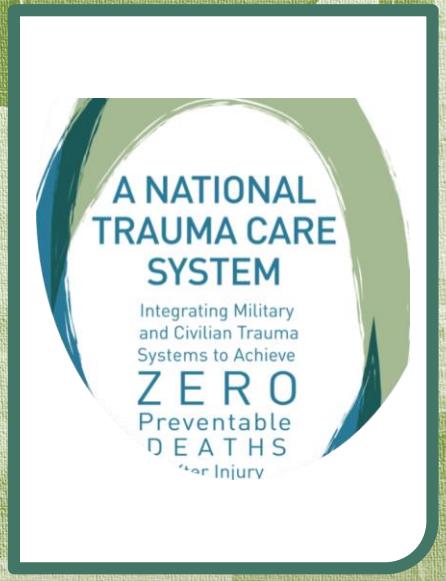


Background and Current Status





National Trauma System Vision

A unified effort is needed to ensure the delivery of optimal trauma care to save the lives of Americans injured within the United States and on the *battlefield.*

NASEM 2016

FINDINGS & RECOMMENDATIONS

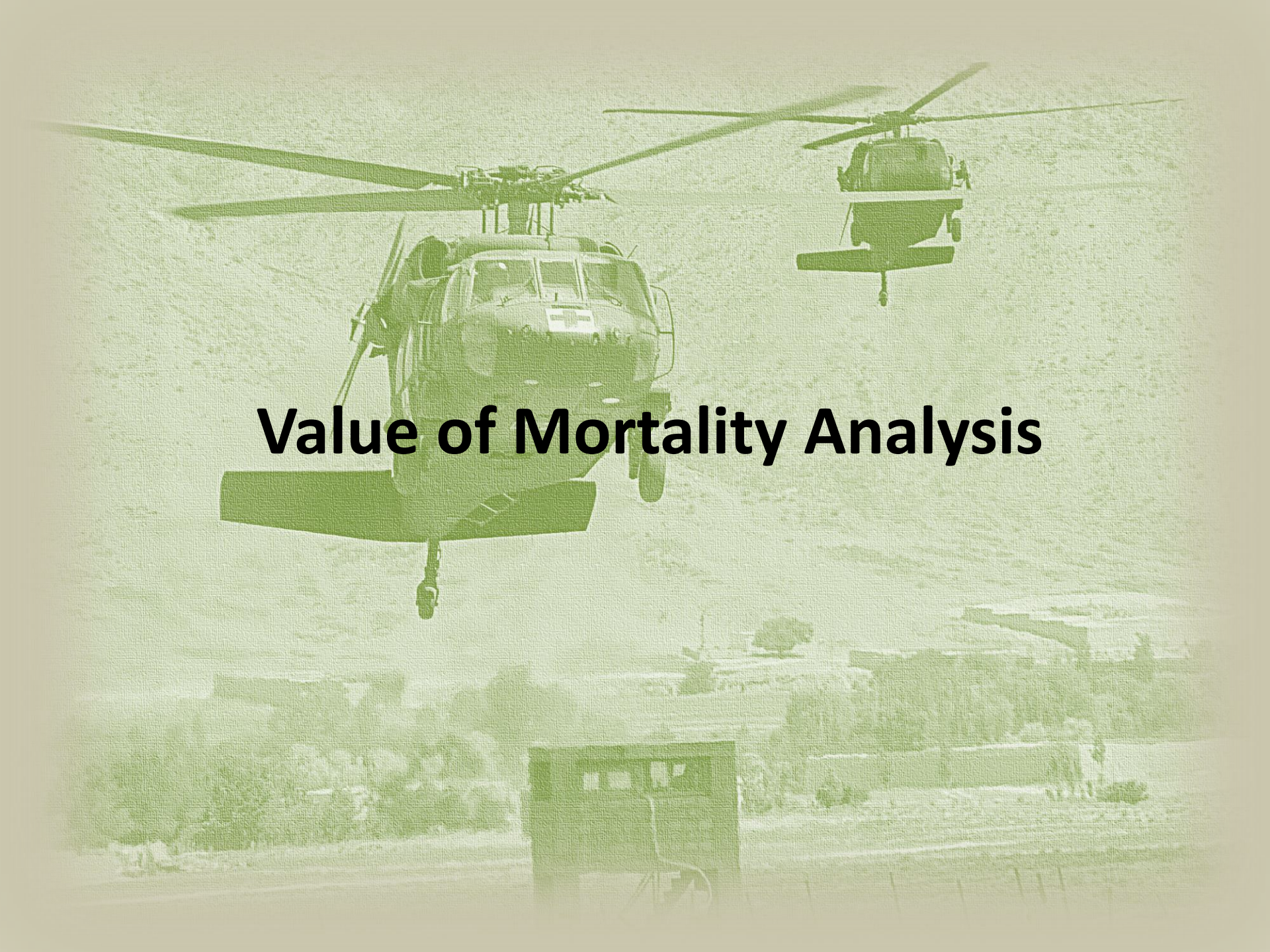
- The Aim (Rec 1)
- Role of Leadership
  - National-Level Leadership (Rec 2)
  - Military Leadership (Rec 3)
  - Civilian Sector Leadership (Rec 4)
- Integrated Military–Civilian Framework for Learning to Advance Trauma Care
  - Improving the Collection, Integration, and Use of Data (Recs 5 and 9)
  - Collaborative Research Infrastructure in a Supportive Regulatory Environment (Recs 7 and 8)
- Systems and Incentives for Improving Prehospital Trauma Care
  - Quality (Rec 10)
  - Developing Expertise (Recs 6 and 11)

Fundamental Gap

Missing Dead:
Trauma System Blind Spot

- 1. portion of a field that cannot be seen or inspected with available equipment
- 2. failure to exercise judgment or discrimination
- 3. lack of understanding or impartiality

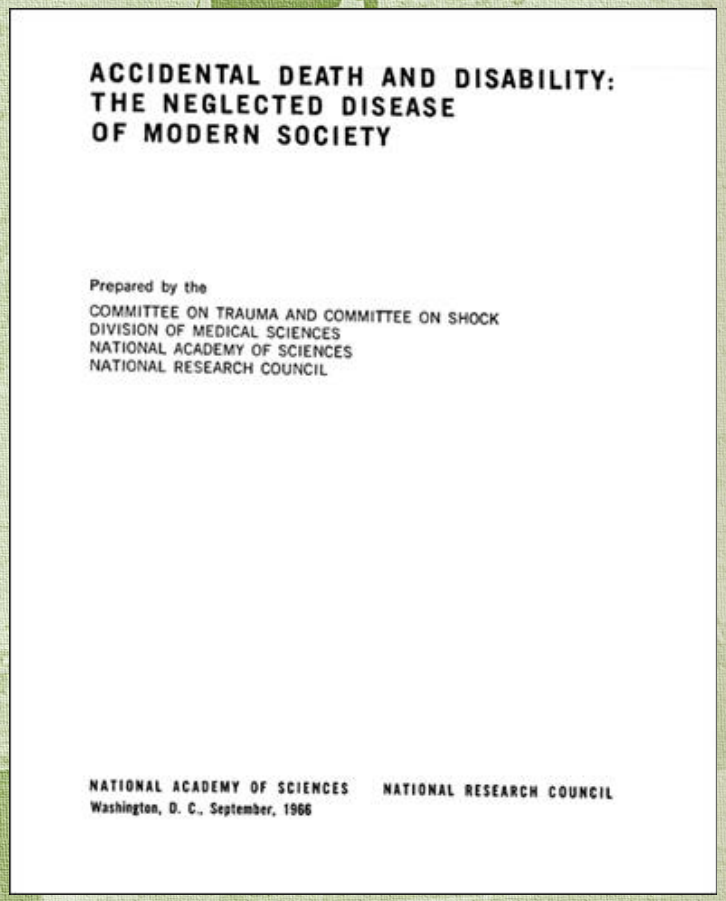
If we do not recognize it, we will not develop strategies to remediate



Value of Mortality Analysis

IOM Report 1966

“If this opportunity to ascertain the specific cause of death is to be grasped, complete autopsies must be performed routinely on those who have died as the result of injury. Furthermore, the findings in large numbers of autopsies must be critically analyzed in order to point the way to necessary changes in treatment.”



ACCIDENTAL DEATH AND DISABILITY:
THE NEGLECTED DISEASE
OF MODERN SOCIETY

Prepared by the
COMMITTEE ON TRAUMA AND COMMITTEE ON SHOCK
DIVISION OF MEDICAL SCIENCES
NATIONAL ACADEMY OF SCIENCES
NATIONAL RESEARCH COUNCIL

NATIONAL ACADEMY OF SCIENCES — NATIONAL RESEARCH COUNCIL
Washington, D. C., September, 1966

NASEM Findings
Medical Examiner Systems 2003

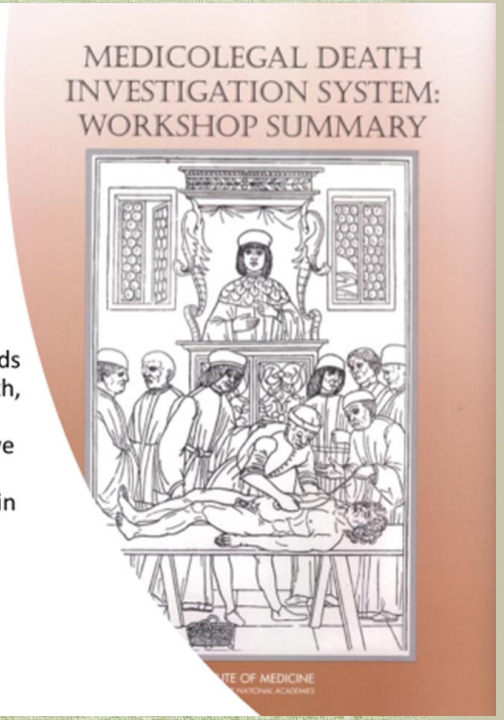
"The current practices of medicolegal death investigation in this country are in substantial need of improvement.

Need accurate data on the circumstances and causes of death

Valuable to public health which accrues to the benefit of the nation as a whole."

Value of a Functional Medical Examiner System

"On first glance, official identification of human remains and certification of the cause of death appear to be mundane endeavors that serve mainly private needs of families, insurers, and litigants. In truth, however, valid and reliable data on the circumstances and causes of deaths serve a variety of important public needs, including fair and accurate adjudication in criminal and civil cases, maintenance of accurate vital statistics, effective public health surveillance and response, advances in health and safety research, and improvement in quality of heath care."



NASEM Zero Preventable Death

Specific Recommendations for Mortality Analysis and ME System Integration

Gap:

Linkages are incomplete or entirely missing among prehospital care; hospital-based acute care; rehabilitation; and medical examiner data.

“A critical but often neglected source of data—particularly in civilian systems—is autopsy reports on trauma deaths, which could be used to determine the preventability of fatalities based on a common, accepted lexicon.”

Recommendation 5:

The Secretary of Health and Human Services and the Secretary of Defense, together with their governmental, private, and academic partners, should work jointly to ensure that military and civilian trauma systems collect and share common data spanning the entire continuum of care

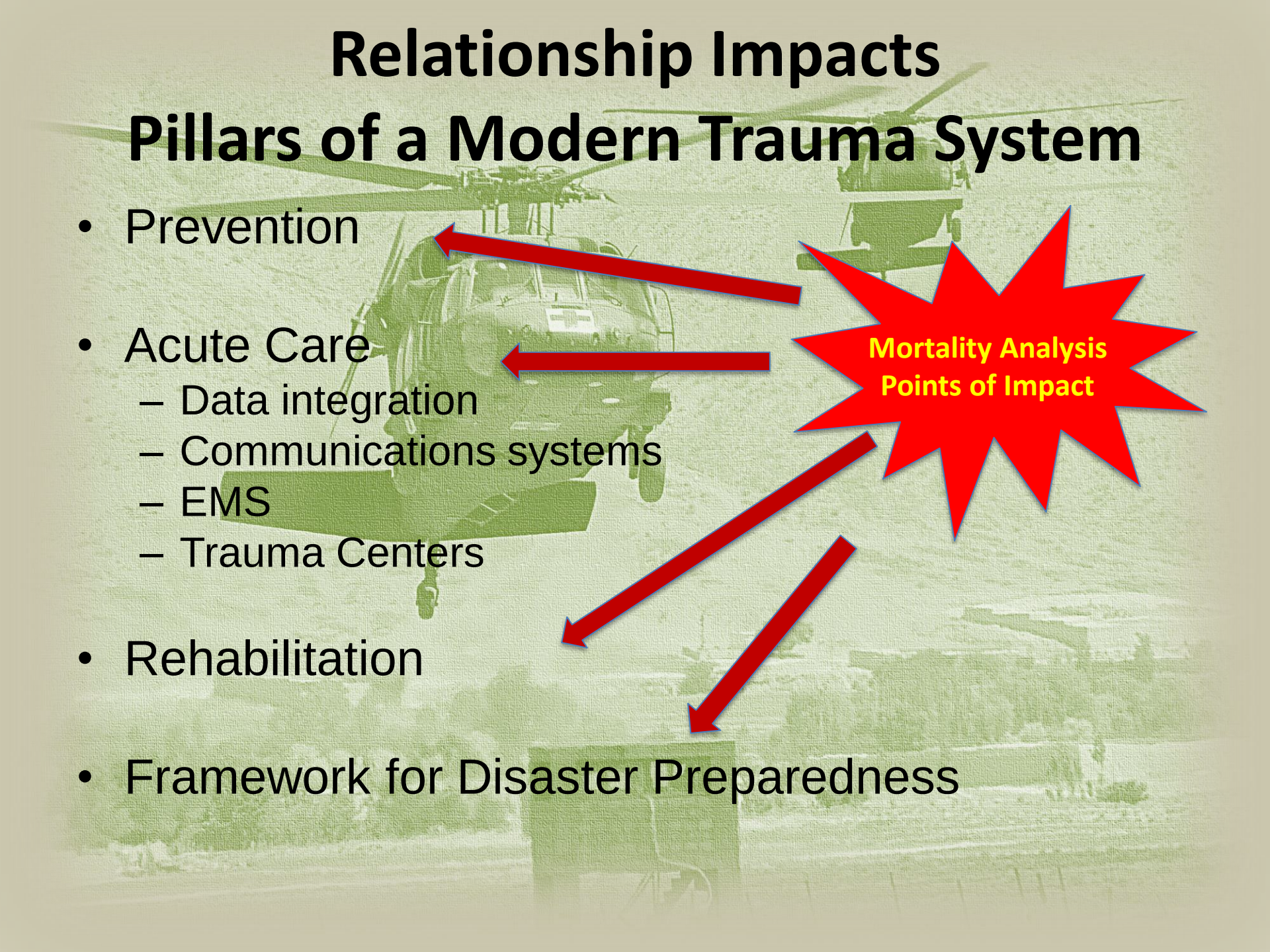
Understanding Combat Casualty Mortality: Developing Targets for Mitigation Strategies

- Advances in care in both trauma centers and trauma systems have substantially reduced death and disability associated with injury
- Substantial opportunity to further reduce deaths in pre-hospital setting.
  - Opportunities for trauma system improvement in pre-hospital environment must be identified and remediated in order to reduce the number of potentially preventable deaths.

Relationship Impacts

Pillars of a Modern Trauma System

- Prevention
- Acute Care
  - Data integration
  - Communications systems
  - EMS
  - Trauma Centers
- Rehabilitation
- Framework for Disaster Preparedness



Joint Trauma System

Learning Healthcare System

History of Battlefield Medical Innovation

OEF / OIF
- Military trauma system (JTS / DoDTR)
- Damage control resuscitation
- Tactical Combat Casualty Care
- Tourniquet
- Understanding of preventable death
- Combat casualty care research

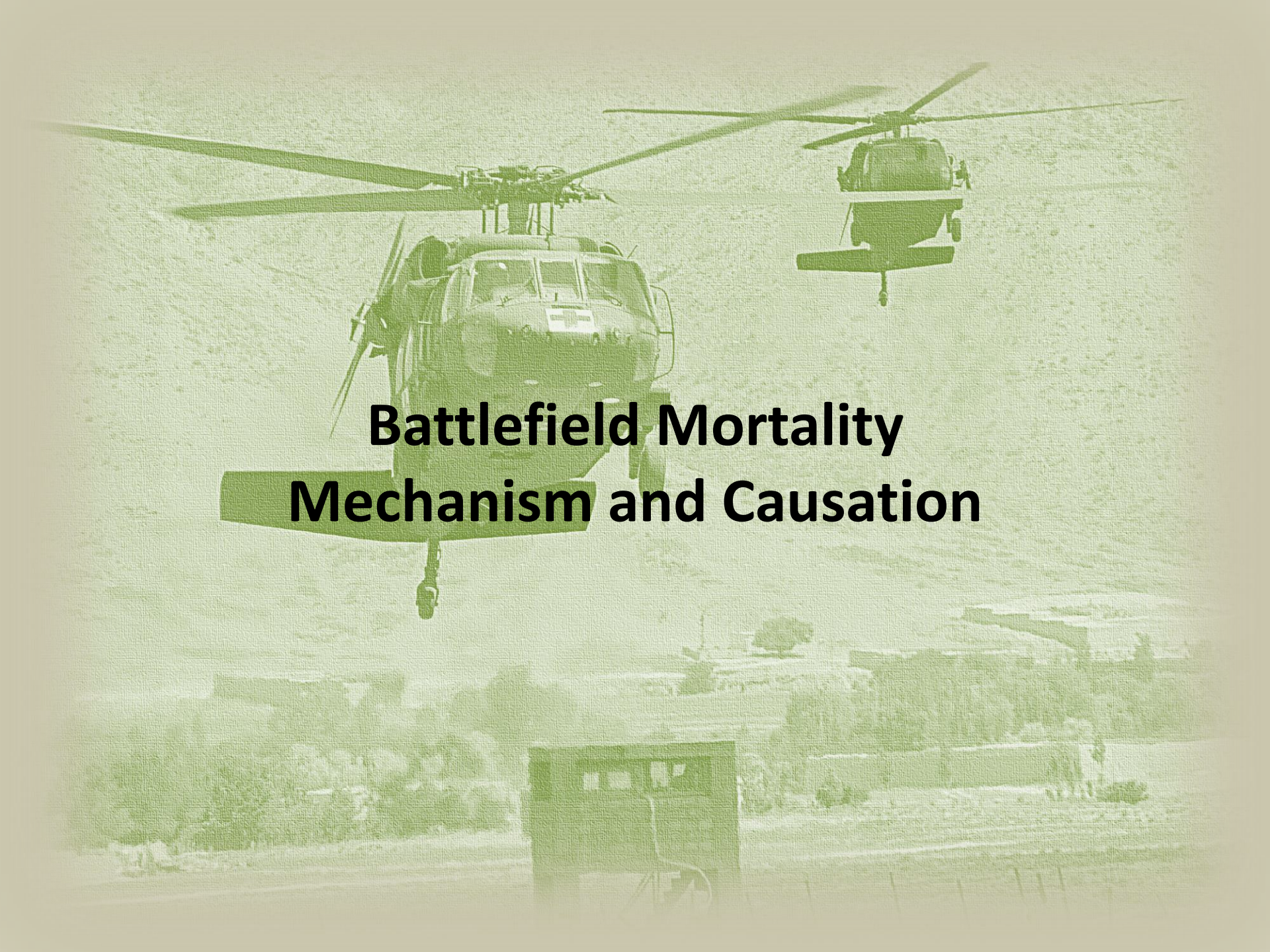
Desert Shield/Storm
- Burn team augmentation of evacuation hospitals to provide theater-wide burn care
- Intercontinental aeromedical transport of burn patients

Vietnam
- Improved use of helicopters
- Improved laboratory support
- Portable radiology equipment
- Mechanical ventilators in theater

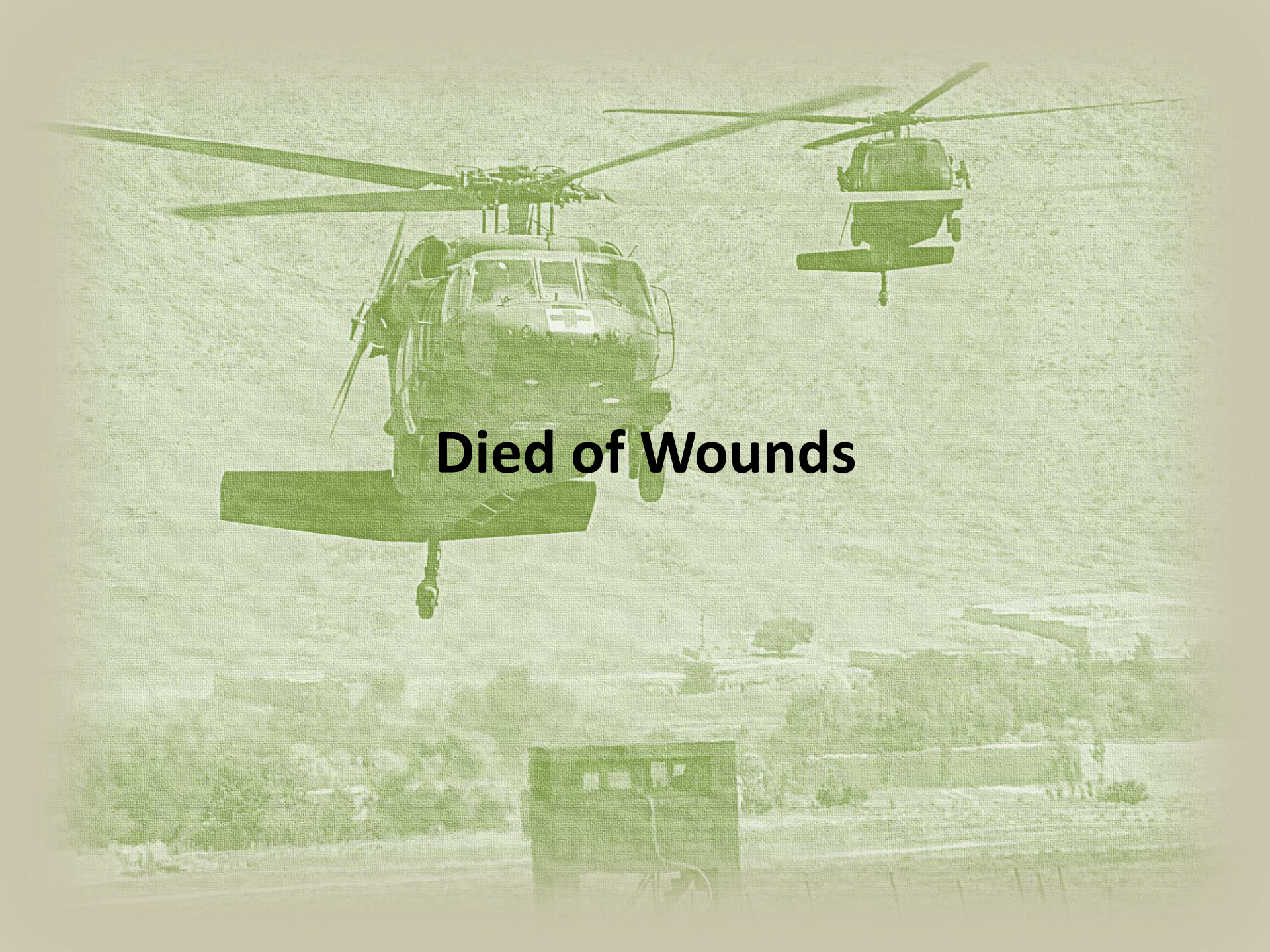
Korean Conflict
- Improved fluid resuscitation
- Forward availability of definitive surgery
- Helicopters for patient evac/transport
- Primary repair/grafts for vascular injury

World War II
- Whole blood/plasma a
- Specialty-specific surgical groups
- Antibiotics
- Fixed wing aero-medical evacuation

World War I
- IV fluids
- Blood transfusions
- Motorized ambulances
- Topical antisepsis



Battlefield Mortality Mechanism and Causation



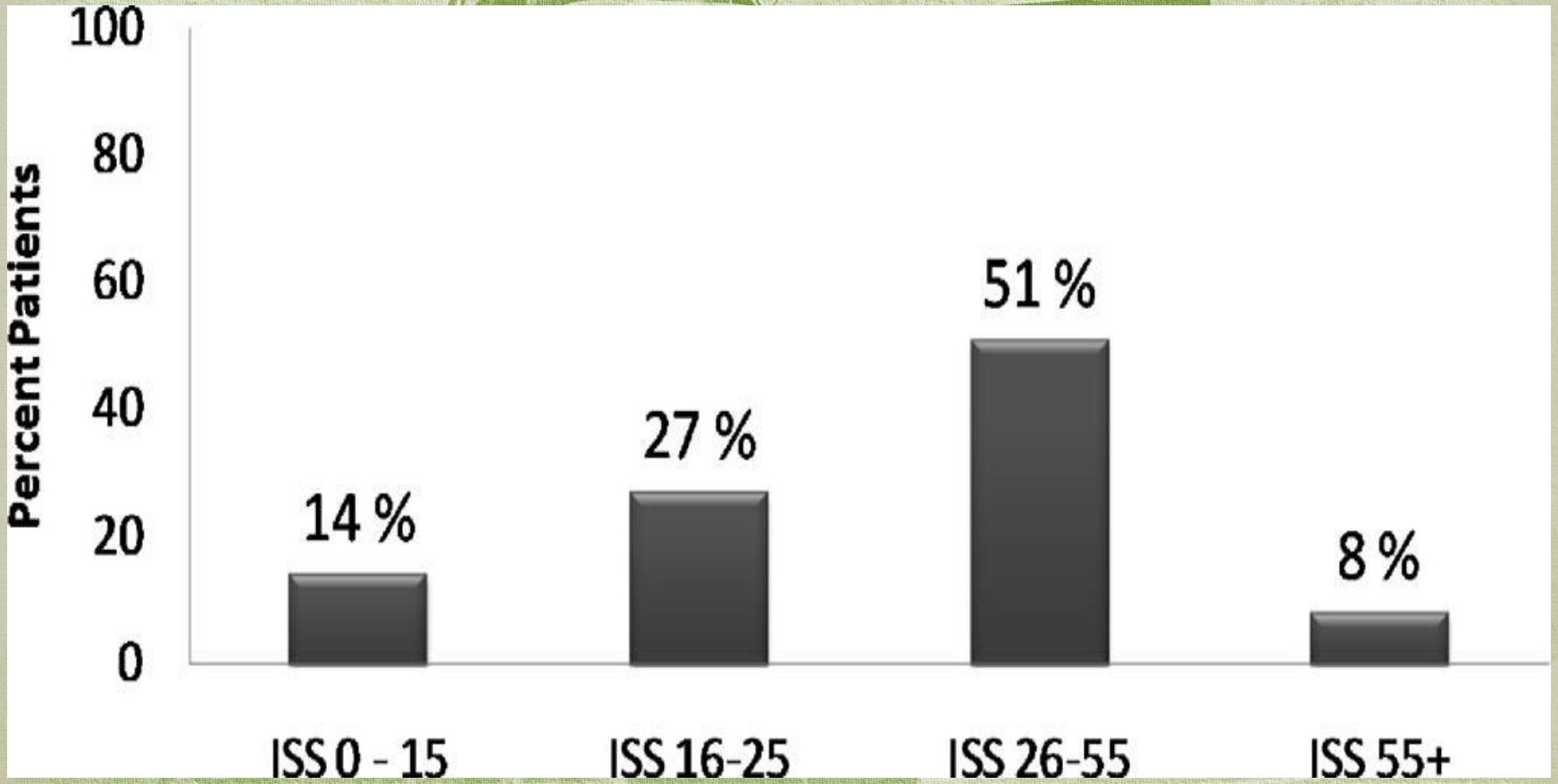
Died of Wounds

DOW Analysis

- Review died of wounds (DOW)deaths n=558
- Data sources
  - DoD Trauma Registry
  - Armed Forces Medical Examiner System (AFMES)
- Variables
  - Demographics
  - Mechanism and cause
  - Injury severity
- Expert panel trauma surgeons, emergency physician, neurosurgeon, and forensic pathologist graded deaths as non survivable or potentially survivable.

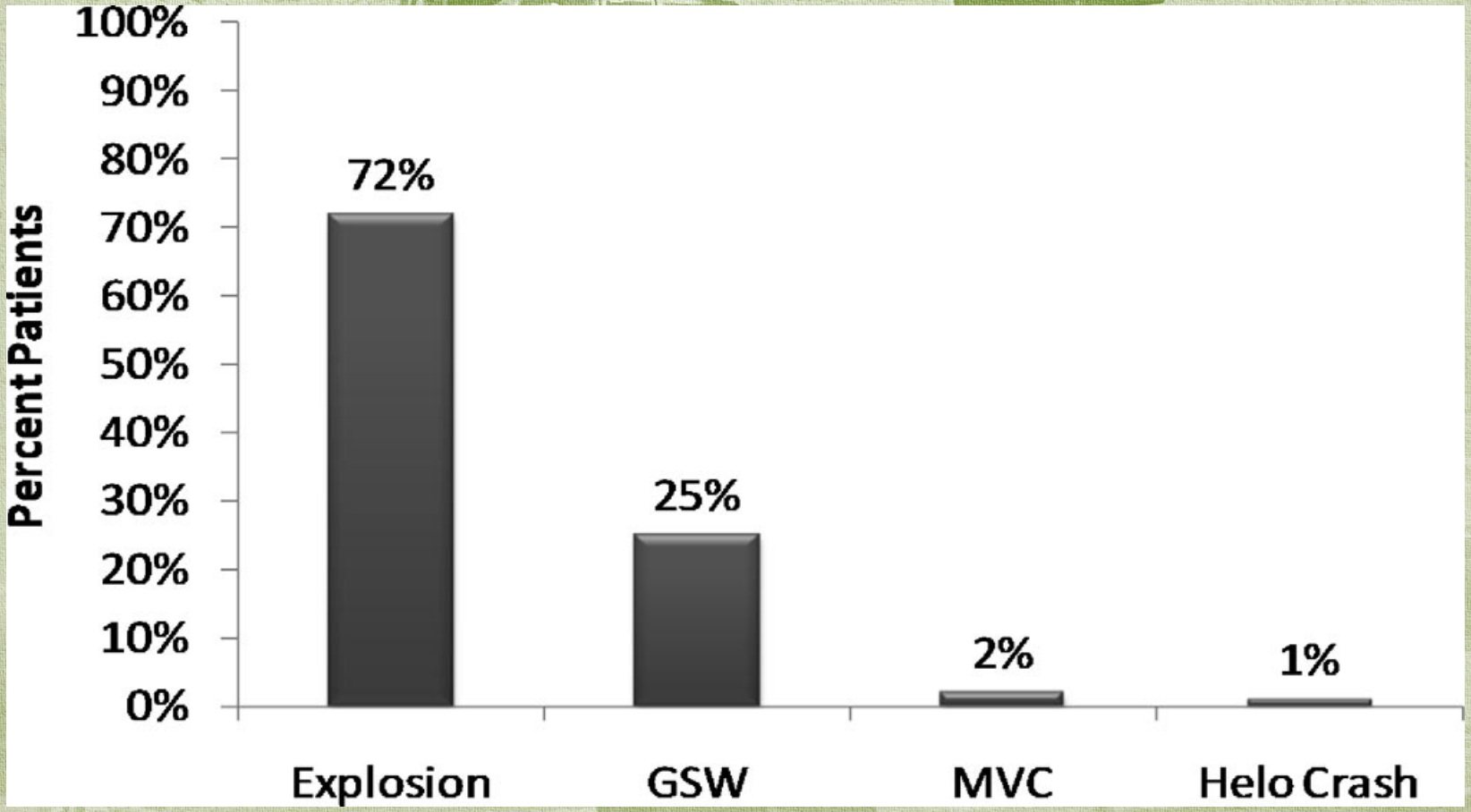
- Goal: Identify areas for improved training, medical care, material, research and development

DOW ISS



Eastridge et al: Died of Wounds on the Battlefield. J Trauma 2011

DOW Cause



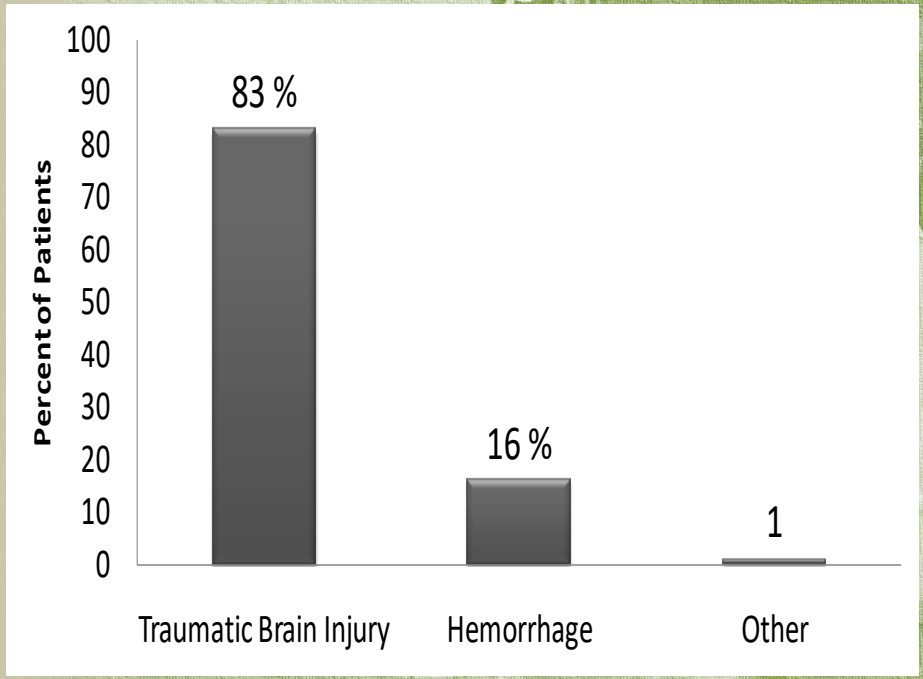
Eastridge et al: Died of Wounds on the Battlefield. J Trauma 2011

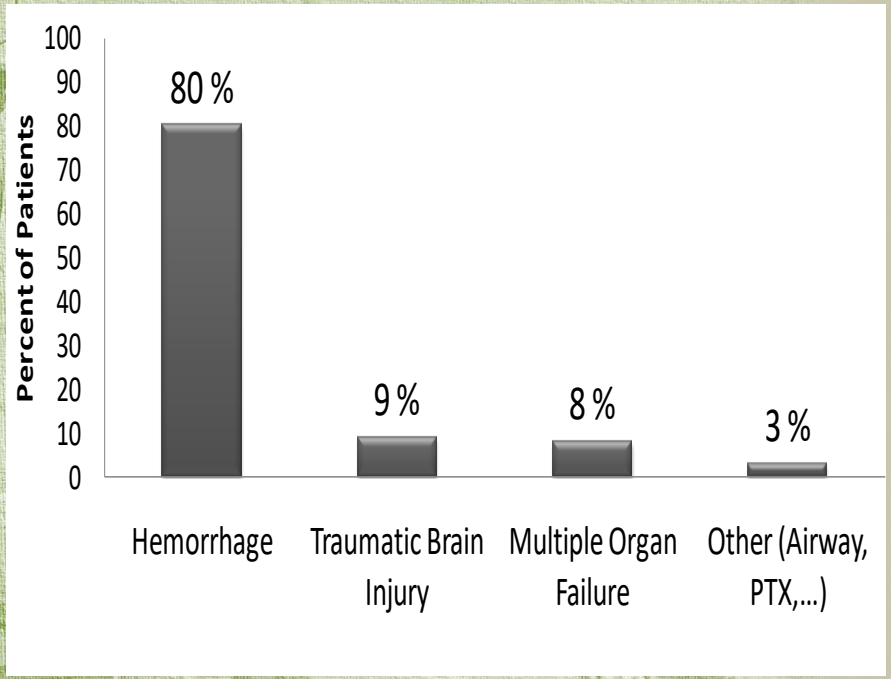
DOW Survivability

Non-Survivable

- DOW rate 4.6%
- NS in 271 (48.6%) and PS in 287 (51.4%)

Potentially Survivable





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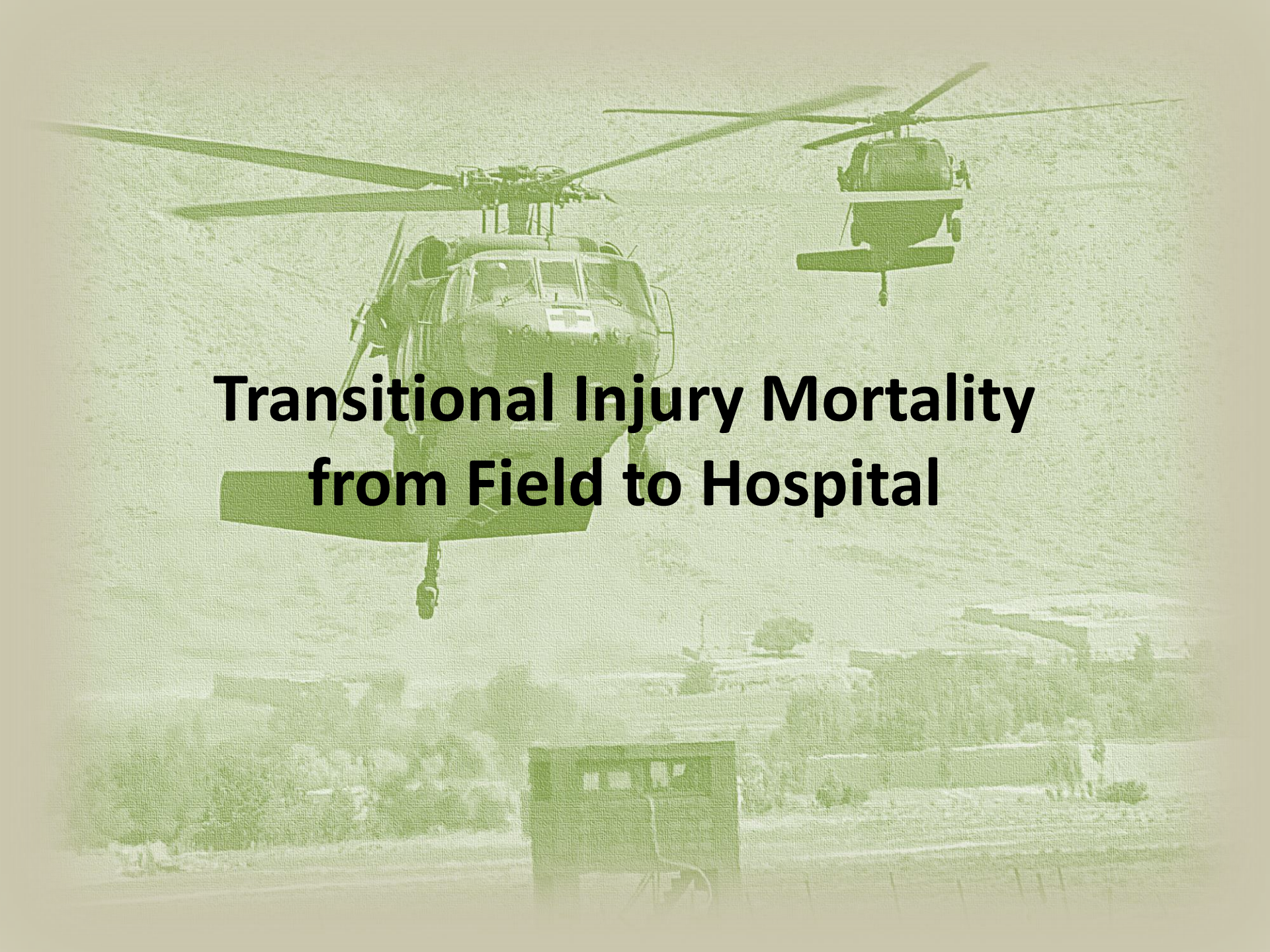


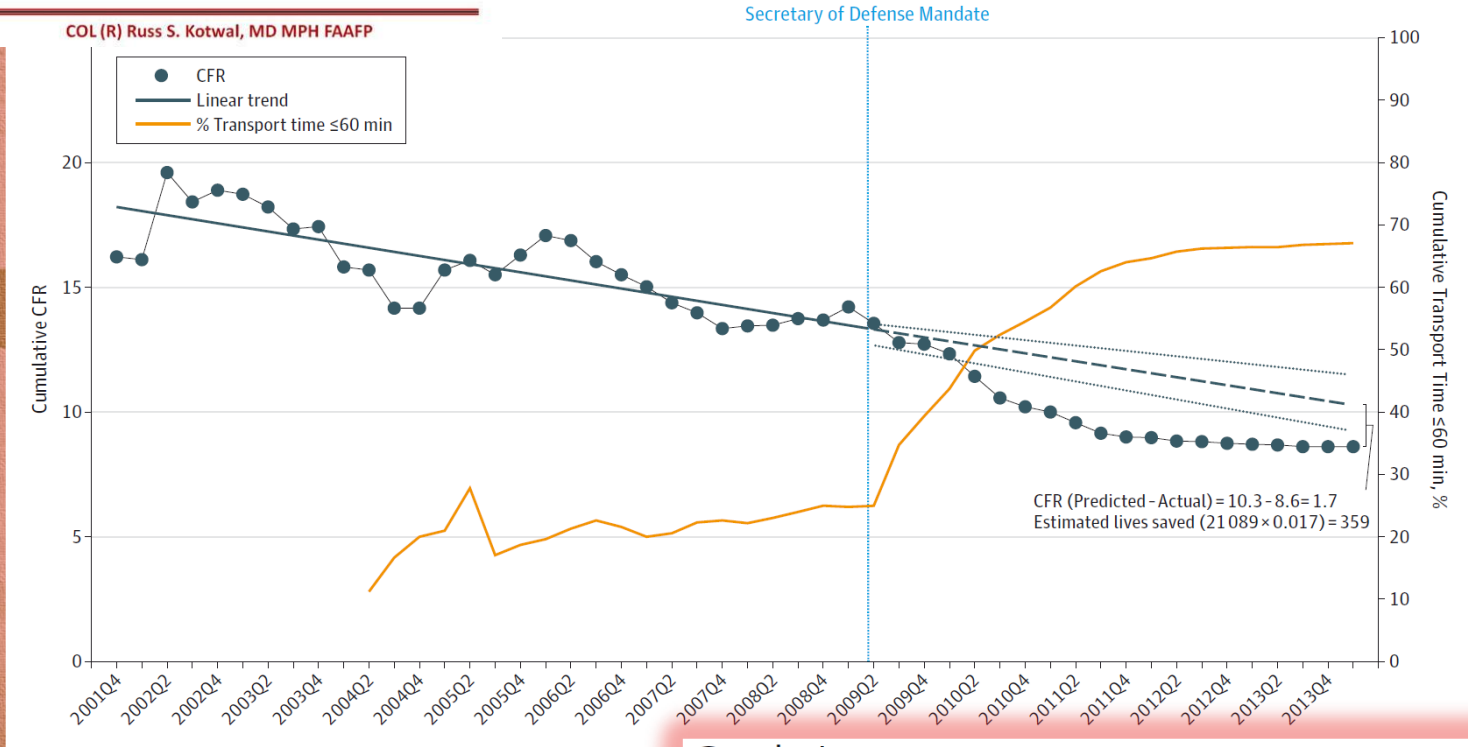
Transitional Injury Mortality from Field to Hospital

Abstract Presentation for:
Committee on Tactical Combat Casualty Care Meeting
Atlanta, Georgia – February 4, 2015

Saving Lives on the Battlefield: The Golden Hour and the Gates Effect

COL (R) Russ S. Kotwal, MD MPH FAAFP

Gates Effect

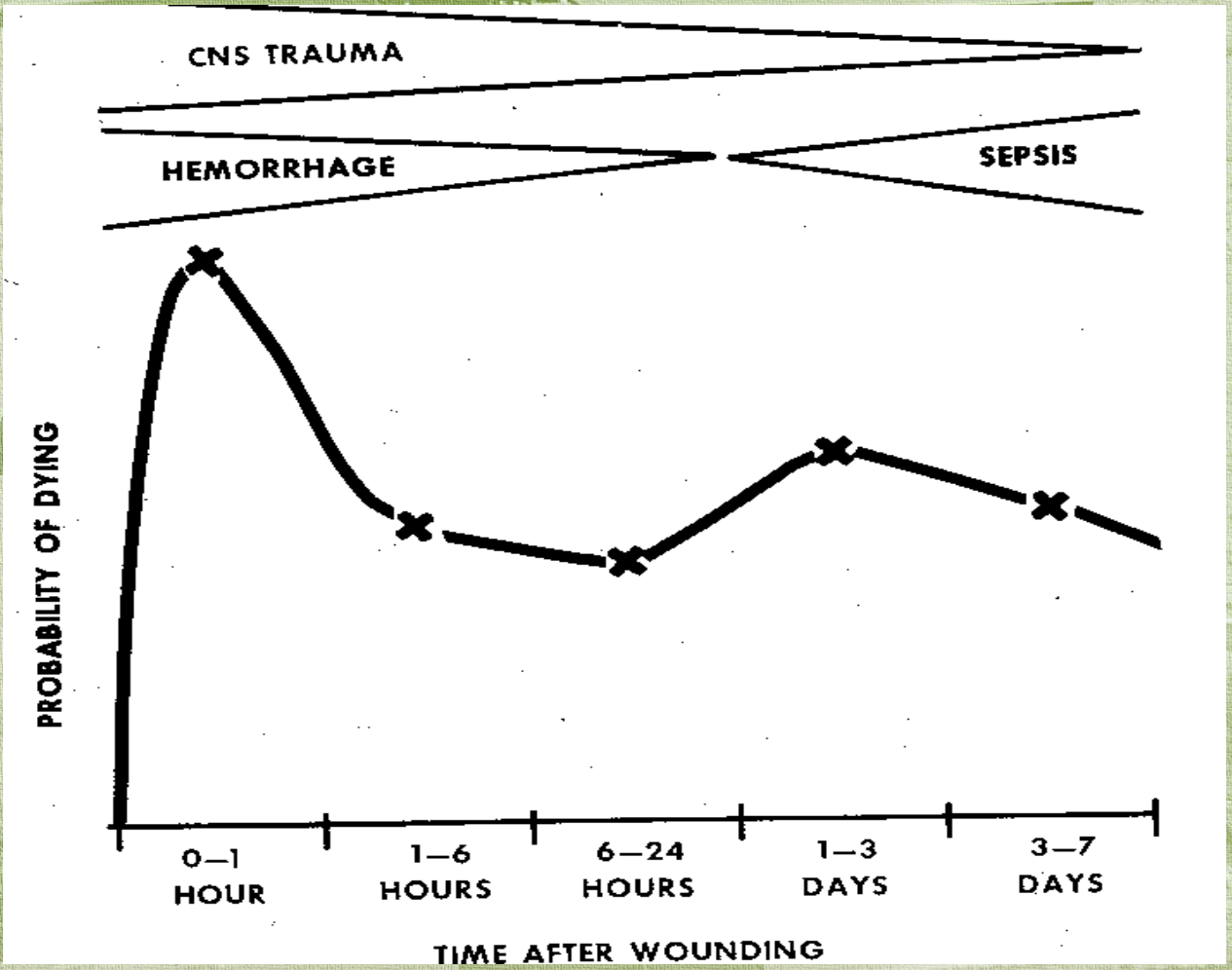


Conclusions

A 2009 mandate by Secretary of Defense Gates reduced the time between critical injury and definitive care for combat casualties in Afghanistan. Despite evidence of increased severity and complexity of wounds from explosive devices, the combination of reduced prehospital transport time and increased treatment capability are likely contributors of casualty survival.

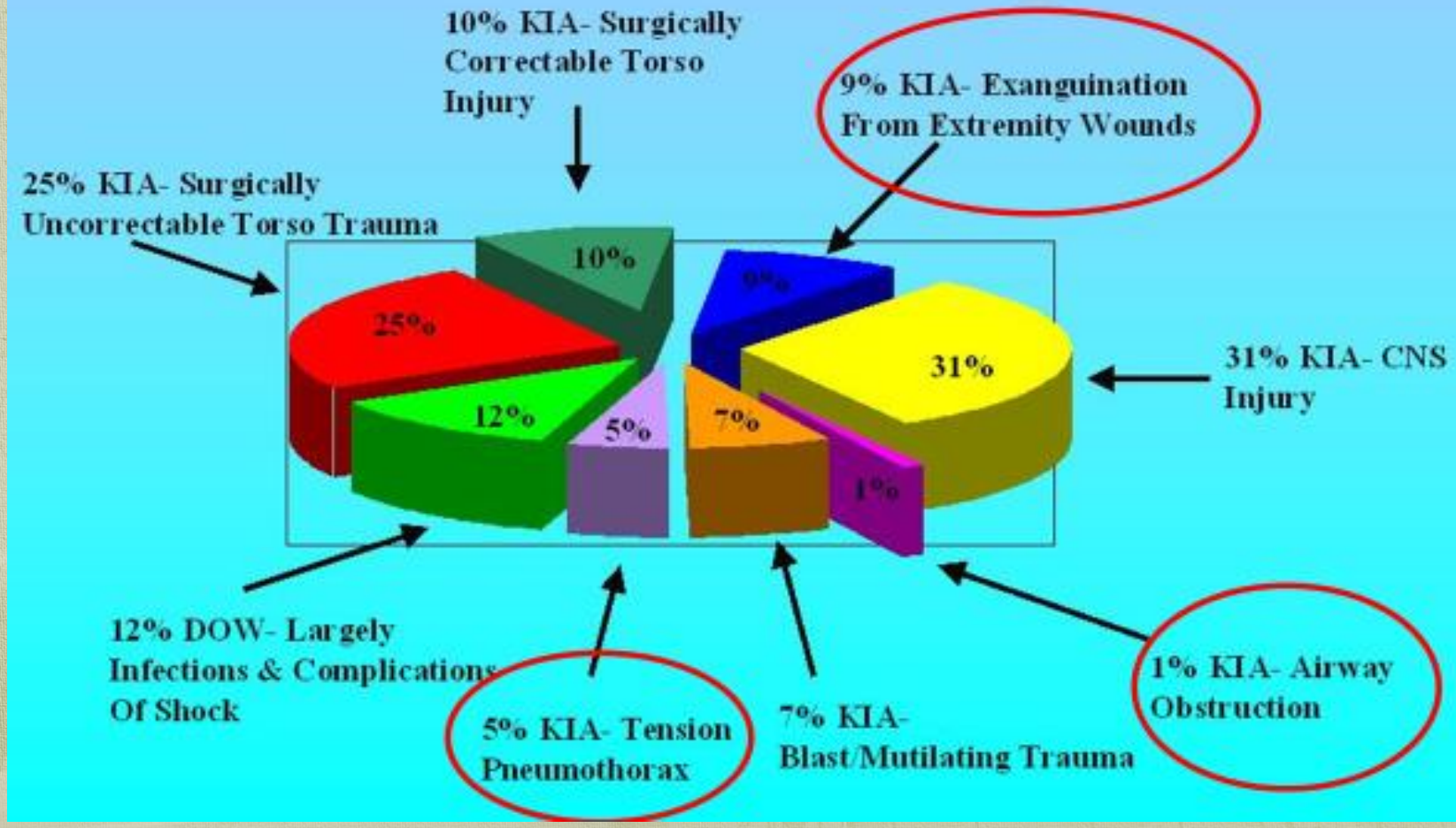

Killed in Action

Empiric Probability of Combat Death



Bellamy, J Trauma, 1984

How People Die In Ground Combat (From COL Ron Bellamy)



KIA Analysis

- Review battlefield deaths (n=4,596)
- Data sources
  - DoD Trauma Registry
  - Armed Forces Medical Examiner System (AFMES)
- Variables
  - Demographics
  - Mechanism and cause
  - Injury severity
- Expert panel trauma surgeons, emergency physician, neurosurgeon, and forensic pathologist graded deaths as non survivable or potentially survivable.

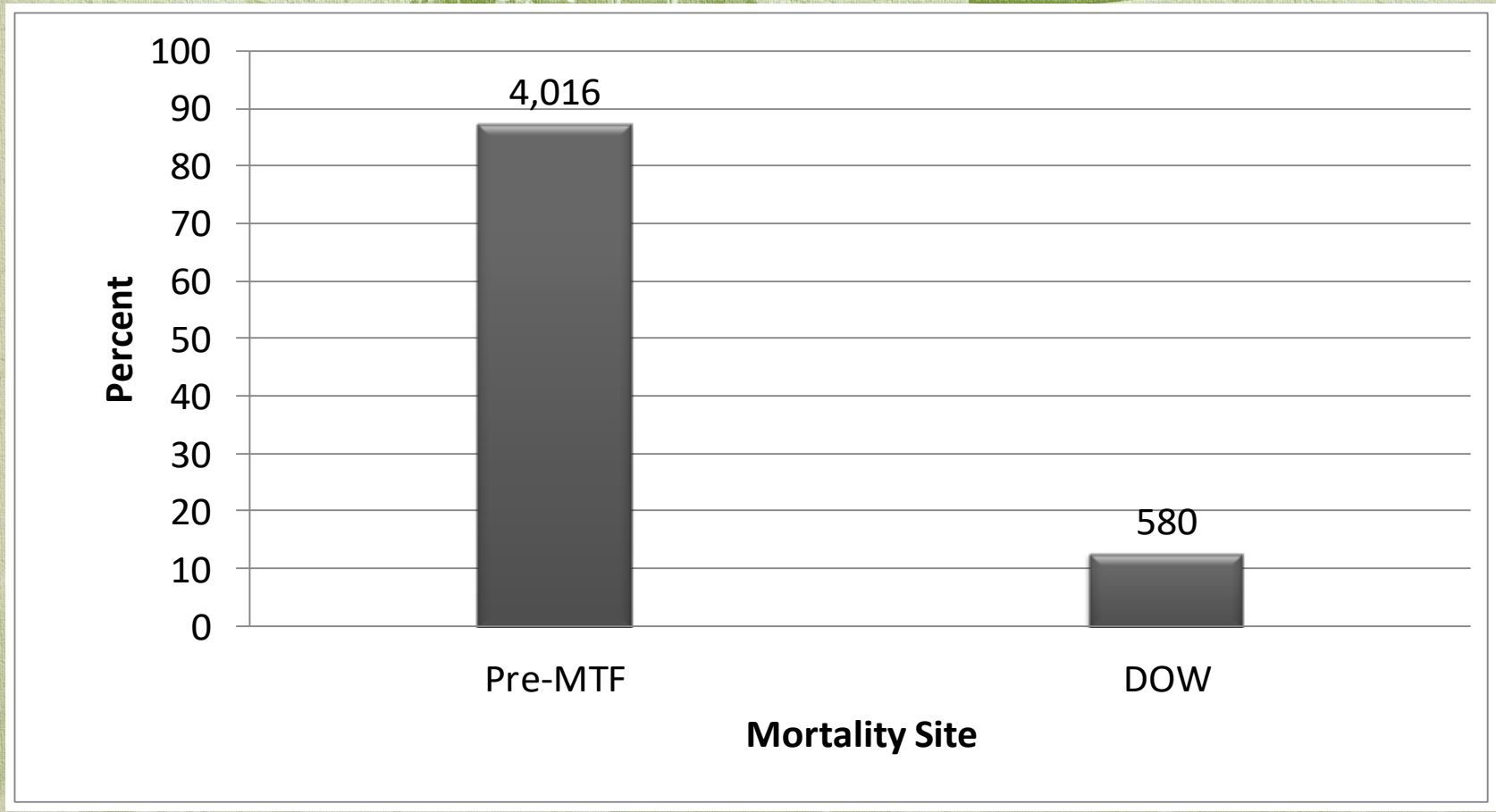
- Goal: Identify areas for improved training, medical care, material, research and development

KIA Analysis

- Nonsurvivable
  - Dismemberment
  - Traumatic brain injury
  - Cervical cord transection (above C3)
  - Airway transection within thorax
  - Cardiac injury (>1/2”), thoracic aorta injury, pulmonary artery
  - Hepatic avulsion
  - Junctional lower extremity amputations with open pelvis with soft tissue loss

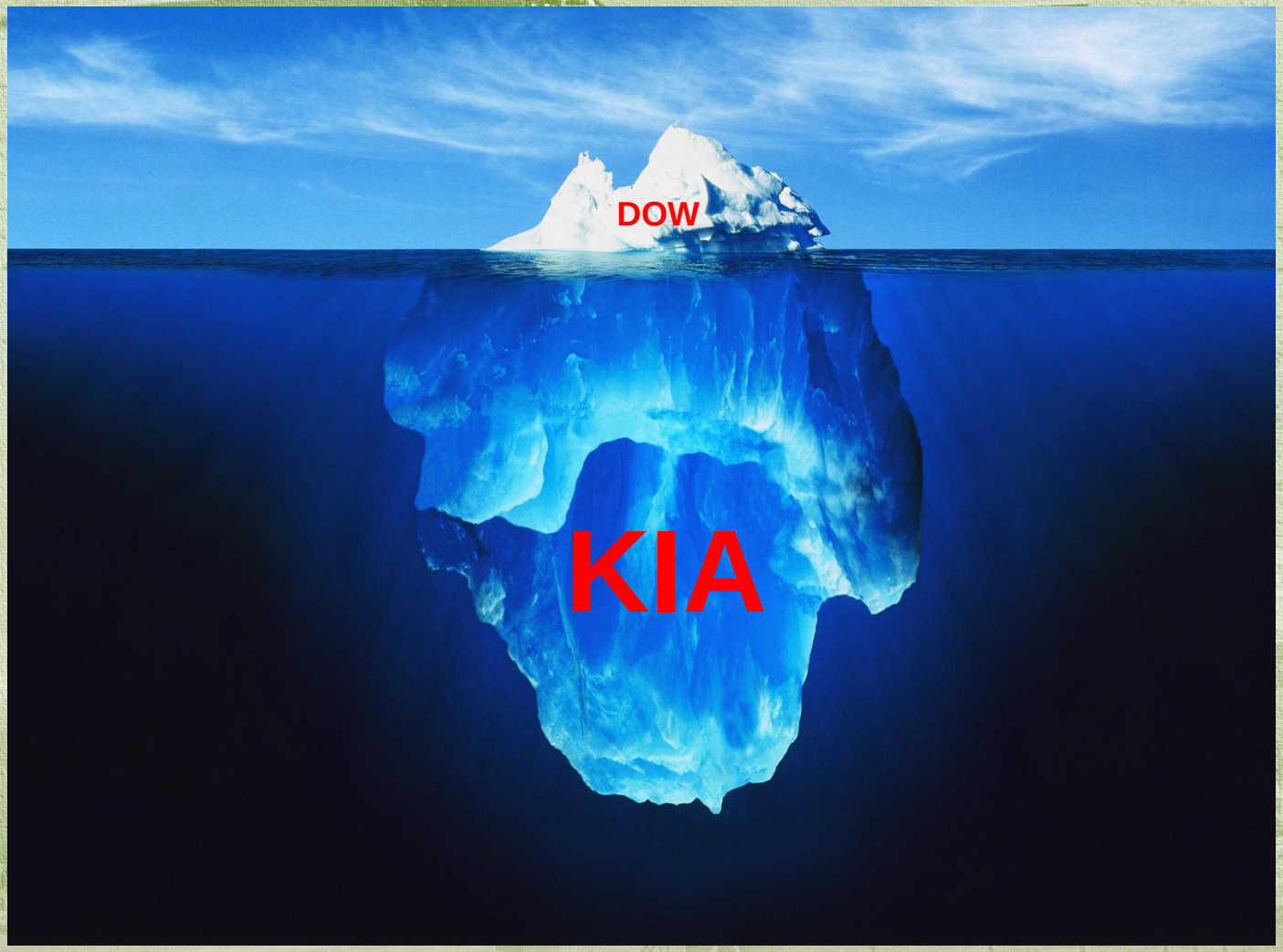
- Potentially Survivable
  - All other

Where Battlefield Casualties Die n=4,596

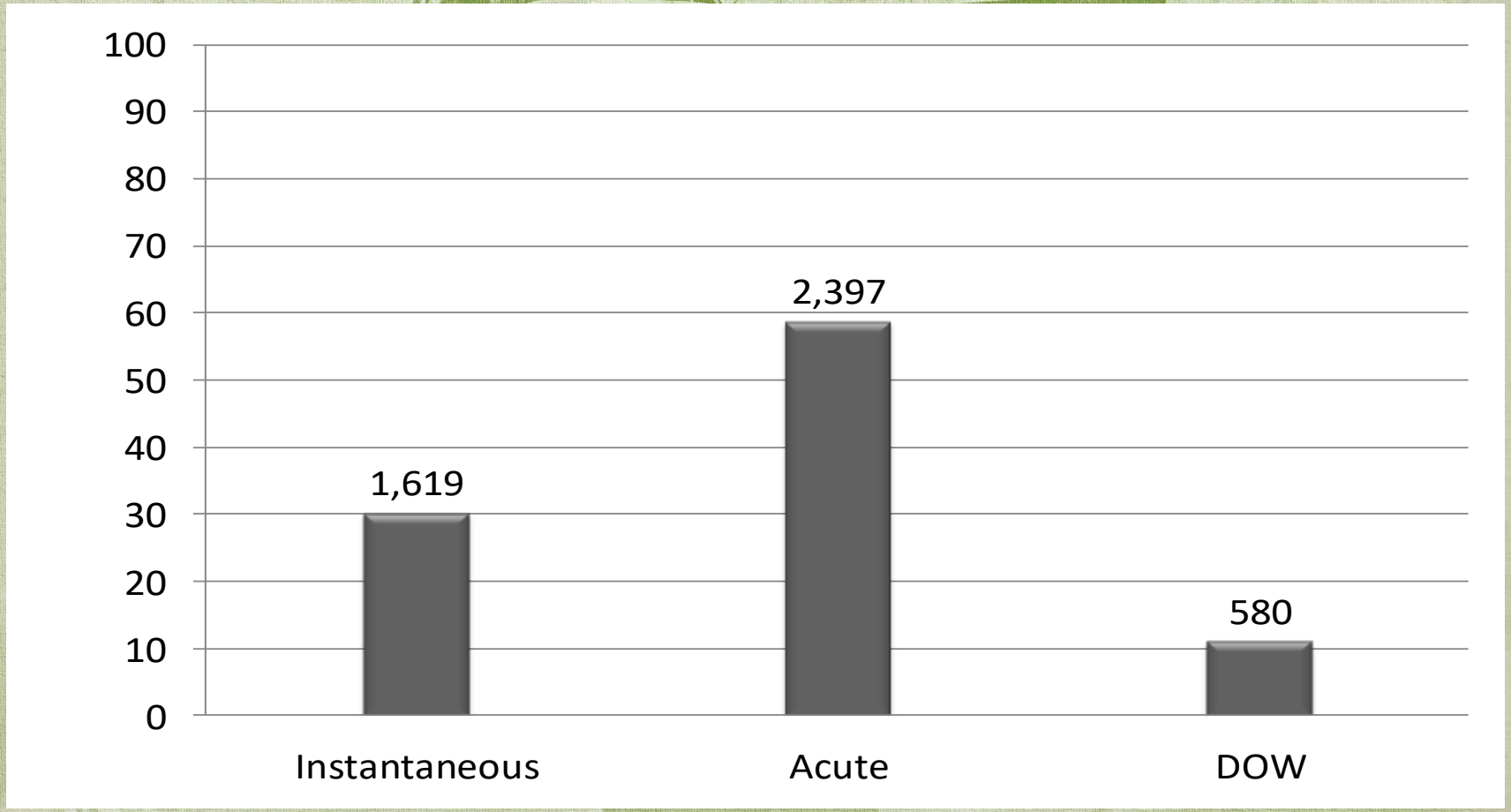


Eastridge et al: Death on the Battlefield: Implications for the Future of Combat Casualty Care. J Trauma 2012

Putting it in Perspective

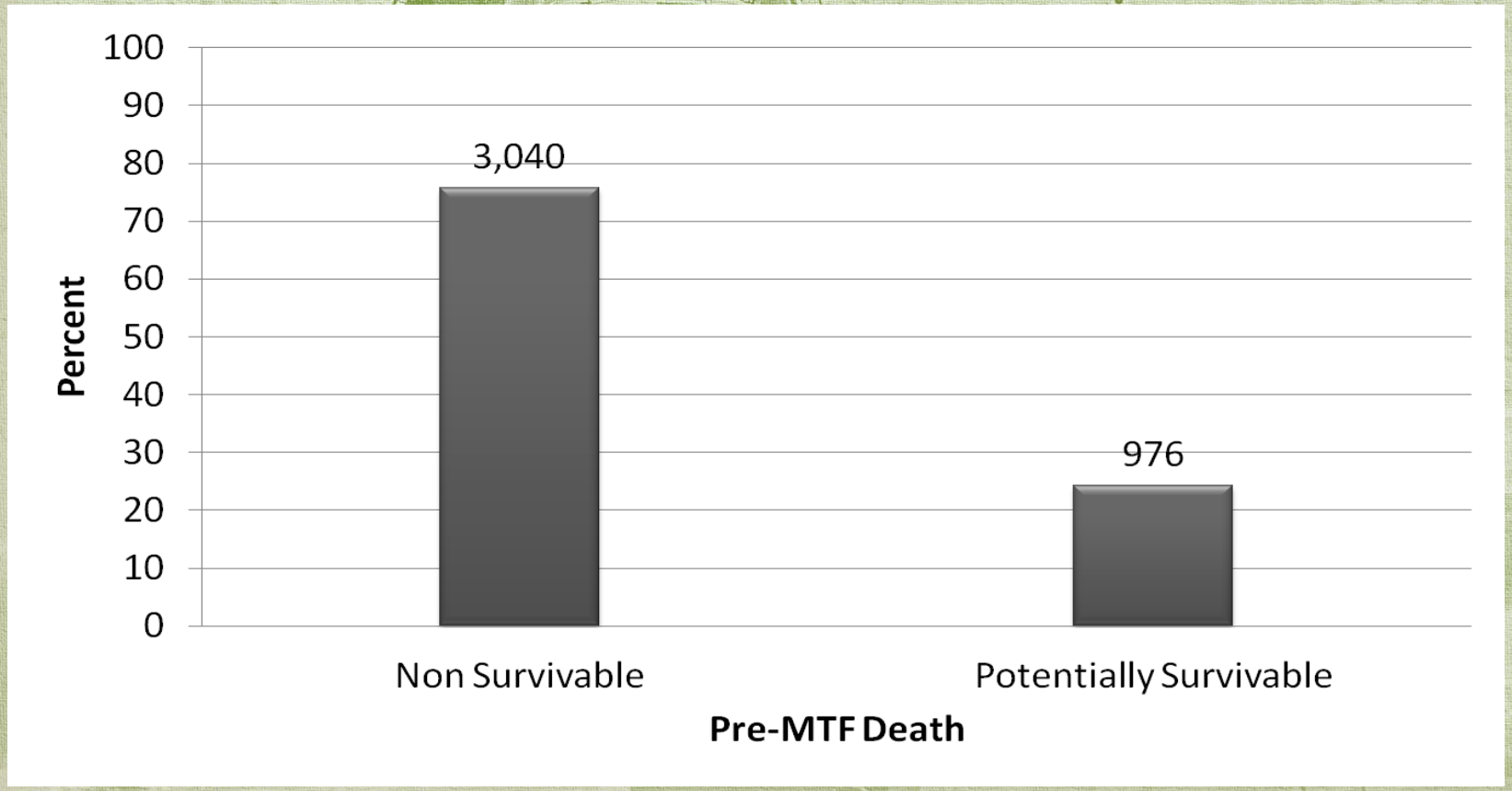


Distribution of Battlefield Death n=4,596



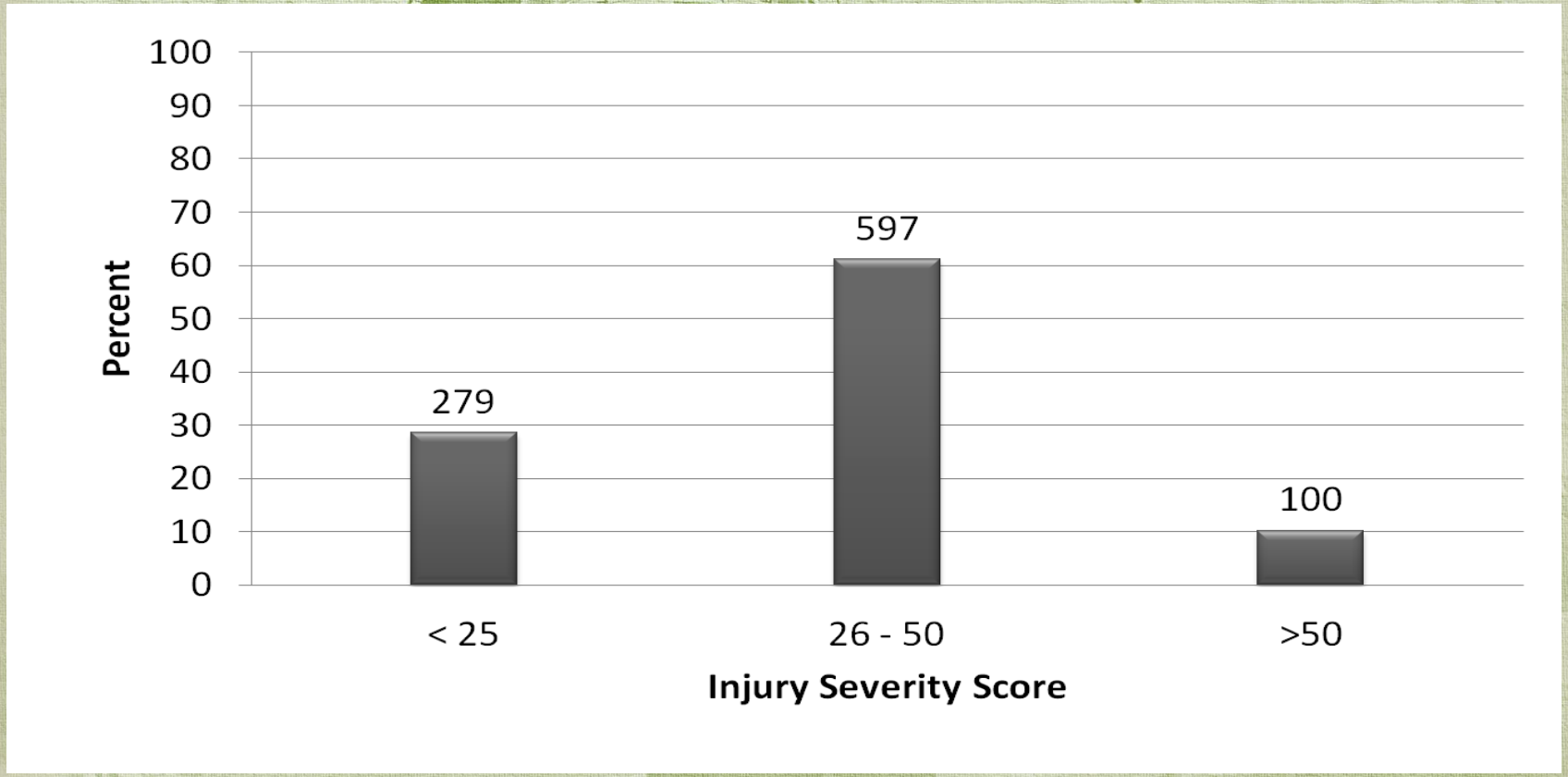
Eastridge et al: Death on the Battlefield: Implications for the Future of Combat Casualty Care. J Trauma 2012

Battlefield Pre-Hospital Death Analysis n=4,016 (DOW excluded)



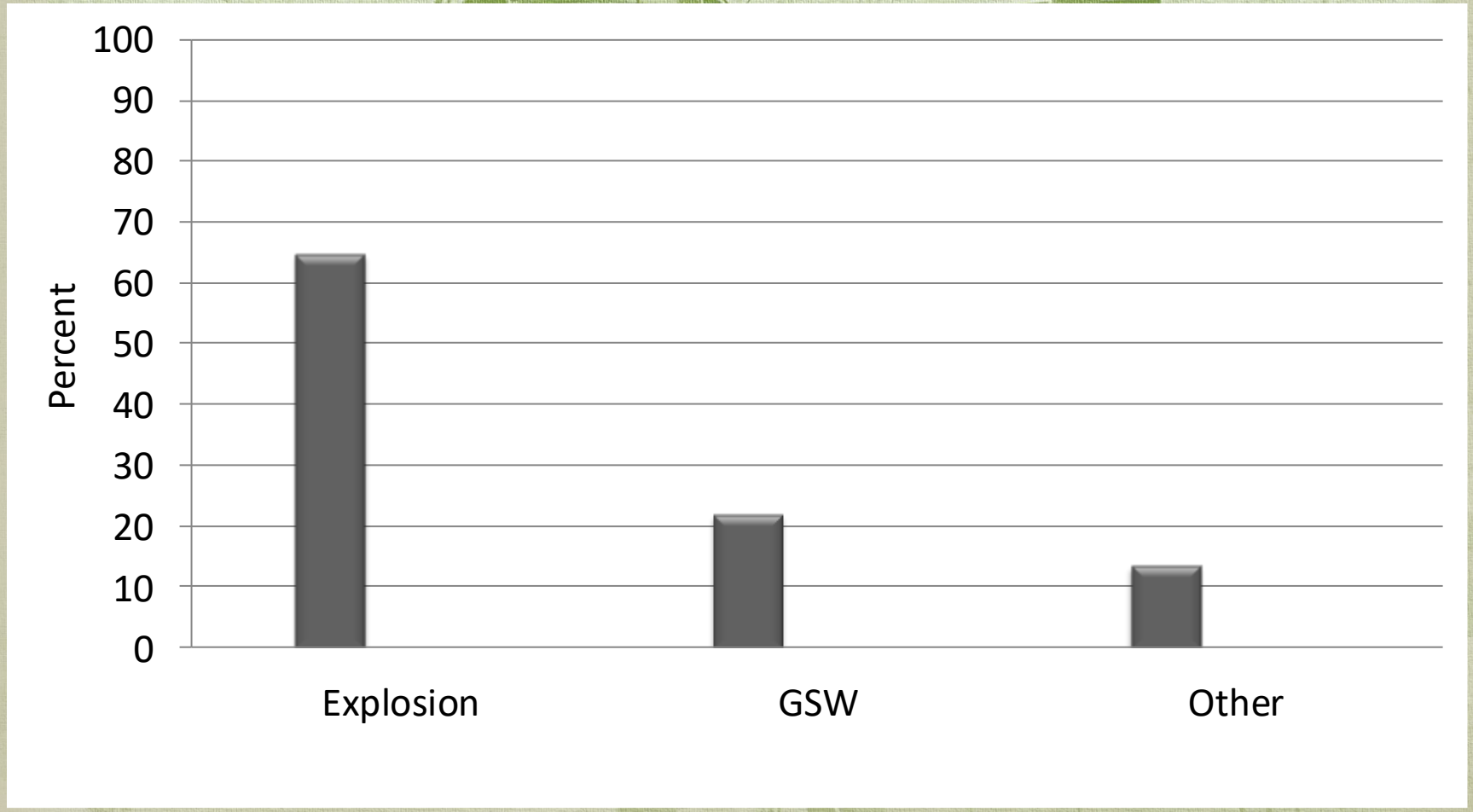
Eastridge et al: Death on the Battlefield: Implications for the Future of Combat Casualty Care. J Trauma 2012

Potentially Survivable Pre-MTF Death Analysis (n=976)



Eastridge et al: Death on the Battlefield: Implications for the Future of Combat Casualty Care. J Trauma 2012

Battlefield Pre-MTF Mortality Cause n=4,016



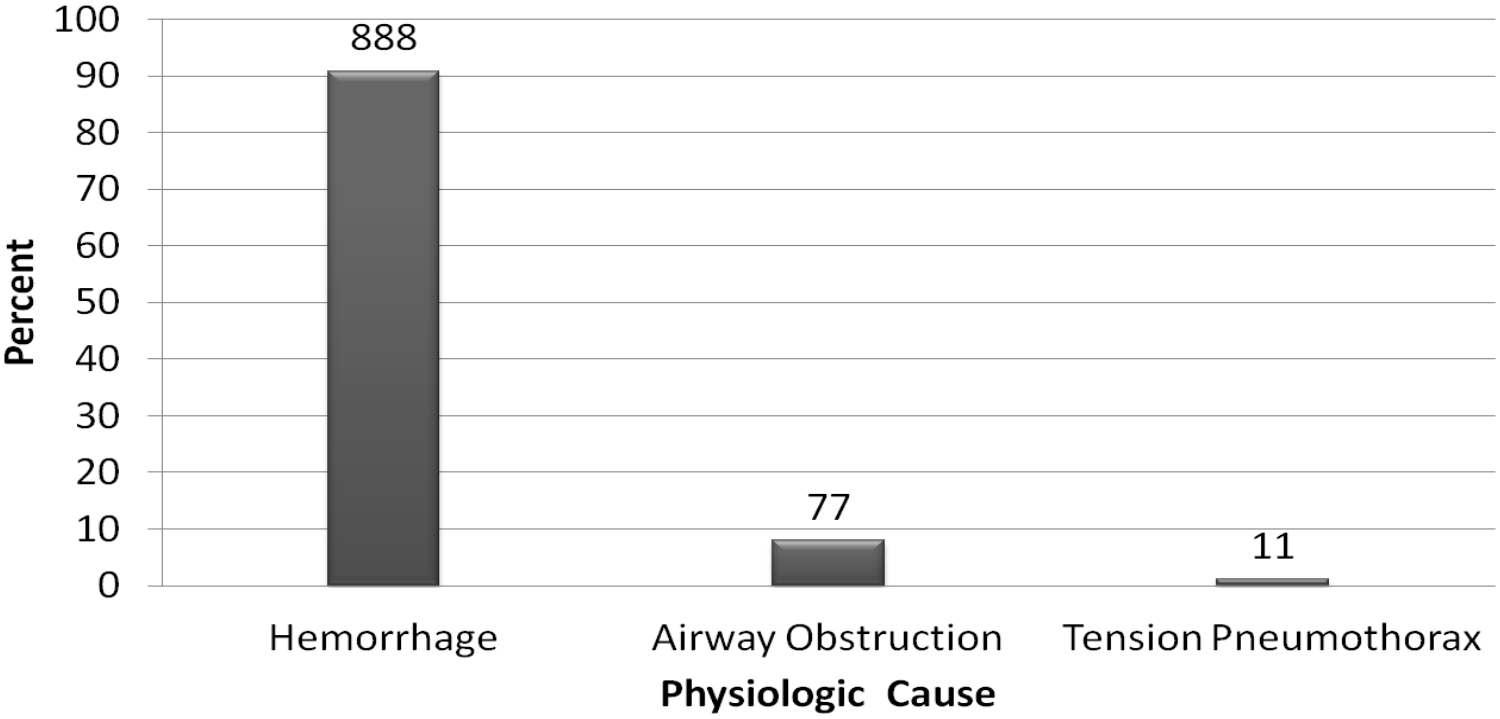
Eastridge et al: Death on the Battlefield: Implications for the Future of Combat Casualty Care. J Trauma 2012

Battlefield NS Lethality

Cause of Death	Instantaneous (n=1,619)	Acute (n=1,421)
Brain Injury	38.3% (620)	53.0% (753)
High Spinal Cord Injury	---	9.2% (131)
Dismemberment	31.6% (512)	---
Heart/ Thoracic Injury	23.6% (383)	21.8% (310)
Open Pelvic Injury	---	6.5% (93)
Other	6.5% (104)	9.5% (134)

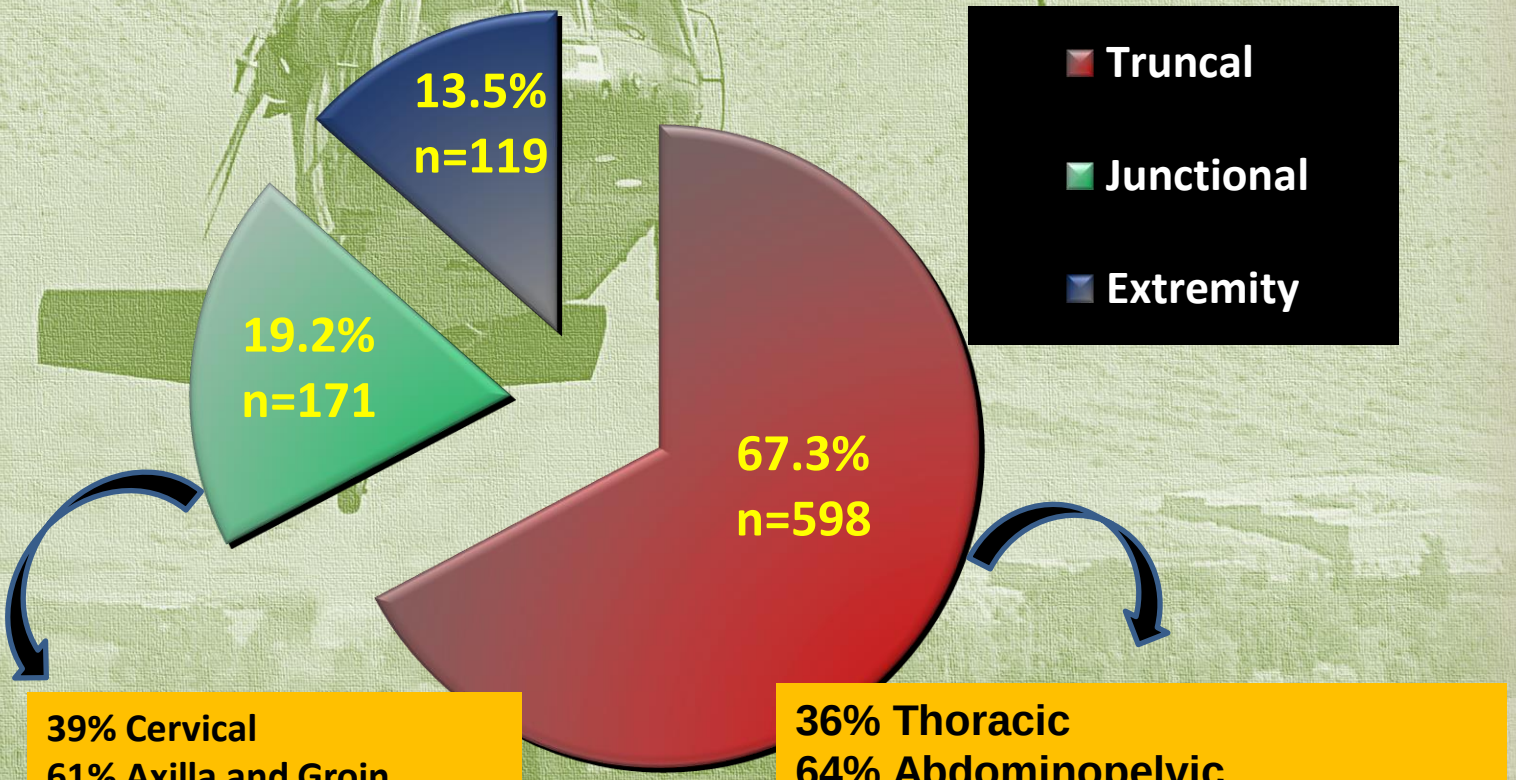
Eastridge et al: Death on the Battlefield: Implications for the Future of Combat Casualty Care. J Trauma 2012

Battlefield Acute Lethality Potentially Survivable n=976



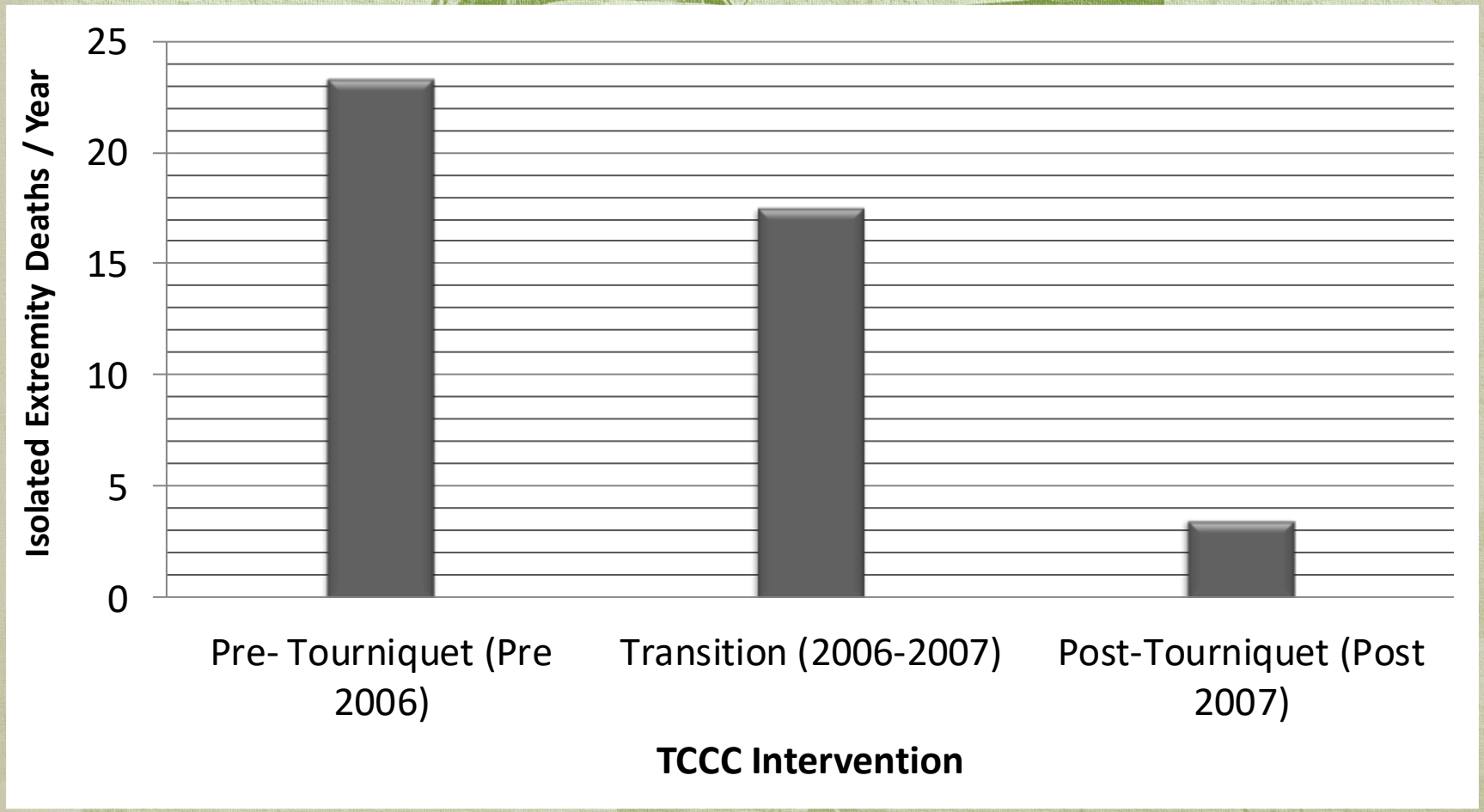
Eastridge et al: Death on the Battlefield: Implications for the Future of Combat Casualty Care. J Trauma 2012

Anatomic Locus of Hemorrhagic Death



Eastridge BJ, Mabry RL, Seguin PG, et al. Death on the battlefield (2001-2011): implications for the future of combat casualty care. Journal of Trauma, 2012. In press.

Can We Have An Impact?



Eastridge et al: Death on the Battlefield: Implications for the Future of Combat Casualty Care. J Trauma 2012

Summary

- Most battlefield casualties (87.3 %) die on the battlefield
- Majority of battlefield deaths (75.7%) are non-survivable
  - Mitigation strategy: prevention
- Hemorrhage is the major mechanism of death in (90.9 %) of PS combat injuries .
  - Mitigation strategy: hemorrhage control
    - Tourniquets
    - Junctional hemorrhage control
    - Intracorporeal hemostasis
      - Freeze dried plasma
      - TXA
      - Novel therapeutics
    - Extending the survival time window from POI to MTF

U.S. military
potentially survivable injury:
<u>24%</u>

Ranger
Potentially preventable death incidence:
<u>3%</u>

ORIGINAL ARTICLE

Death on the battlefield (2001–2011): Implications for the future of combat casualty care

Brian J. Eastridge, MD, Robert L. Mabry, MD, Peter Seguin, MD, Joyce Cantrell, MD, Terrill Tops, MD, Paul Uribe, MD, Olga Mallett, Tamara Zubko, Lynne Oetjen-Gerdes, Todd E. Rasmussen, MD, Frank K. Butler, MD, Russell S. Kotwal, MD, John B. Holcomb, MD, Charles Wade, PhD, Howard Champion, MD, Mimi Lawnick, Leon Moores, MD, *and* Lorne H. Blackbourne, MD

BACKGROUND: Critical evaluation of all aspects of combat casualty care, including mortality, with a special focus on the incidence and causes of potentially preventable deaths among US combat fatalities, is central to identifying gaps in knowledge, training, equipment, and execution of battlefield trauma care. The impetus to produce this analysis was to develop a comprehensive perspective of battlefield death, concentrating on deaths that occurred in the pre–medical treatment facility (pre-MTF) environment.

METHODS: The Armed Forces Medical Examiner Service Mortality Surveillance Division was used to identify Operation Iraqi Freedom and Operation Enduring Freedom combat casualties from October 2001 to June 2011 who died from injury in the deployed environment. The autopsy records, pertinent torn records, photographs on file, and Mortality Trauma Registry of the Armed Forces Medical Examiner Service were used to compile mechanism of injury, cause of injury, medical intervention performed, Abbreviated Injury Scale (AIS) score, and Injury Severity Score (ISS) on all lethal injuries. All data were used by the expert panel for the conduct of the potential for injury survivability assessment of this study.

RESULTS: For the study interval between October 2001 and June 2011, 4,596 battlefield fatalities were reviewed and analyzed. The stratification of mortality demonstrated that 87.3% of all injury mortality occurred in the pre-MTF environment. Of the pre-MTF deaths, 75.7% (n = 3,040) were classified as nonsurvivable, and 24.3% (n = 976) were deemed potentially survivable (PS). The injury/physiologic focus of PS acute mortality was largely associated with hemorrhage (90.9%). The site of lethal hemorrhage was truncal (67.3%), followed by junctional (19.2%) and peripheral-extremity (13.5%) hemorrhage.

CONCLUSION: Most battlefield casualties died of their injuries before ever reaching a surgeon. As most pre-MTF deaths are nonsurvivable, mitigation strategies to impact outcomes in this population need to be directed toward injury prevention. To significantly impact the outcome of combat casualties with PS injury, strategies must be developed to mitigate hemorrhage and optimize airway management or reduce the time interval between the battlefield point of injury and surgical intervention.

Understanding battlefield mortality is a vital component of the military trauma system. Emphasis on this analysis should be placed on trauma system optimization, evidence-based improvements in Tactical Combat Casualty Care guidelines, data-driven research, and development to remediate gaps in care and relevant training and equipment enhancements that will increase the survivability of the fighting force. (*J Trauma Acute Care Surg.* 2012;73: S431–S437. Copyright © 2012 by Lippincott Williams & Wilkins)

KEY WORDS: Military; mortality; hemorrhage; prehospital; outcomes.

The vision of the Joint Trauma System is that every soldier, marine, sailor, or airman injured in the battlefield or in the theater of operations has the optimal chance for survival and maximal potential for functional recovery. Implicit within this vision is the mission to improve trauma care delivery and patient outcomes across the entire continuum from point of injury through rehabilitation using techniques for continuous performance improvement driven by evidence-based medicine across the entire continuum. A preliminary study evaluated these issues in Special Operations forces early in the war.[1] Within the past decade, a tremendous amount of evidence has been amassed validating improvements in combat casualty care once a casualty has reached a military medical treatment facility (MTF). However, no studies have comprehensively evaluated the outcomes of wounded warriors who died of their injuries before reaching an MTF. This relative blind spot is exacerbated by several factors, including lack of prehospital data,[2] the incomplete understanding of the tactical circumstances during which the injuries were sustained, and the integration of existing data sources into the Joint Theater Trauma Registry.

For the last decade of continuous war, the dominant mechanism of injury on the battlefield has been overwhelmingly penetrating in nature occurring in nearly 75% of casualties associated with explosive fragmentation and gunshot wounds. The survivability of those injured on the battlefield is an unprecedented historical level of 90%, compared with

From the US Army Institute of Surgical Research (B.J.E., R.L.M., T.E.R., L.H.B.), Fort Sam Houston, Texas; Armed Forces Medical Examiner Service (P.S., J.C., T.T., P.U., O.M., T.Z., F.K.B., R.S.K., J.B.H., C.W., H.C., M.L., L.M.), Mortality Surveillance Division, Rockville, Maryland.

Deceased (L.O.-G.).

The opinions or assertions contained herein are the private views of the author and are not to be construed as official or as reflecting the views of the US Department of the Army or the US Department of Defense.

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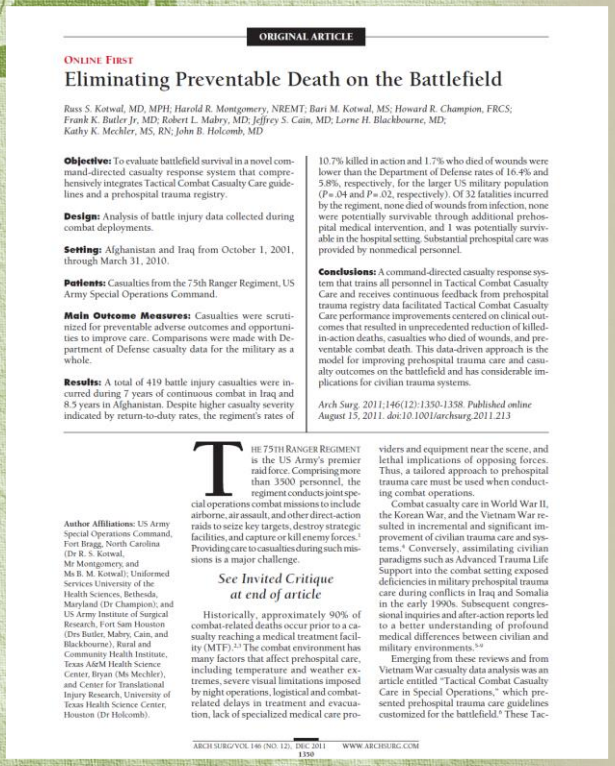
All US Military Battlefield Deaths

Rangers



ORIGINAL ARTICLE

ONLINE FIRST

Eliminating Preventable Death on the Battlefield

Russ S. Kotwal, MD, MPH; Harold R. Montgomery, NREMT; Bari M. Kotwal, MS; Howard R. Champion, FRCS; Frank K. Butler Jr, MD; Robert L. Mabry, MD; Jeffrey S. Cain, MD; Lorne H. Blackbourne, MD; Kathy K. Mechler, MS, RN; John B. Holcomb, MD

Objective: To evaluate battlefield survival in a novel command-directed casualty response system that comprehensively integrates Tactical Combat Casualty Care guidelines and a prehospital trauma registry.

Design: Analysis of battle injury data collected during combat deployments.

Setting: Afghanistan and Iraq from October 1, 2001, through March 31, 2010.

Patients: Casualties from the 75th Ranger Regiment, US Army Special Operations Command.

Main Outcome Measures: Casualties were scrutinized for preventable adverse outcomes and opportunities to improve care. Comparisons were made with Department of Defense casualty data for the military as a whole.

Results: A total of 419 battle injury casualties were incurred during 7 years of continuous combat in Iraq and 8.5 years in Afghanistan. Despite higher casualty severity indicated by return-to-duty rates, the regiment's rates of 10.7% killed in action and 1.7% who died of wounds were lower than the Department of Defense rates of 16.4% and 5.8%, respectively, for the larger US military population ($P = .04$ and $P = .02$, respectively). Of 32 fatalities incurred by the regiment, none died of wounds from infection, none were potentially survivable through additional prehospital medical intervention, and 1 was potentially survivable in the hospital setting. Substantial prehospital care was provided by nonmedical personnel.

Conclusions: A command-directed casualty response system that trains all personnel in Tactical Combat Casualty Care and receives continuous feedback from prehospital trauma registry data facilitated Tactical Combat Casualty Care performance improvements centered on clinical outcomes that resulted in unprecedented reduction of killed-in-action deaths, casualties who died of wounds, and preventable combat death. This data-driven approach is the model for improving prehospital trauma care and casualty outcomes on the battlefield and has considerable implications for civilian trauma systems.

Arch Surg. 2011;146(12):1350-1358. Published online August 15, 2011. doi:10.1001/archsurg.2011.213

Author Affiliations: US Army Special Operations Command, Fort Bragg, North Carolina (Dr R. S. Kotwal, Mr Montgomery, and Ms B. M. Kotwal); Uniformed Services University of the Health Sciences, Bethesda, Maryland (Dr Champion); and US Army Institute of Surgical Research, Fort Sam Houston (Drs Butler, Mabry, Cain, and Blackbourne), Rural and Community Health Institute, Texas A&M Health Science Center, Bryan (Ms Mechler), and Center for Translational Injury Research, University of Texas Health Science Center, Houston (Dr Holcomb).

THE 75TH RANGER REGIMENT is the US Army's premier raid force. Comprising more than 3500 personnel, the regiment conducts joint special operations combat missions to include airborne, air assault, and other direct-action raids to seize key targets, destroy strategic facilities, and capture or kill enemy forces.[1] Providing care to casualties during such missions is a major challenge.

See Invited Critique at end of article

Historically, approximately 90% of combat-related deaths occur prior to a casualty reaching a medical treatment facility (MTF).[2,3] The combat environment has many factors that affect prehospital care, including temperature and weather extremes, severe visual limitations imposed by night operations, logistical and combat-related delays in treatment and evacuation, lack of specialized medical care providers and equipment near the scene, and lethal implications of opposing forces. Thus, a tailored approach to prehospital trauma care must be used when conducting combat operations.

Combat casualty care in World War II, the Korean War, and the Vietnam War resulted in incremental and significant improvement of civilian trauma care and systems.[3] Conversely, assimilating civilian paradigms such as Advanced Trauma Life Support into the combat setting exposed deficiencies in military prehospital trauma care during conflicts in Iraq and Somalia in the early 1990s. Subsequent congressional inquiries and after-action reports led to a better understanding of profound medical differences between civilian and military environments.[3,4]

Emerging from these reviews and from Vietnam War casualty data analysis was an article entitled "Tactical Combat Casualty Care in Special Operations," which presented prehospital trauma care guidelines customized for the battlefield.[5] These Tac-

Injury survivability

Injury death preventability

DoD Lexicon

Combat Casualty Mortality Assessment Definitions

Defense Health Agency

PROCEDURAL INSTRUCTION

NUMBER 6040.03
August 21, 2018

Assistant Director, Combat Support Agency (CSA)

SUBJECT: Joint Trauma Lexicon

References: See Enclosure 1.

1. PURPOSE. This Defense Health Agency-Procedural Instruction (DHA-PI), based on the authority of References (a) and (b), and in accordance with the guidance of References (c) through (m), establishes the Defense Health Agency's (DHA) procedures to develop a universally accepted, standardized Joint Trauma Lexicon.

2. APPLICABILITY. This DHA-PI applies to OSD, the Military Departments (MILDEPs), the Office of the Chairman of the Joint Chiefs of Staff (CJCS) and the Joint Staff, the Combatant Commands, the Office of the Inspector General of the DoD, the Defense Agencies, the DoD Field Activities, and all other organizational entities within the DoD (referred to collectively in this DHA-PI as the "DoD Components").

3. POLICY IMPLEMENTATION. It is DHA's instruction, pursuant to References (e) and (f), that the Joint Trauma Lexicon establishes and defines key common trauma terms used in support of trauma care, operational medical planning, performance improvement, and research across the full range of military operations. The DHA serves as the Military Health System's authoritative source for Joint Trauma Lexicon; therefore, this DHA-PI will be used to update DoD Issuances, Joint Publications (JPs), DHA Publications, and Service-level regulations. The DoD will use these terms where applicable and, if not used, the author of the alternative term and/or definition will disclose the reason.

4. RESPONSIBILITIES. See Enclosure 2.

5. PROCEDURES. See Enclosure 3.

12 non-survivable injury	An injury so severe the casualty would not have survived even if all required medical resources were available and appropriate medical care was optimally administered initially and throughout the continuum of care.			X
13 potentially preventable death	A death that occurred from a survivable or potentially survivable injury when the tactical situation limited prompt and/or optimal medical care.			X
14 potentially survivable injury	An injury that the casualty might have survived if all required medical resources were available and appropriate medical care was optimally administered initially and throughout the continuum of care.			X
15 preventable death	A death that occurred from a survivable injury when the tactical situation did not limit prompt or optimal medical care.		X	
[redacted]				
21 survivable injury	An injury that the casualty should have survived if all required medical resources were available and appropriate medical care was optimally administered initially and throughout the continuum of care.			X

Conclusion

- Understanding battlefield mortality is a vital component of the trauma system
  - Trauma system optimization
  - TCCC improvements
  - Data driven research and development focus
  - Command emphasis
  - Training & tactical perspective
  - Equipment and materiel

Multiinstitutional Multidisciplinary Injury Mortality Investigation in Civilian PreHospital Environment

PIs:Eastridge, Nolte, MacKenzie

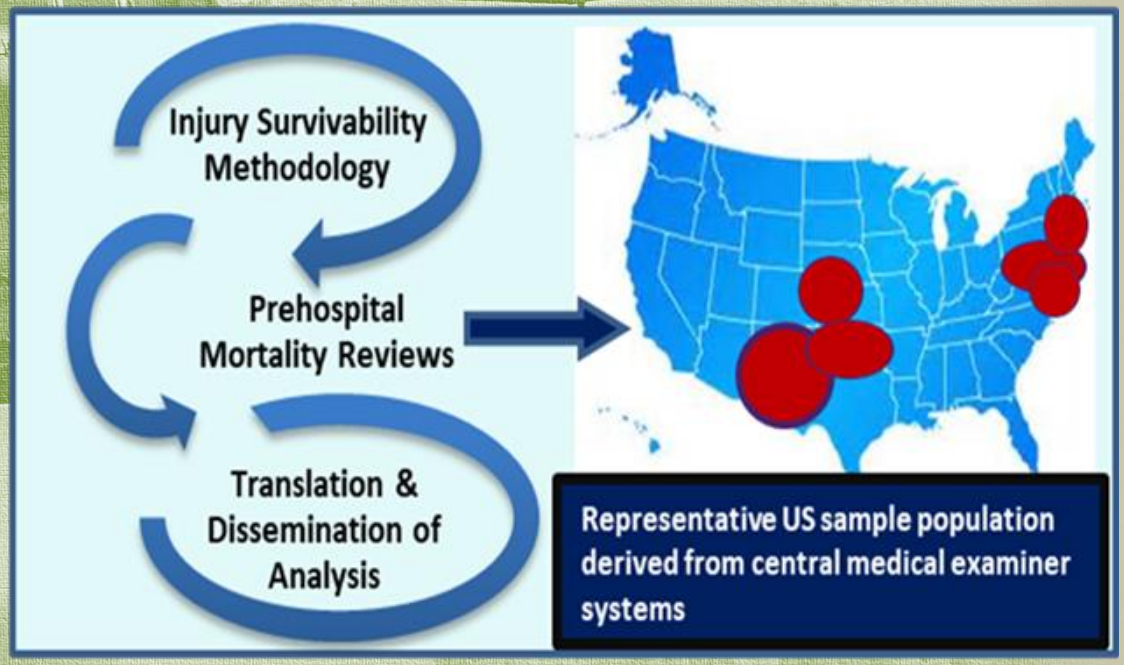
Funded by USAMRMC
(Department of Defense)

Purpose of this proposal is to develop a coordinated, multidisciplinary, multi-institutional effort within the civilian clinical sector to identify and characterize the causes of pre-mortality from trauma

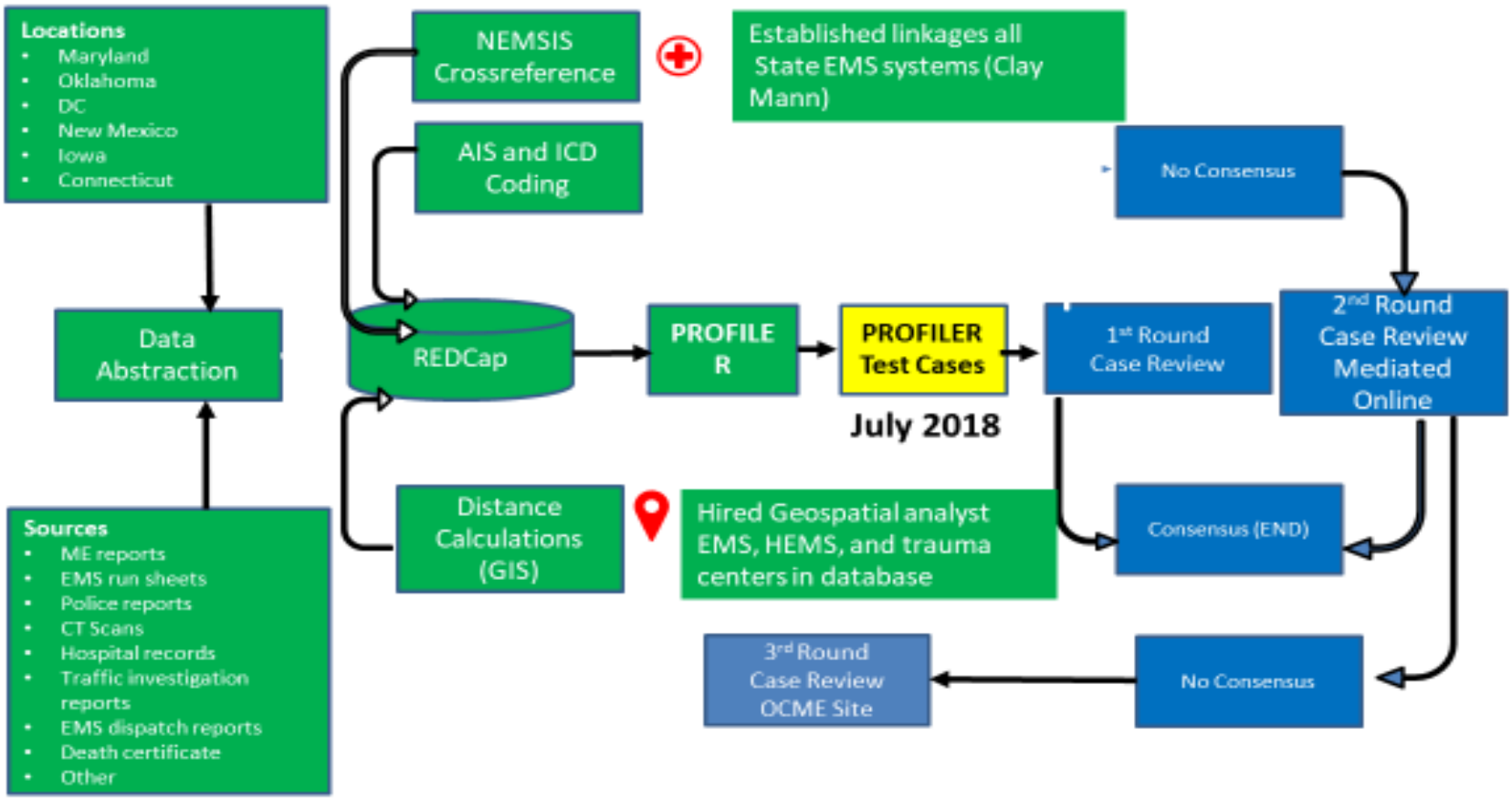
Identify potential high yield areas for research and development in pre-hospital medical care, injury prevention, and trauma systems.

Multi-Disciplinary Multi-Institutional Mortality Investigation in the Civilian Prehospital Environment (MIMIC)

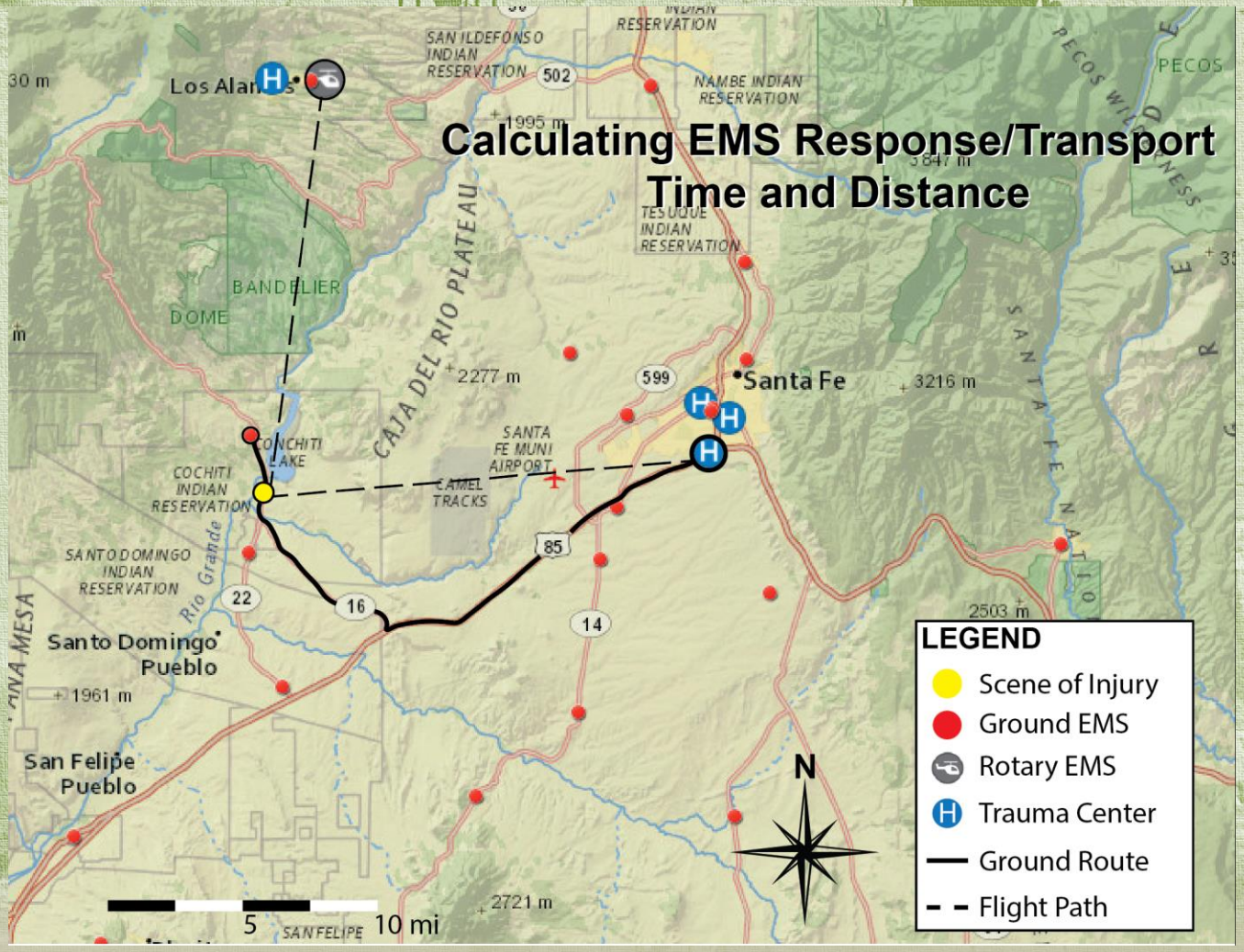
- Develop a framework for evaluating the causes and pathophysiology of pre-hospital deaths
- Network of experts identify the causes of 3,000 pre-hospital deaths due to trauma and estimate potential for survivability.
  - Trauma surgery
  - Neurosurgery
  - Orthopedic surgery
  - Forensic pathology
  - Emergency medicine
  - Emergency medical services



MIMIC


Locations
Maryland
Oklahoma
DC
New Mexico
Iowa
Connecticut
NEMSIS Crossreference
Established linkages all State EMS systems (Clay Mann)
AIS and ICD Coding
No Consensus
Data Abstraction
REDCap
PROFILE R
PROFILER Test Cases
July 2018
1st Round Case Review
2nd Round Case Review Mediated Online
Sources
ME reports
EMS run sheets
Police reports
CT Scans
Hospital records
Traffic investigation reports
EMS dispatch reports
Death certificate
Other
Distance Calculations (GIS)
Hired Geospatial analyst EMS, HEMS, and trauma centers in database
Consensus (END)
3rd Round Case Review OCME Site
No Consensus

Integrating Geospatial Modeling



Project Update

Data Abstraction

- 2,539 of 3,000 cases have been abstracted

Coding

- AIS/ICD – 860 cases completed
- GIS – 2,587 cases completed

Case Reviews

- Created 13 review team panels each consisting of 4 surgeons, 1 EM/EMS reviewer, and 1 Forensic Reviewer. All panels have a reviewer with past military experience, and a minimum of 1 female reviewer on each panel.
- Case reviews were launched to the first review team panel in January 2019.
- To date, 775 cases have been released to panels.
- 585 cases have been completed.

Preliminary
Round 1 and Round 2 Data

- Q2: Assume the survival status of this patient is unknown, with immediate access to care at a level I trauma center, assess the survival potential of this patient.

RESEARCH AND DEVELOPMENT OPPORTUNITIES TO INFORM INJURY PREVENTION

	Frequency
	322 (78%)
	87 (21%)
Definitely Survivable	5 (1%)
Cannot Judge	0

Note: Using 414 cases that have reached consensus on survivability assessments

Preliminary
Round 1 and Round 2 Data

- Q3: Assume the survival status of this patient is unknown, given the conditions of the actual scenario in which the injury occurred (i.e. discovery, EMS response, access to trauma center, weather etc.), assess the survival potential of this patient

Actual Scenario Survivability	Frequency
	389 (94%)
	24 (6%)
	1
Cannot Judge	0

OPPORTUNITIES TO IMPROVE CURRENT TRAUMA SYSTEM

Note: Using 414 cases that have reached consensus on survivability assessments

Immediate Access Survivability	Frequency
Non-survivable	322 (78%)
Potentially Survivable	87 (21%)
Definitely Survivable	5 (1%)
Cannot Judge	0

RESEARCH AND DEVELOPMENT OPPORTUNITIES TO IMPROVE FUTURE TRAUMA SYSTEMS

Actual Scenario Survivability	equency
Non-survivable	9 (94%)
Potentially Survivable	24 (6%)
Definitely Survivable	1
Cannot Judge	0

Preliminary
Round 1 and Round 2 Data

- Q4: Which injury prevention programs/devices or interventions might have improved the chances of survival for this individual?

Prevention Program(s)	Frequency
Behavioral health	777
Alcohol / drug	469
Seat belt	149
Airbag	55
Helmet	34
Child Restraint	5
Protective Clothing	5
Personal Flotation Device	4

***Note:** Using records from all reviewers in Round 1 and Round 2.*

Current State

Gaps and Vulnerabilities

Opportunities

Combat Casualty Death Review

Does the DoD have at present reliable methodology for reviewing all combat fatalities and identifying those deaths that might have been prevented if optimal care had been provided?

DoD CCC Mortality Analysis Current State

- Interval process based upon established DoD CCC mortality review process
- Ability of JTS subject matter experts to perform comprehensive reviews of battlefield deaths proximate to date of death
- Ability of Armed Forces Medical Examiner System (AFMES) to perform full autopsy analysis of combat casualty deaths supported by low operational tempo
- Limited prehospital Tactical Combat Casualty Care data
- Mortality review focuses determinations based upon most severe injuries

DoD CCC Mortality Analysis
Gaps and Vulnerabilities

- Lack of prehospital data limits ability of JTS / AFMES review team to examine salient factors necessary to render decision
- Review and cataloging of combat mortality injury survivability data is not codified by “requirement”
- Sensitivity and operational security issues may limit open discussion and review of cases

DoD CCC Mortality Analysis
Gaps and Vulnerabilities

- Complete autopsy, including imaging may be constrained / delayed by high operational tempo scenarios
- Review process based upon single system injury severity likely underestimates the complex interactions of multiple injuries

DoD CCC Mortality Analysis Opportunities for Improvement

- Develop requirement for mortality review process and support with commensurate policy (mandate) and resources (monies, manpower) (Near/Immediate)
- Codify mortality review construct (policy, mandate, enforcement) to ensure standardized care, documentation, and data collection practices are performed and transferred to the AFMES and JTS (Near/Immediate)
- Mandate prehospital care documentation (Near/Immediate)

DoD CCC Mortality Analysis Opportunities for Improvement

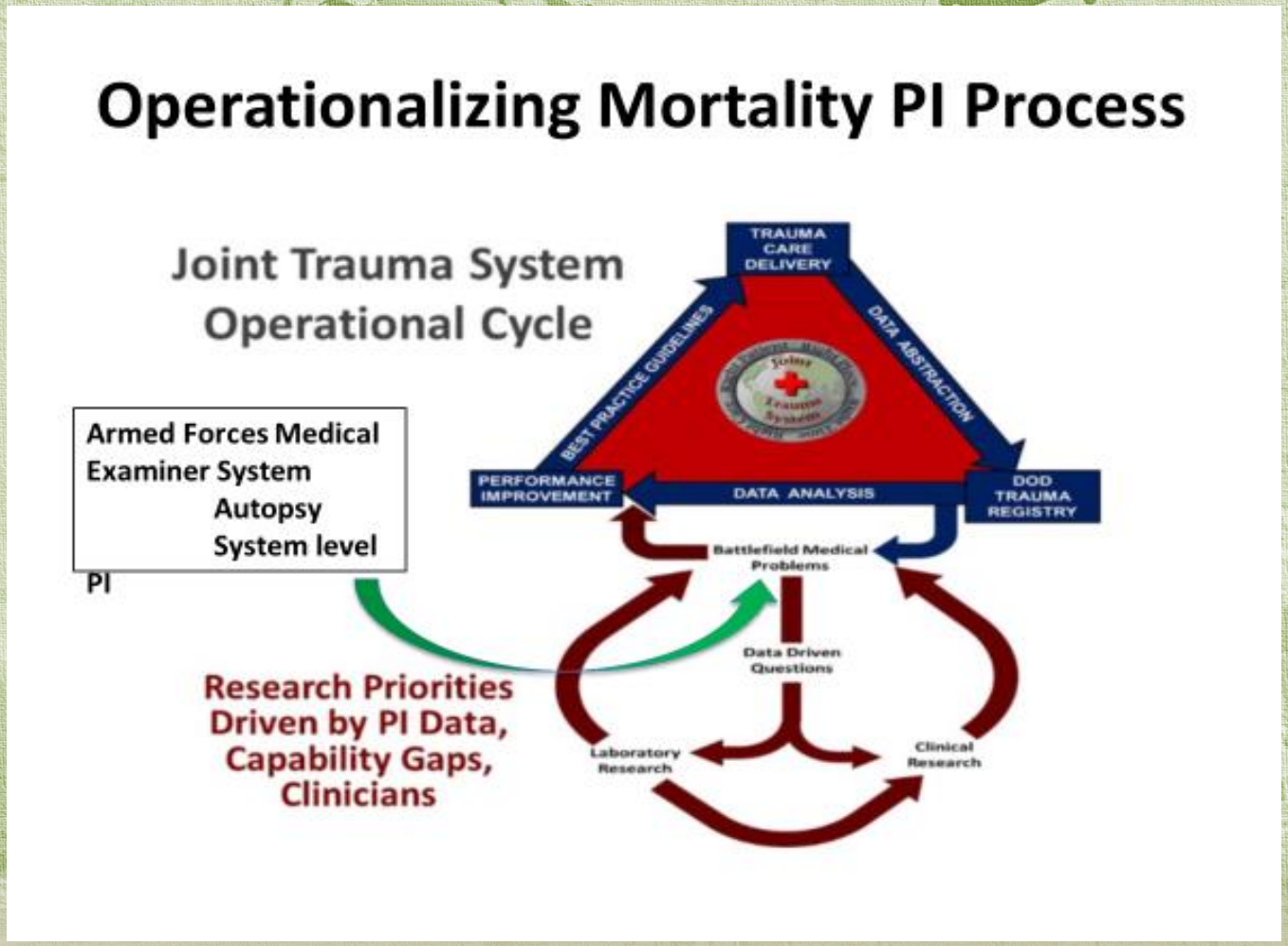
- Augmented ME workforce / contingency plan for mass casualty producing events (Peer / Near Peer / High Volume Casualty Producing Event)
- Consider specialty of Forensic Pathology critical wartime specialty (5 Year)
- Develop interactional review / assessment algorithms for injury mortality outcome determination (5 year)
  - Artificial intelligence solution based upon data (15 year)

Performance Improvement and Loop Closure

For all fatalities identified as preventable or potentially preventable, is there reliable methodology for determining what could have been done differently that might have prevented the casualty's death?

Is there reliable methodology for ensuring that the needed improvements have been made?

PI / Loop Closure
Current State



PI / Loop Closure
Current State

- JTS / TCCC integrate mortality review assessments into system performance improvement activities
- AFMES liaison to the JTS charged with review of battlefield deaths for system PI codified in DHA-AI 107.

PI / Loop Closure
Gaps and Vulnerabilities

- Fundamental challenges related to the perception of performance improvement activities
  - Perception as punitive process limits stakeholder engagement
- Current military investigative processes
  - Perception of wrongdoing
  - UCMJ implication

PI / Loop Closure Opportunities

- Formal integration of performance improvement process in relevant doctrine **(5 year)**
- Further develop "learning healthcare system" perspective of the JTS **(Near/Immediate)**

Informing End User(s)

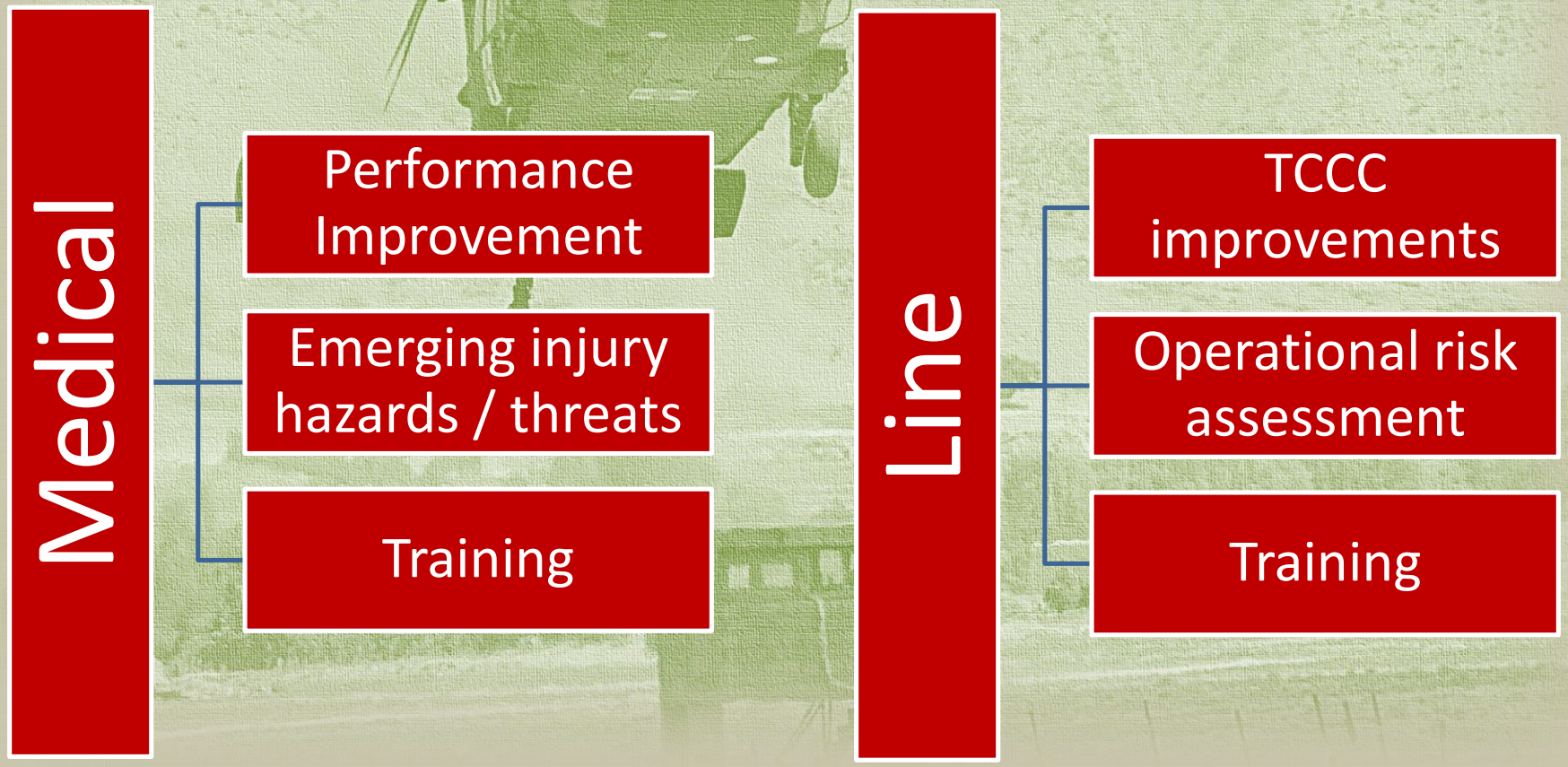
Are these Opportunities for Improvement reliably and effectively communicated to the units and organization that could effect these changes?

Informing End User(s) Current State

- No process exists to effectively communicate mortality review lessons learned to the units and organizations
- No clear pathway exists to disseminate mortality review assessments to leadership
  - Medical
  - Line
- Leadership does not understand the implications and value of combat casuaty mortality review information

Informing End User(s)
Gaps and Vulnerabilities

Unrealized Potential Value



Informing End User(s) Opportunities

- **Develop and implement a formal process to inform commanders about the care and outcomes of their troops (Near/Immediate)**
  - **Communication "pipeline" directly to commanders (medical and non-medical) for their visibility in order to inform decision-making and action**
    - **Medical**
    - **Operational (Near/Immediate)**

Summary

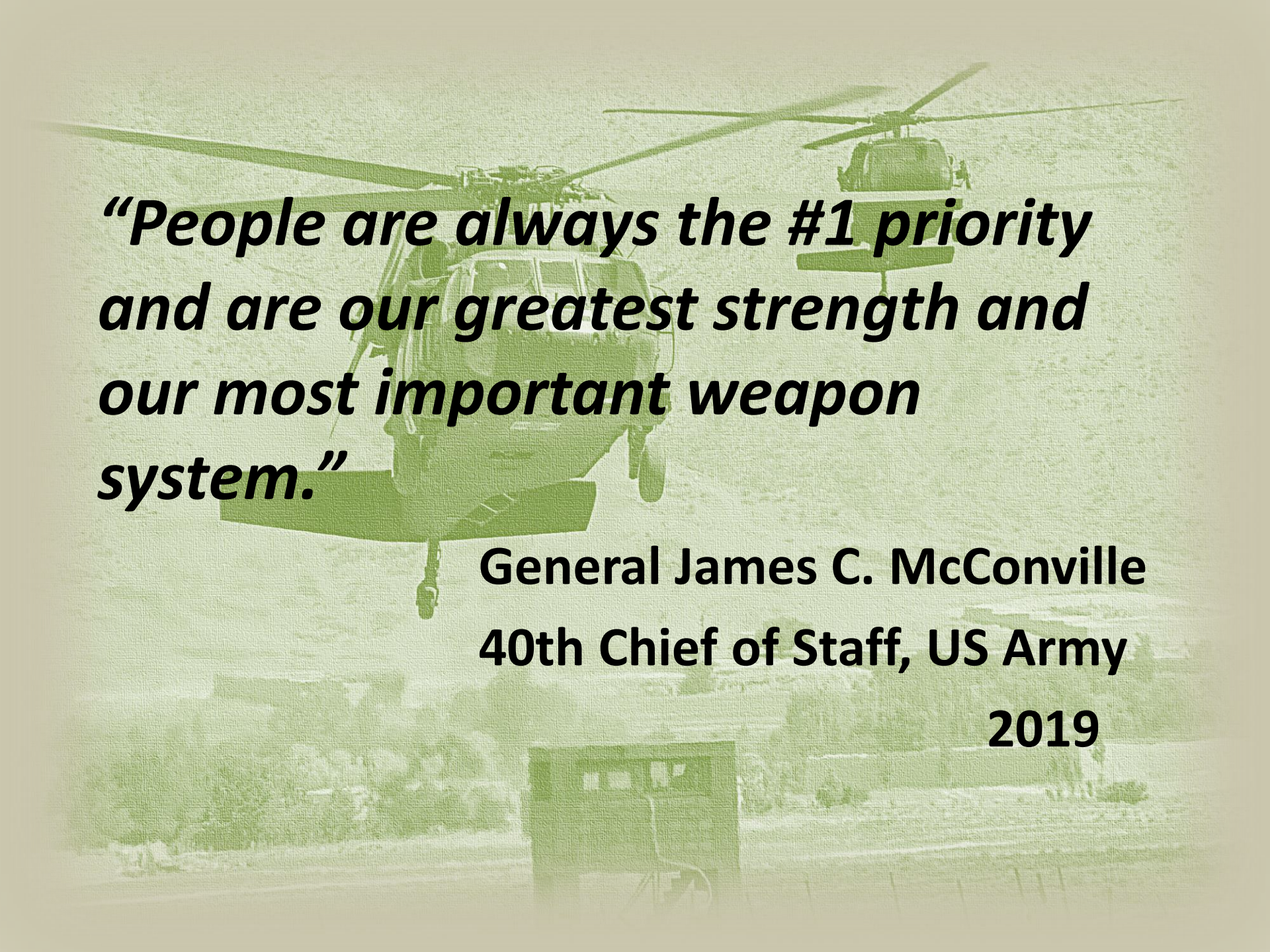
- Battlefield death secondary to injury is a significant operational mission capability issue
  - Majority of deaths in occur pre-hospital environment
  - 24% combat casualty deaths potentially survivable of which most are hemorrhage related
  - Mortality review data informs
    - Training
    - Clincal care
    - Research
    - Operational considerations

Summary

- DoD must develop an organizational commitment to understanding combat casualty mortality and eliminating potentially preventable death.
- Insightful analysis of combat casulty deaths valuable for informing battlefield care, training, the combat casualty research and development agenda, as well as supporting operational risk assessment.

Summary
Highest Value Opportunities

- Develop requirement for mortality review process and support with commensurate policy (mandate) and resources (monies, manpower) (Near/Immediate)
- Develop interactional review / assessment algorithms for injury mortality outcome determination (5 year)
  - Artificial intelligence solution based upon data (15 year)
- Communication "pipeline" directly to commanders (medical and non-medical) for their visibility in order to inform decision-making and action (Near/Immediate)



“People are always the #1 priority and are our greatest strength and our most important weapon system.”

General James C. McConville

40th Chief of Staff, US Army

2019