Death on the Battlefield Implications for Prevention, Training, and Medical Care

US Army Institute of Surgical Research
and
Armed Forces Medical Examiner Service

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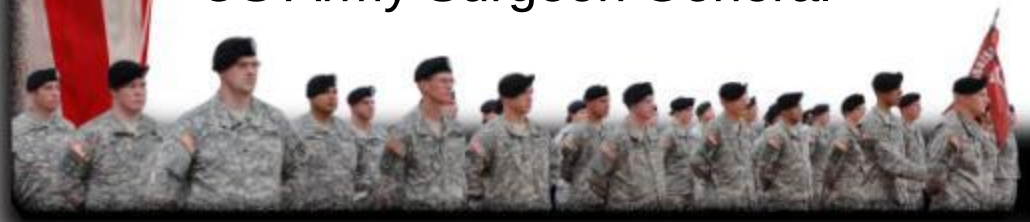

Disclaimer

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JTTS Vision

That every soldier, marine, sailor, or airman injured on the battlefield or in the theater of operations has the optimal chance for survival and maximal potential for functional recovery.

Data Sources

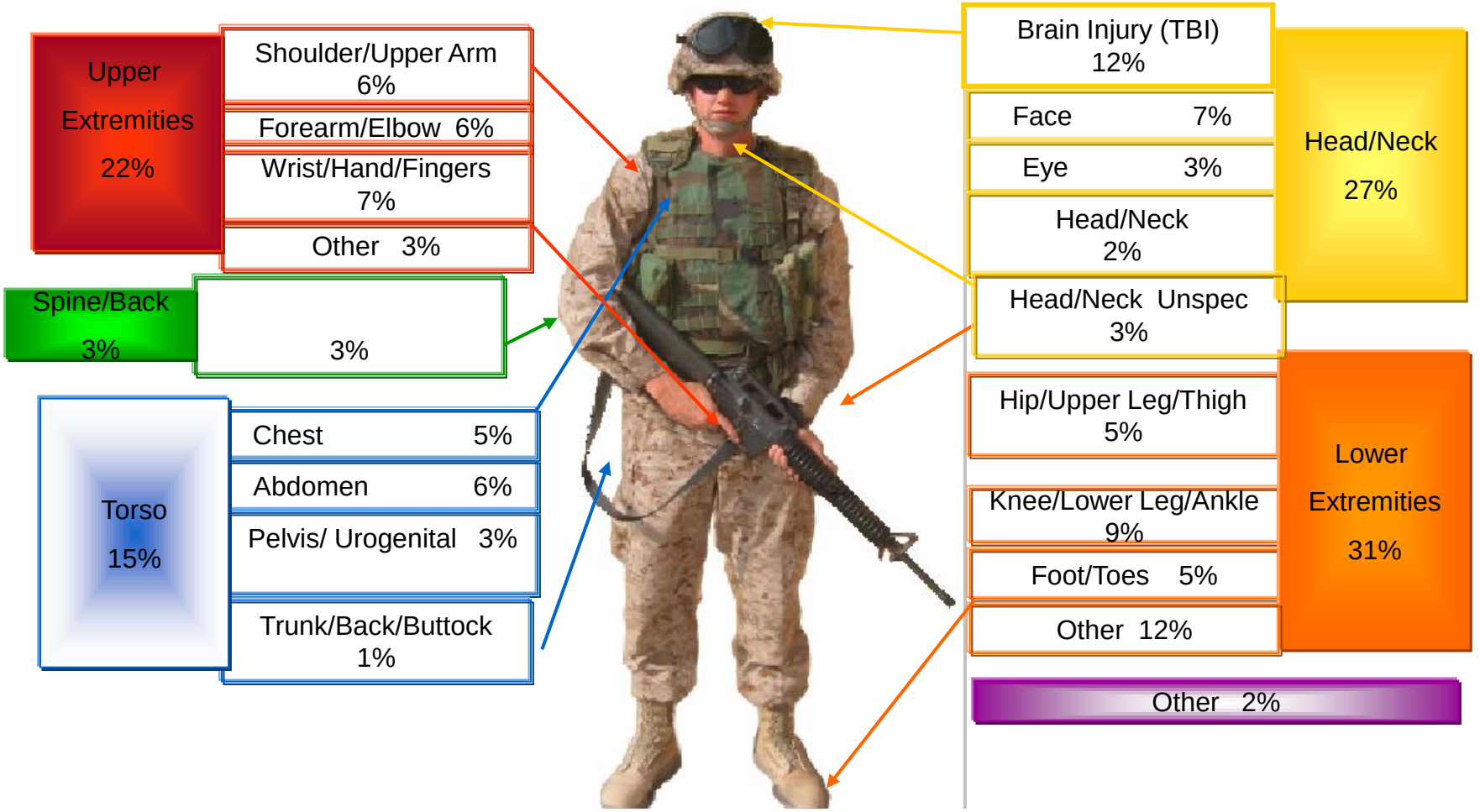
Joint Theater Trauma Registry (JTTR)

- Largest combat Injury database in existence
- All services injury data derived from level IIb, III, IV and V medical charts
  - Scoring of Injuries
  - Diagnosis and Procedures
  - Outcomes
- 60,000 US military injury patient records

Armed Forces Medical Examiner System (AFMES)

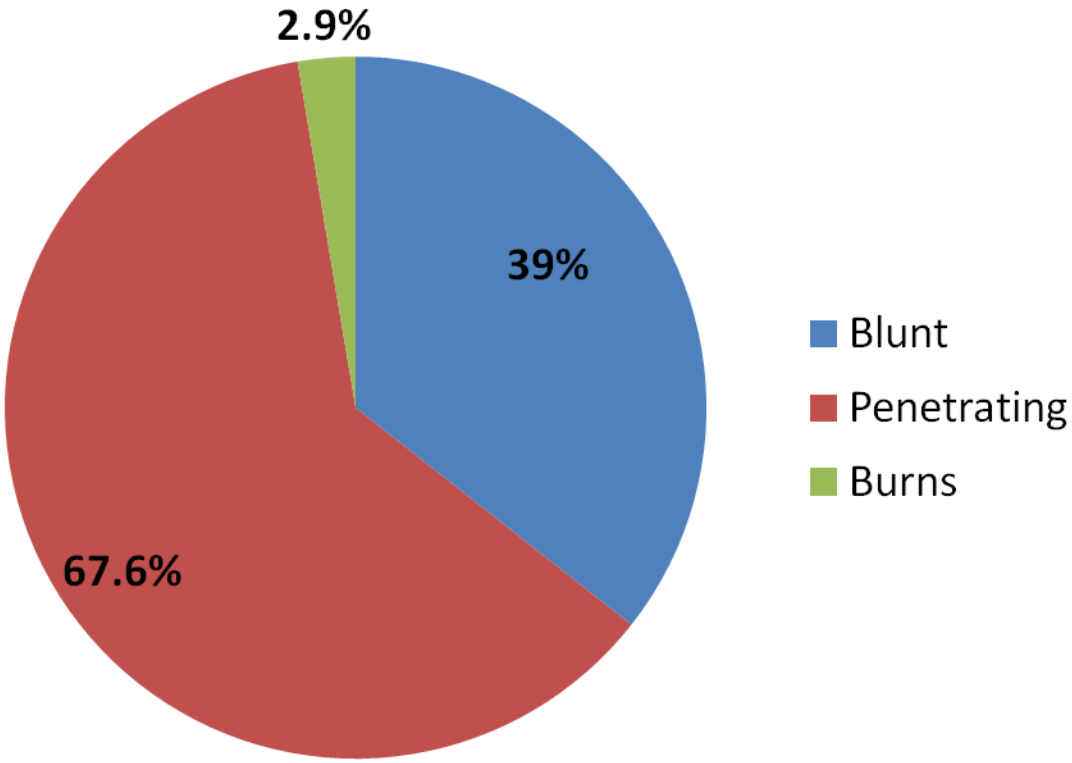
- Maintaining the DoD Medical Mortality Registry. The registry component, which has the broader mission of analyzing all active duty deaths for trends and preventable or modifiable risk factors.

Battle Injuries by Body Region

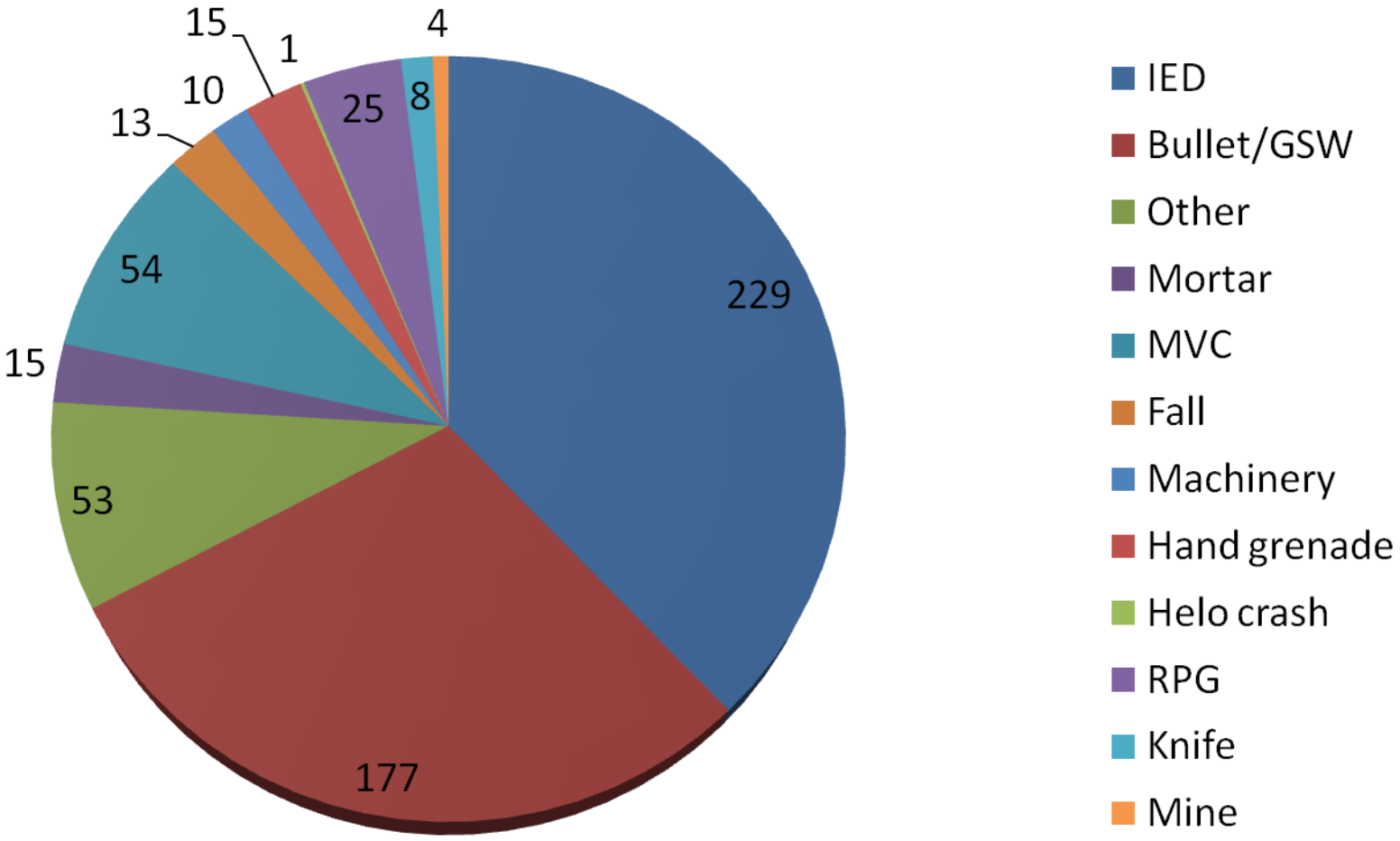


Source: JTTR September 2001 – September 2011

Dominant Mechanism of Injury



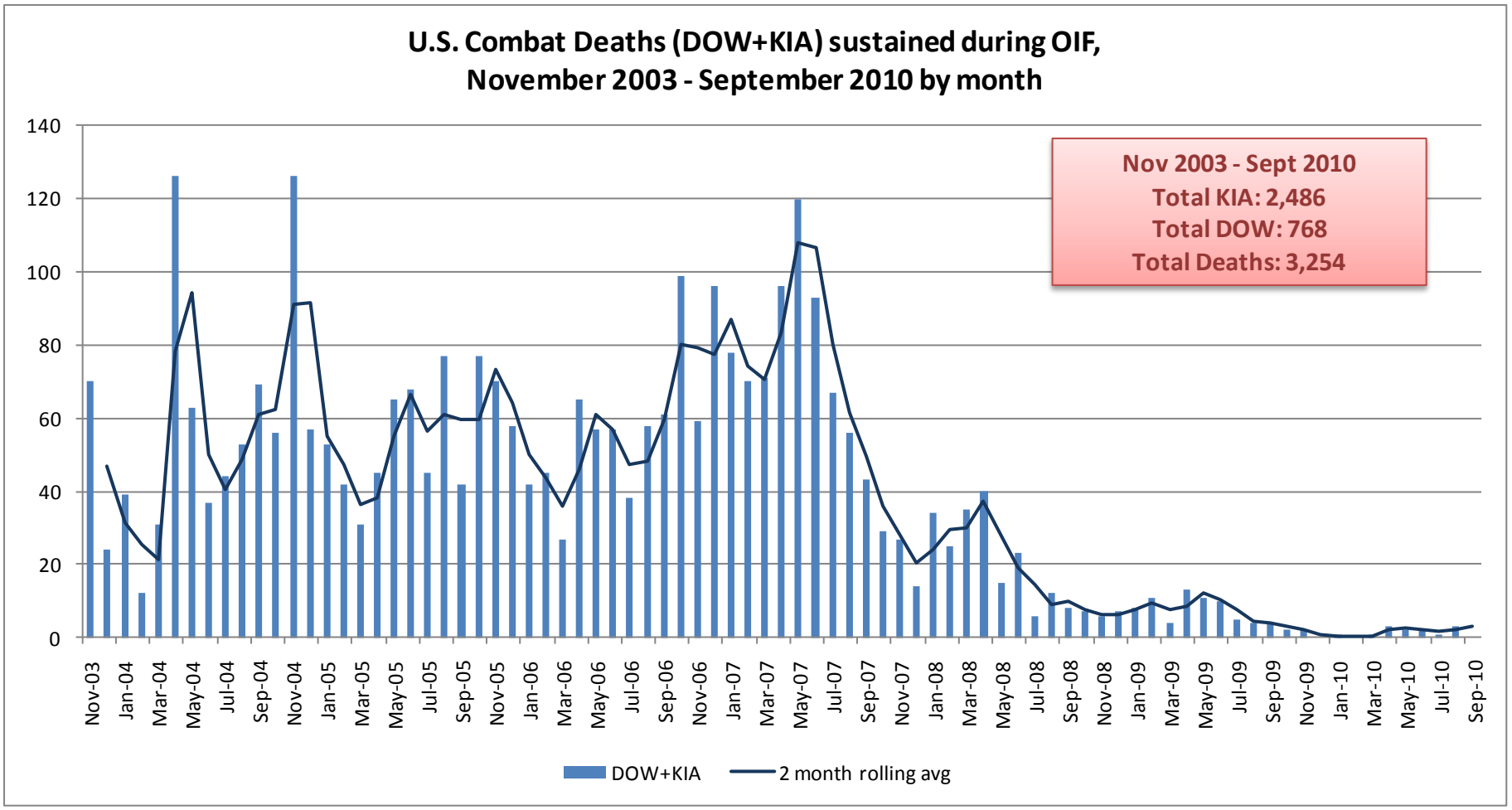
Cause of Injury



**Includes both battle and non-battle injury*

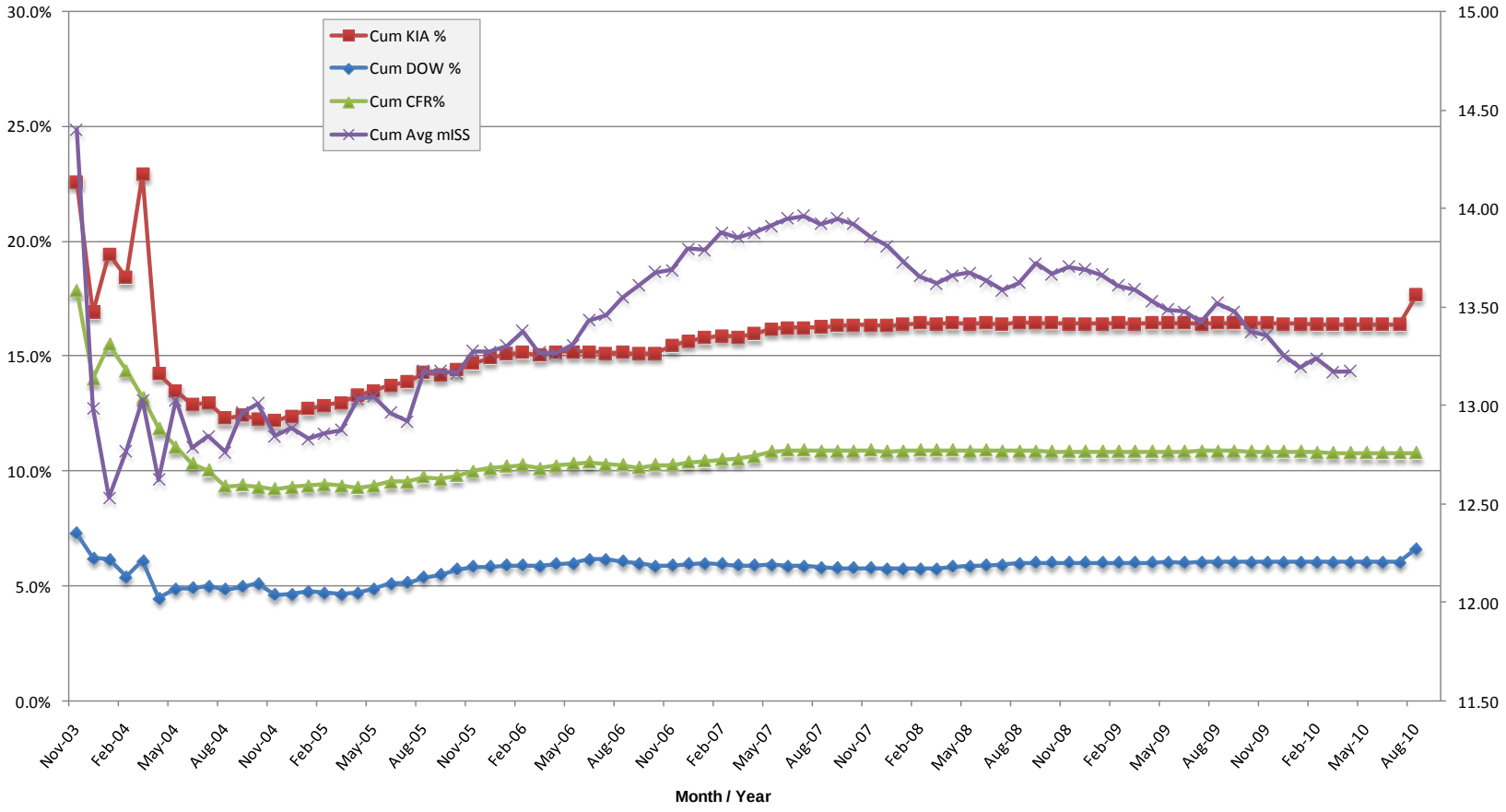
Combat Casualty Care Statistics

- %KIA = $\frac{\text{Deaths before MTF}}{\text{KIA + (WIA – RTD)}} \times 100$
- %DOW = $\frac{\text{Died after reaching MTF}}{\text{WIA – RTD}} \times 100$
- CFR = $\frac{\text{KIA + DOW}}{\text{KIA + WIA}} \times 100$



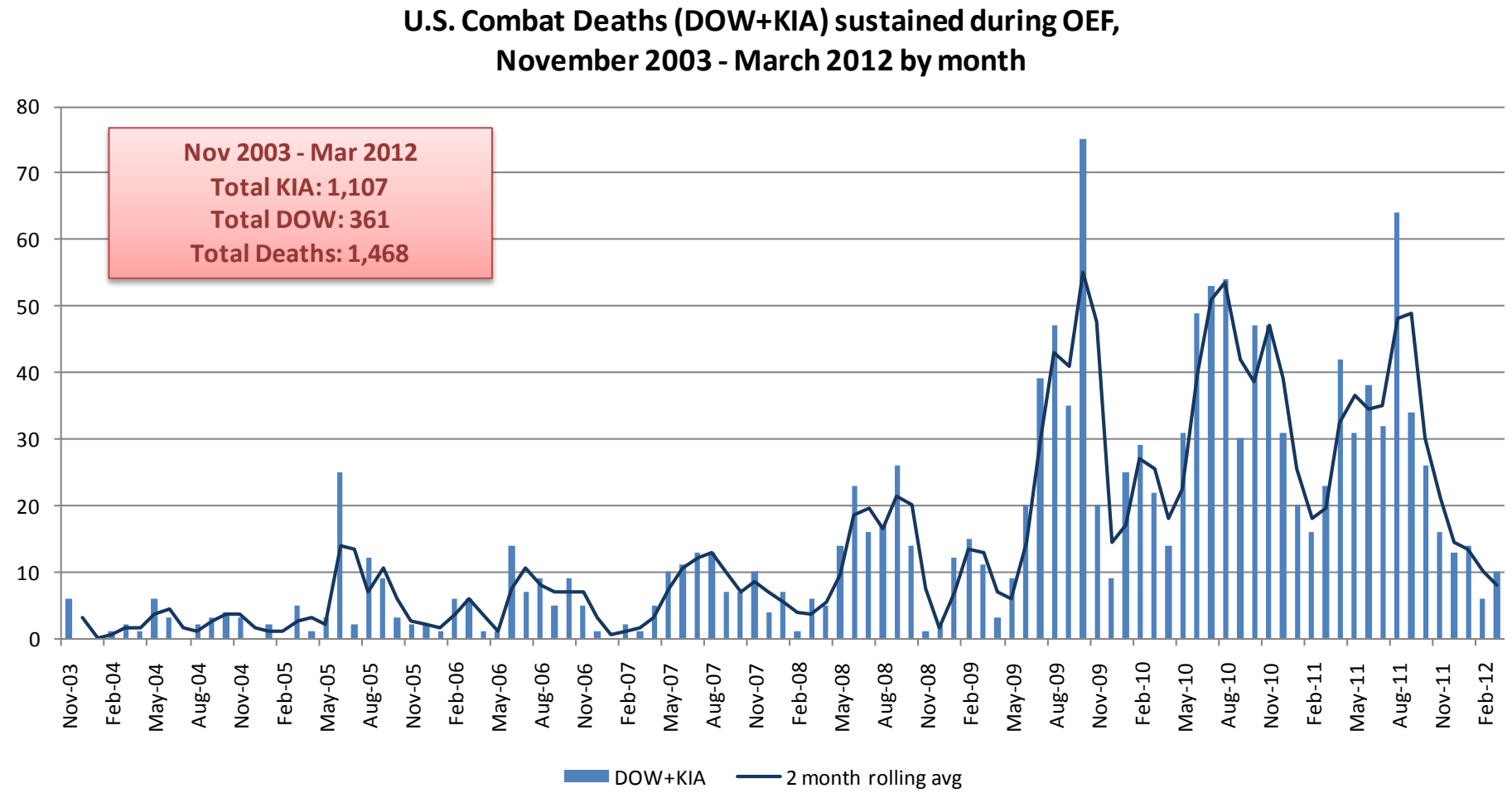
Produced by the Joint Theater Trauma Registry
Data Source: JTTR v.3 data extract supplemented by data provided by DMDC & US Pentagon

OIF Cumulative Rolling Monthly Averages



Produced by the Joint Theater Trauma Registry
Data Source: JTTR v.3 data extract supplemented by data provided by DMDC Statistical Analysis Division & US Pentagon OSD

U.S. Combat Deaths Sustained during OEF



Produced by the Joint Theater Trauma Registry
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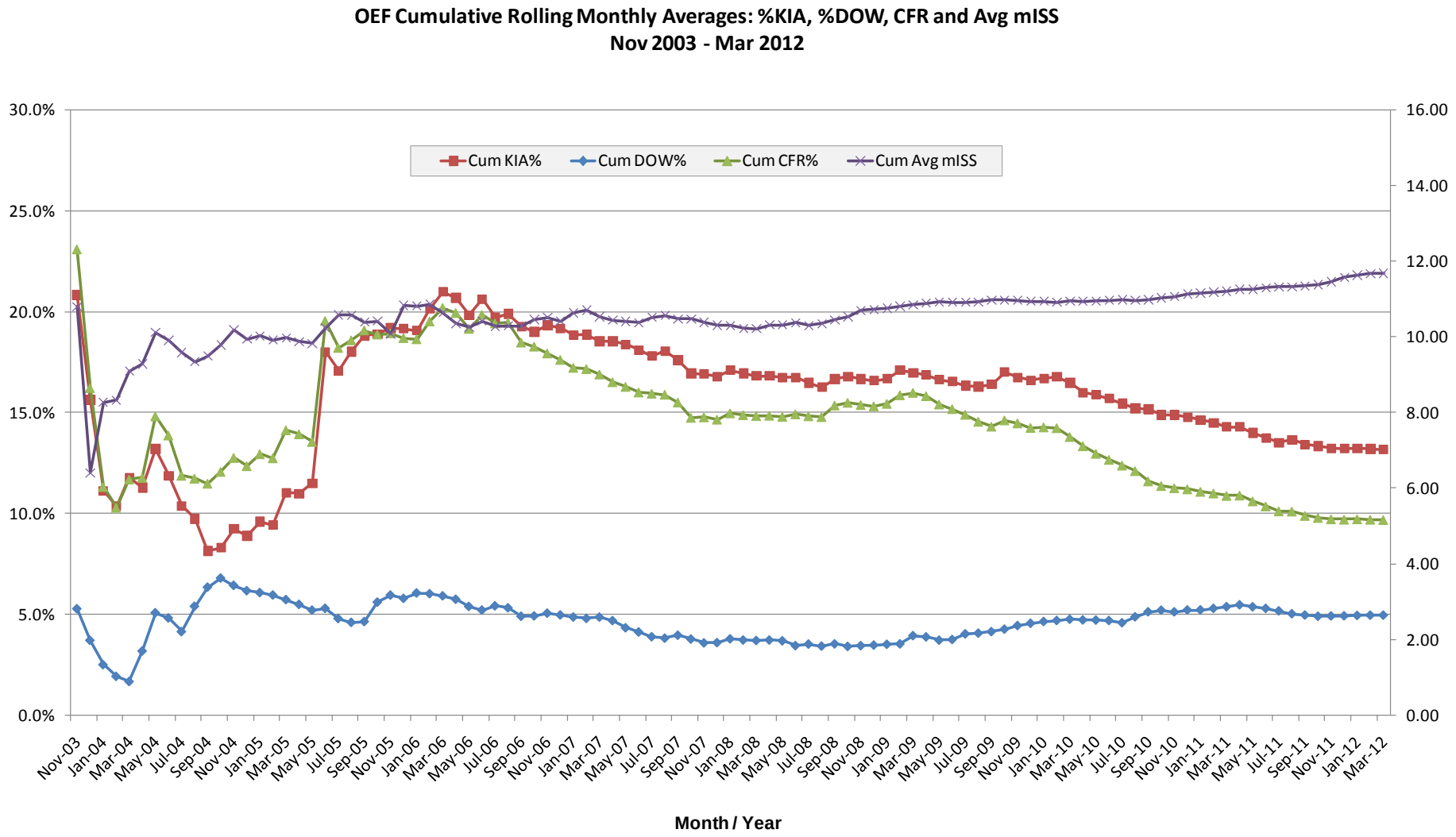
OEF Cumulative Rolling Monthly Averages



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Data Source: JTTR v.3 data extract supplemented by data provided by DMDC Statistical Analysis Division & US Pentagon OSD

Breakdown between WWII, Vietnam, and Iraq/Afghanistan Troops.

How are we doing? Why?

	WW II	Vietnam	Iraq/ Afghanistan
% KIA	25.3[a]	18.6[b]	12.5[c]
% DOW	3.5[a]	3.0[b]	4.1[c]
CFR	19.1[a]	16.1[b]	10.1[c]

a,b,c < 0.001

Right Patient, Right Place, Right Time, Right Care

OEF: 7 October 2001—31 December 2010

OIF: 19 March 2003—31 December 2010

OEF percentage of survivability, October 2001-December 2010 and OIF percentage of survivability, March 2003-December 2010.

Equipment	Doctrine	TacticsTechniques Procedures	Training

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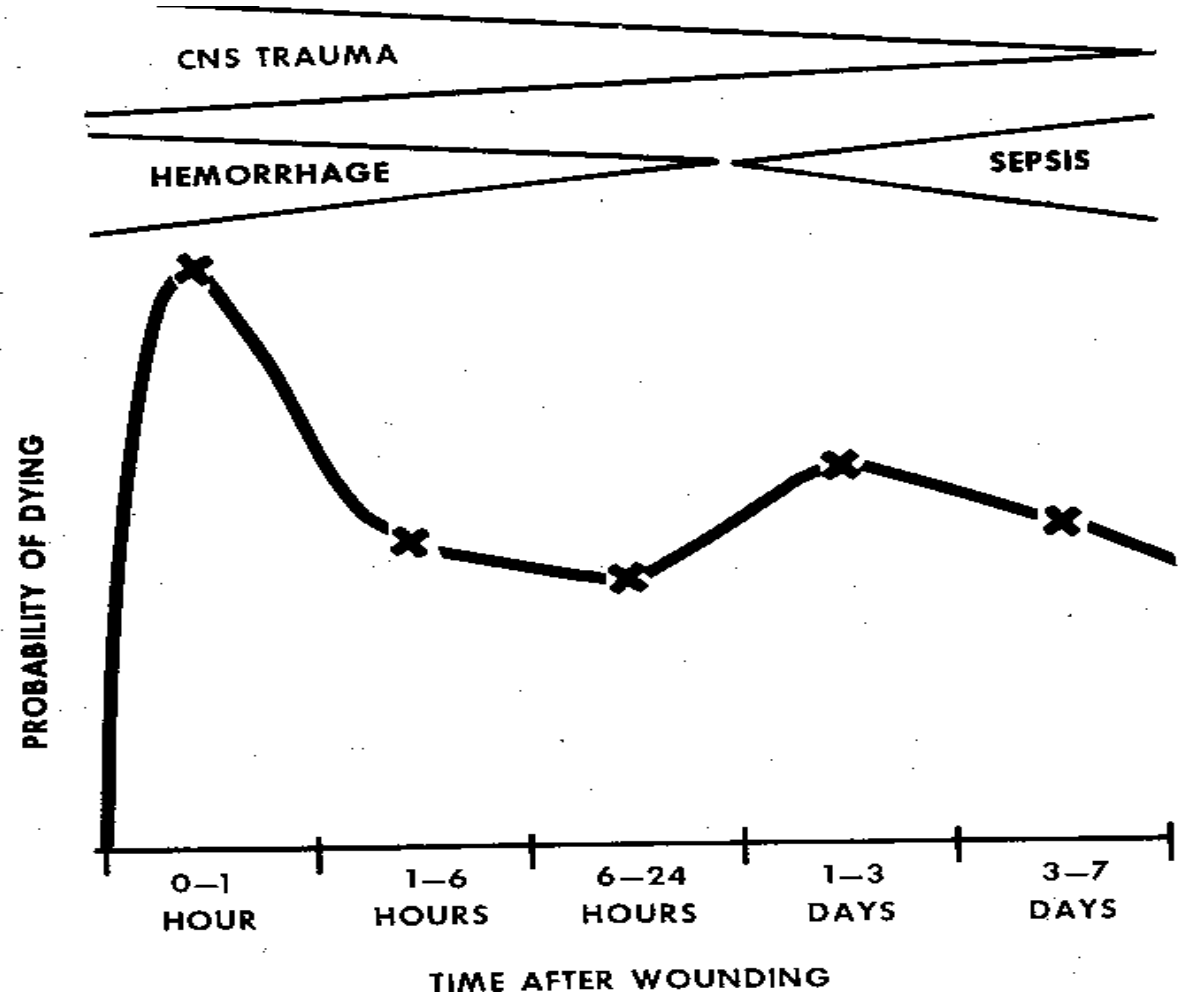
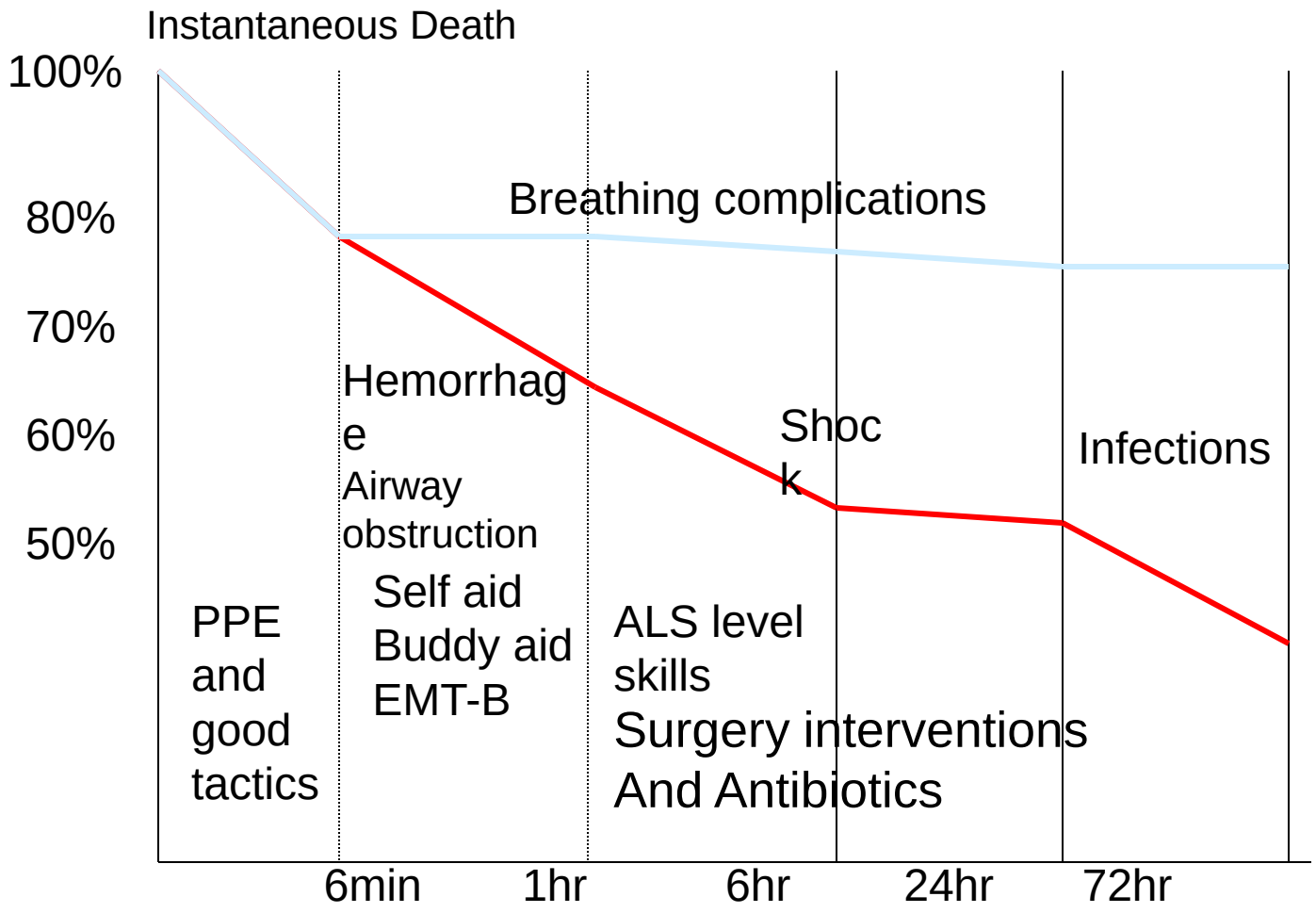
Battlefield Mortality Mechanism and Causation

Empiric Probability Combat Death

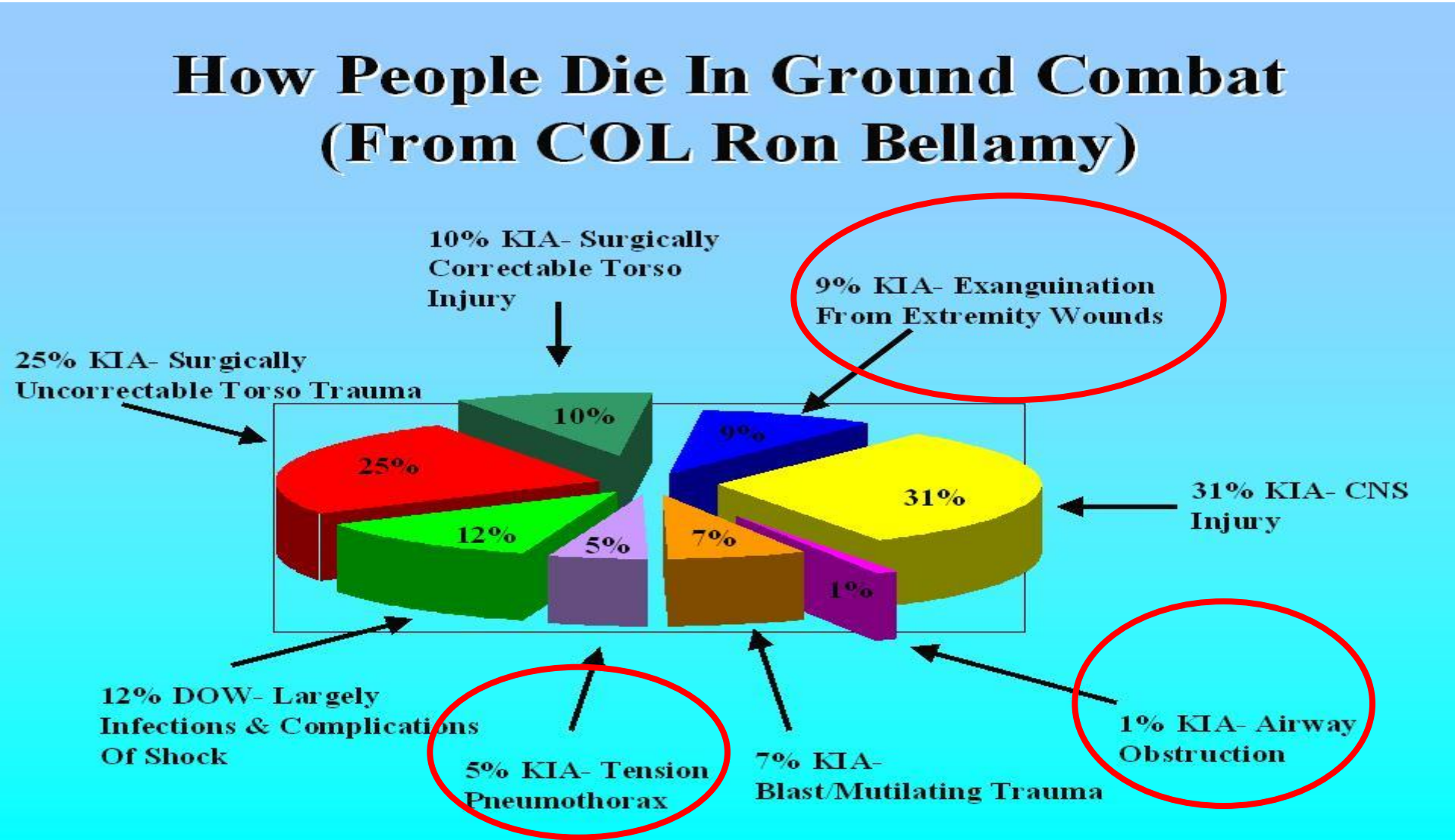


Bellamy, J Trauma, 1984

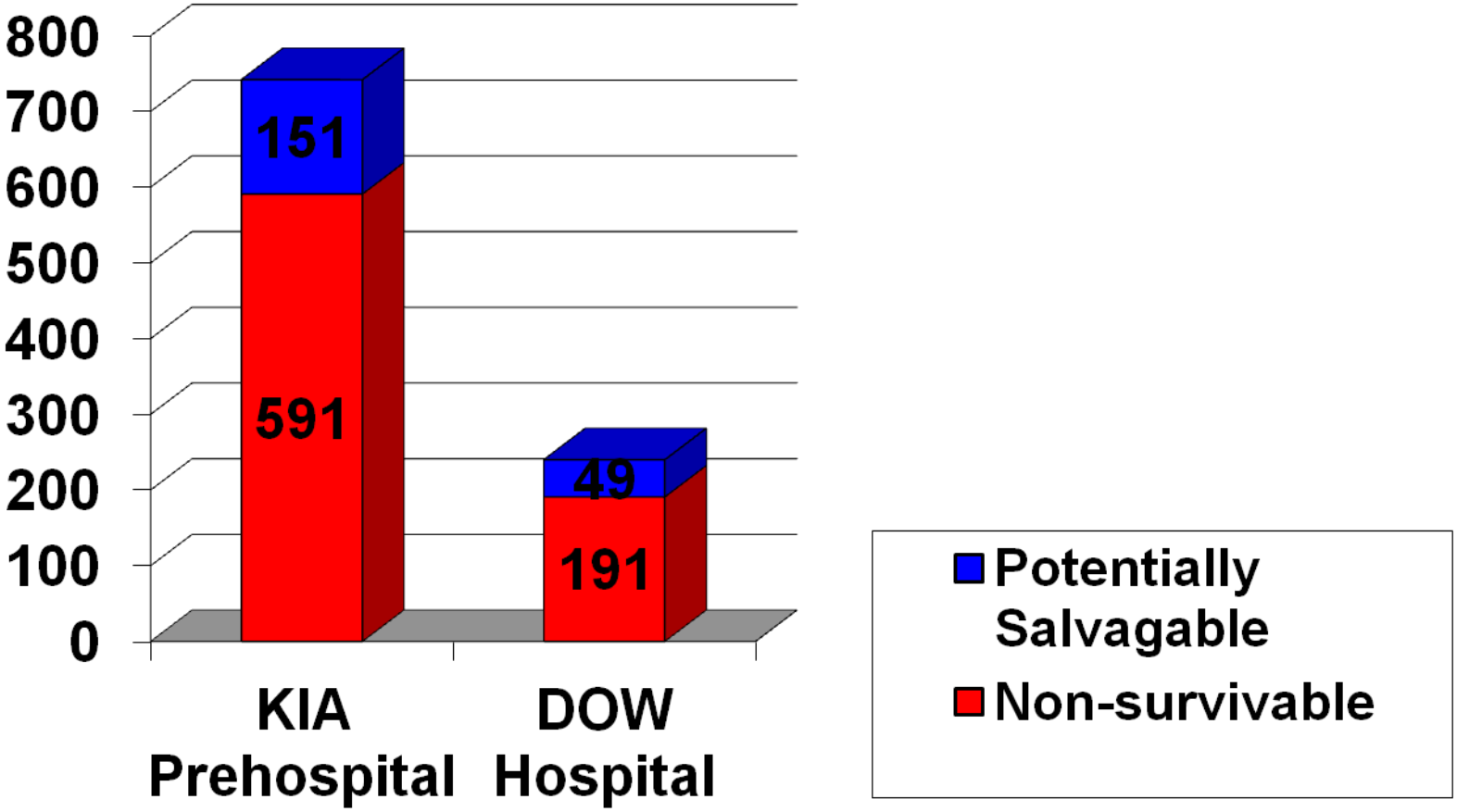
Mortality Penetrating Trauma



How People Die in Ground Combat



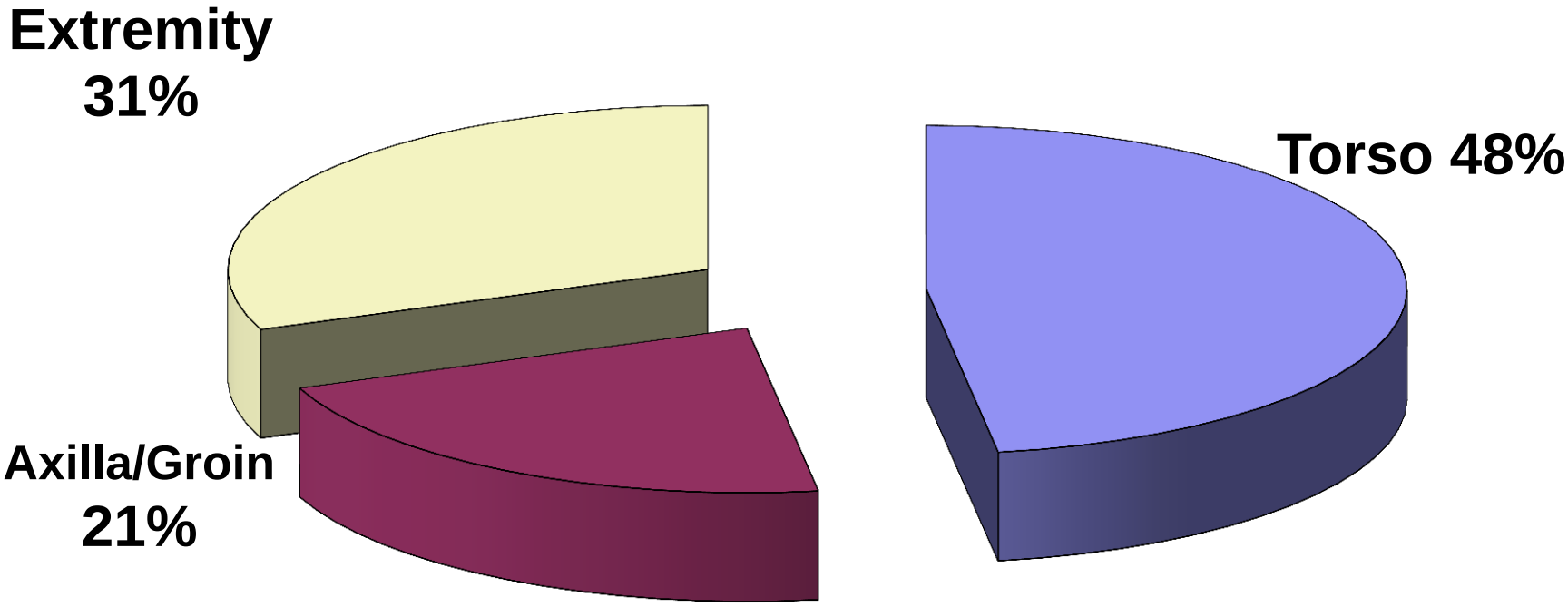
Where can we save the most lives?



Kelly JF, et.al. **Injury severity and causes of death from Operation Iraqi Freedom and Operation Enduring Freedom: 2003-2004 versus 2006**. J Trauma

Potentially Survivable Hemorrhagic Deaths on the Battlefield

Of PS deaths, 79% secondary to hemorrhage



Nearly 50% of deaths not amenable to field control

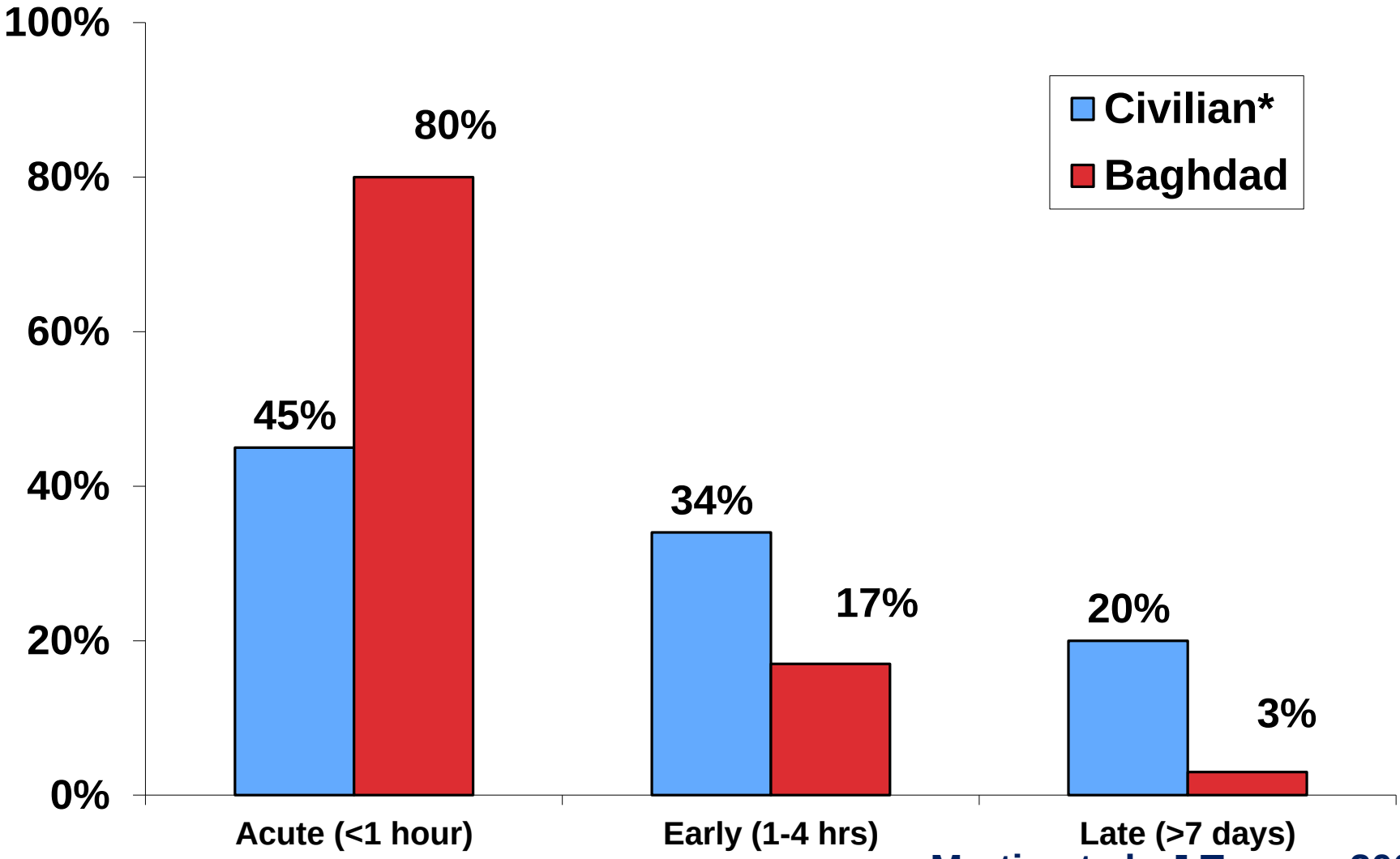
Battlefield Killers

Table 4 Causes of Death Among Potentially Survivable Casualties

Cause of Death*	Group 1 (n = 93) (% Total of PS)	Group 2 (n = 139) (% Total of PS)
CNS	12 (13)	8 (6)
Head	11 (12)	6 (4) ($p < 0.04$)
Neck	1 (1)	0 (0)
Spinal cord	1 (1)	3 (2)
Hemorrhage	81 (87)	116 (83)
Tourniquetable (ext)	31 (33)	46 (33)
Noncompressible (torso)	47 (51)	68 (49)
Nontourniquetable (ax/neck/groin)	19 (20)	29 (21)
Airway	14 (15)	14 (10)
Sepsis/MSOF	2 (2)	9 (6)
Total causes of death identified	219	299

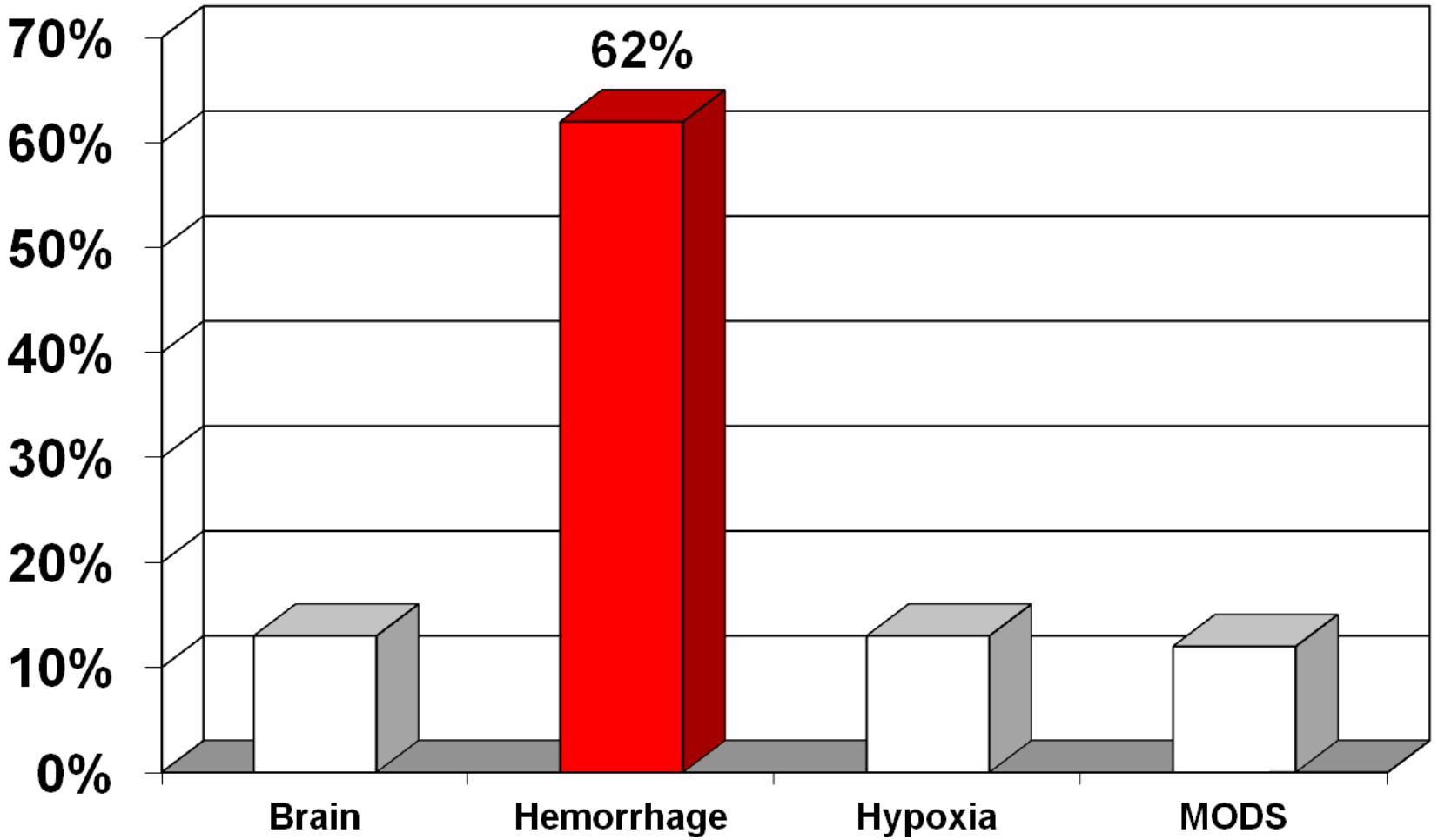
* Casualties could have 1 or more cause of death.
MSOF indicates multisystem organ failure.

Timing of Trauma Death



Martin et al., J Trauma 2009

Combat Hospital Killers



Martin et al., J Trauma 2009

Died of Wounds Analysis

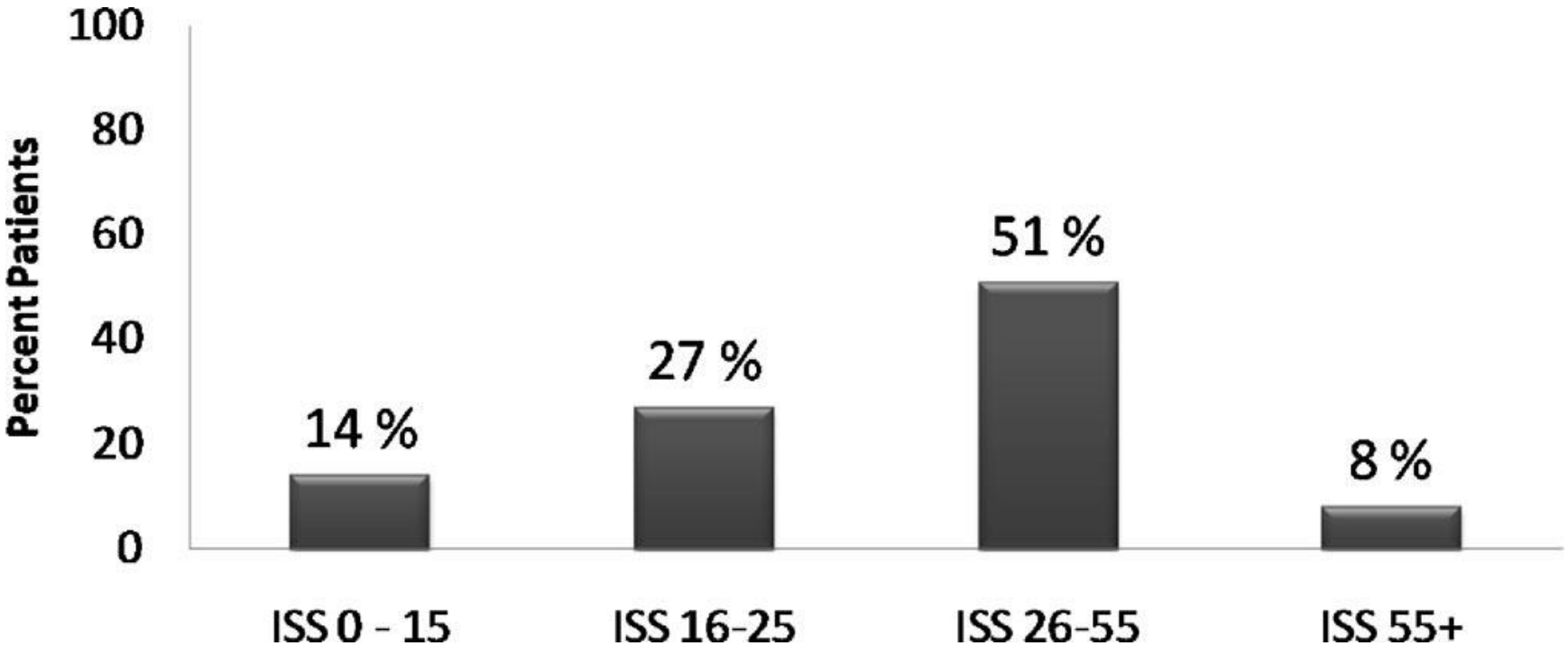
DOW Analysis

- Review died of wounds (DOW)deaths n=558
- Variables
  - Demographics
  - Mechanism and cause
  - Injury severity
- Expert panel trauma surgeons, emergency physiscian, neurosurgeon, and forensic parthologist graded deaths as non survivable or potentially survivable.
- Goal: Identify areas for improved training, medical care, material, research and development

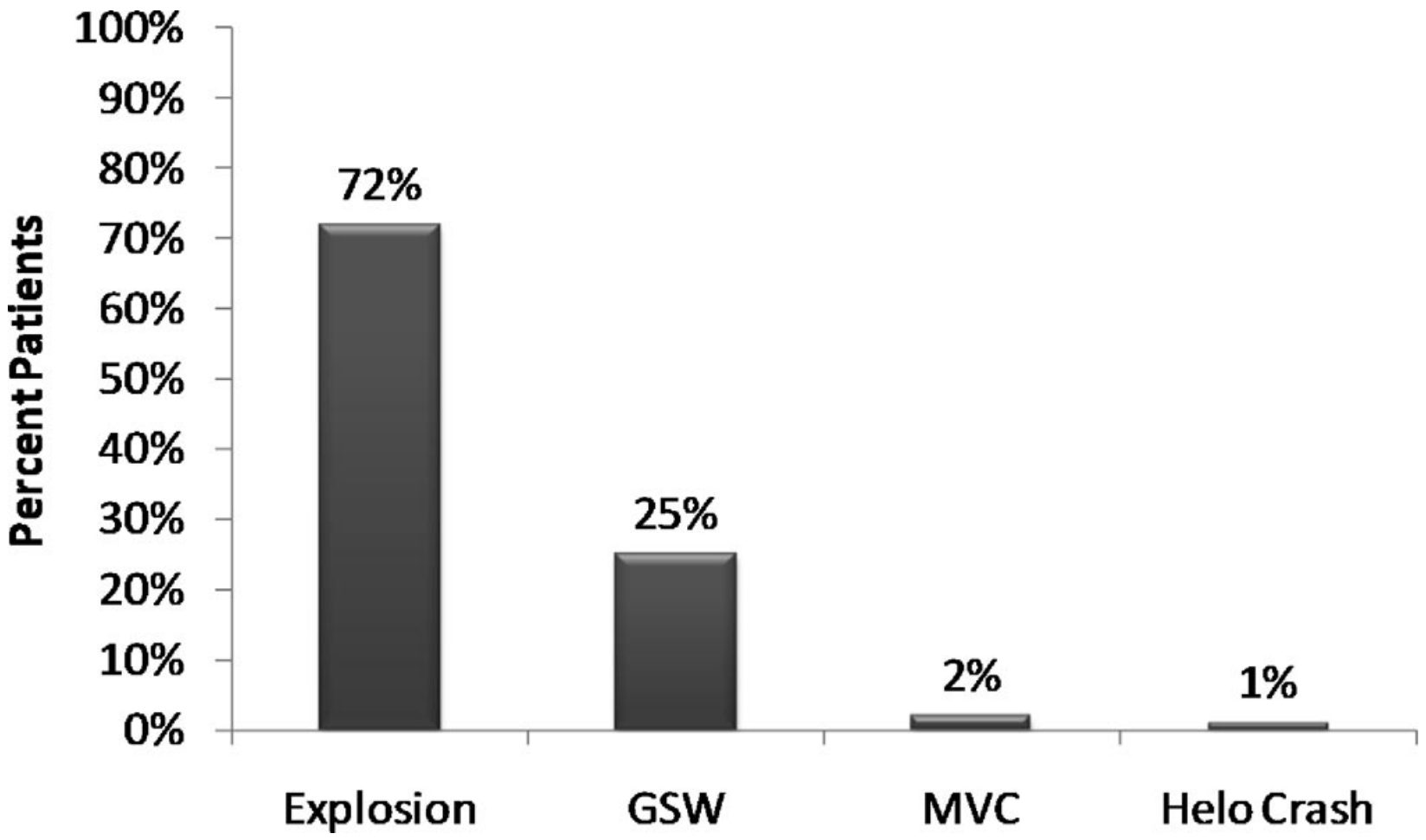
DOW Analysis

- DOW rate 4.6%
- NS in 271 (48.6%) and PS in 287 (51.4%)
- 51% presented in extremis with CPR on admission

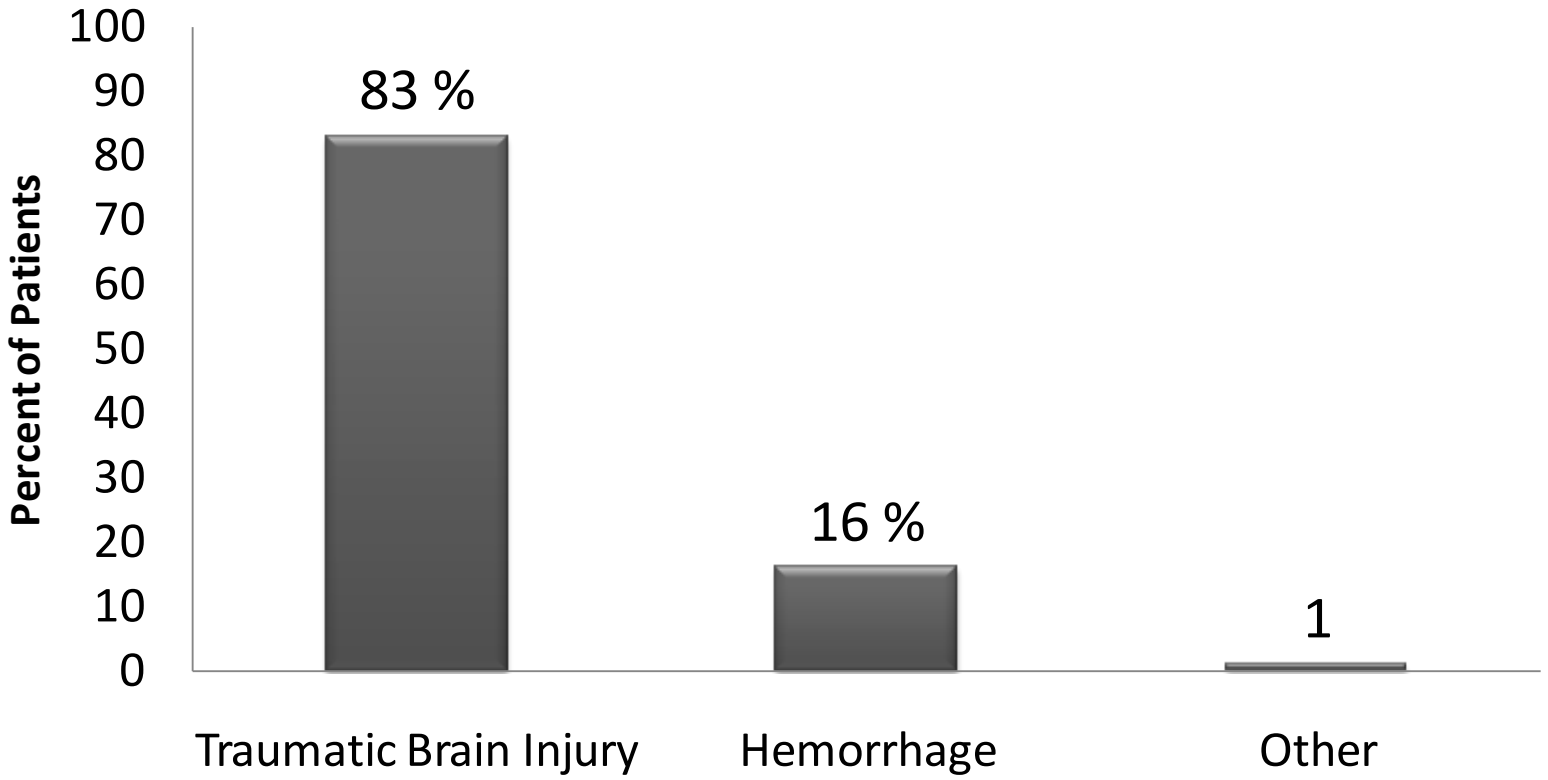
DOW ISS


100
80
60
40
20
0
Percent Patients
14 %
27 %
51 %
8 %
ISS 0 - 15
ISS 16-25
ISS 26-55
ISS 55+

DOW Cause

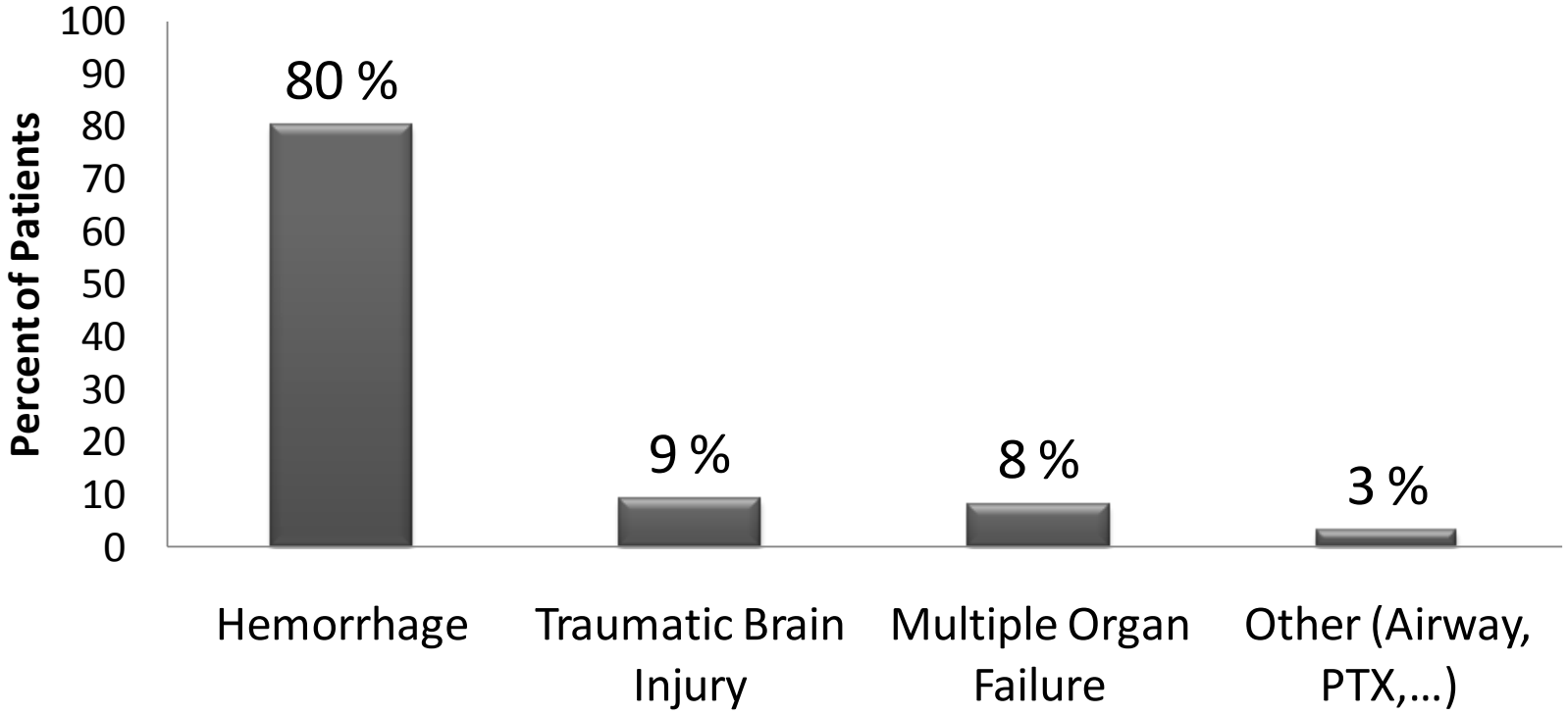

Percent Patients
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
72%
25%
2%
1%
Explosion
GSW
MVC
Helo Crash

DOW
Non-Survivable Etiology



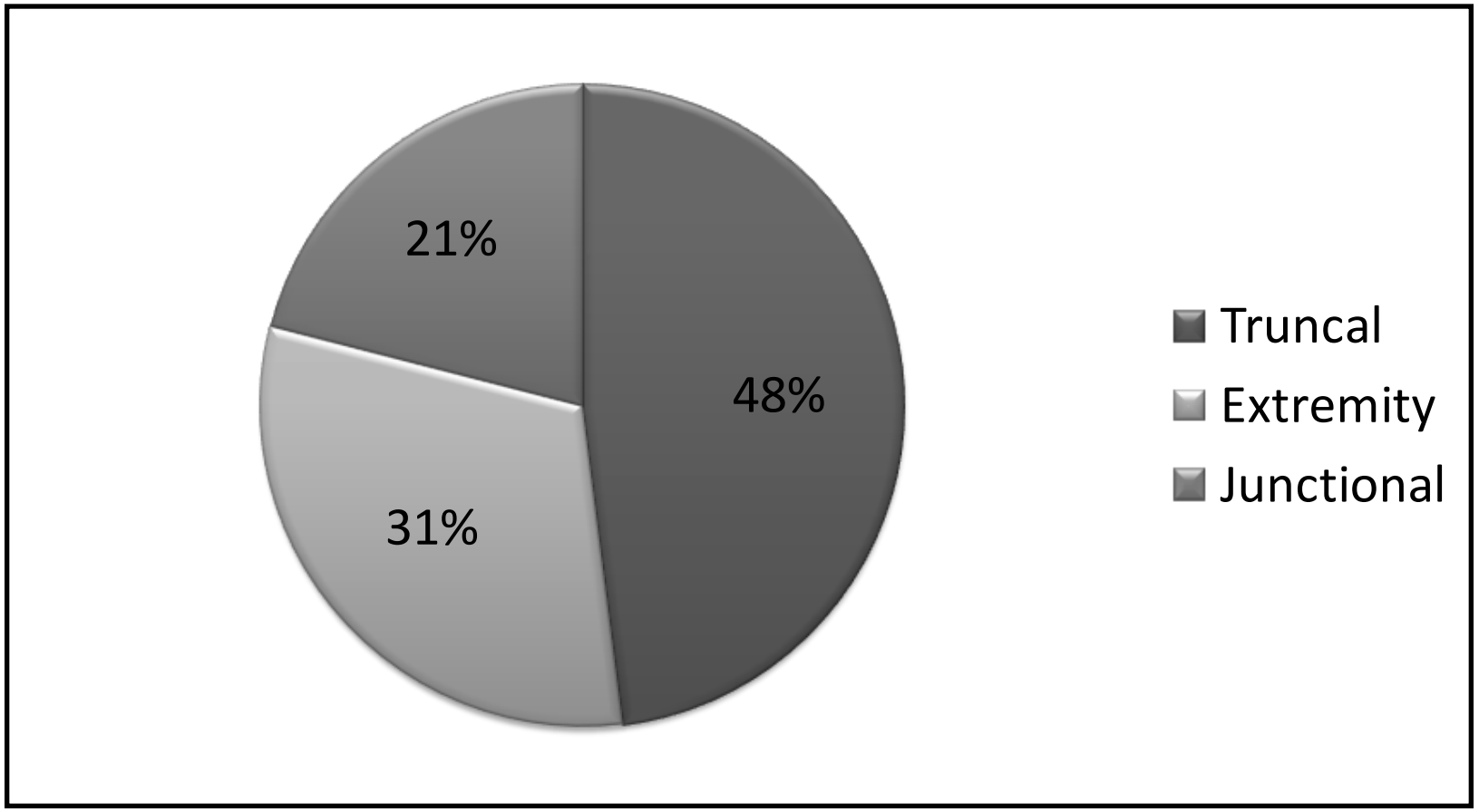
Eastridge et al, J Trauma 2011

DOW
Potentially Survivable Etiology



Eastridge et al, J Trauma 2011

DOW (Potentially Survivable) Hemorrhage Focus



Eastridge et al, J Trauma 2011

United States Army Institute of Surgical Research

Killed in Action Analysis

KIA Analysis

- Review battlefield deaths (n=4,596)
- Variables
  - Demographics
  - Mechanism and cause
  - Injury severity
- Expert panel trauma surgeons, emergency physiscian, neurosurgeon, and forensic parthologist graded deaths as non survivable or potentially survivable.
- Goal: Identify areas for improved training, medical care, material, research and development

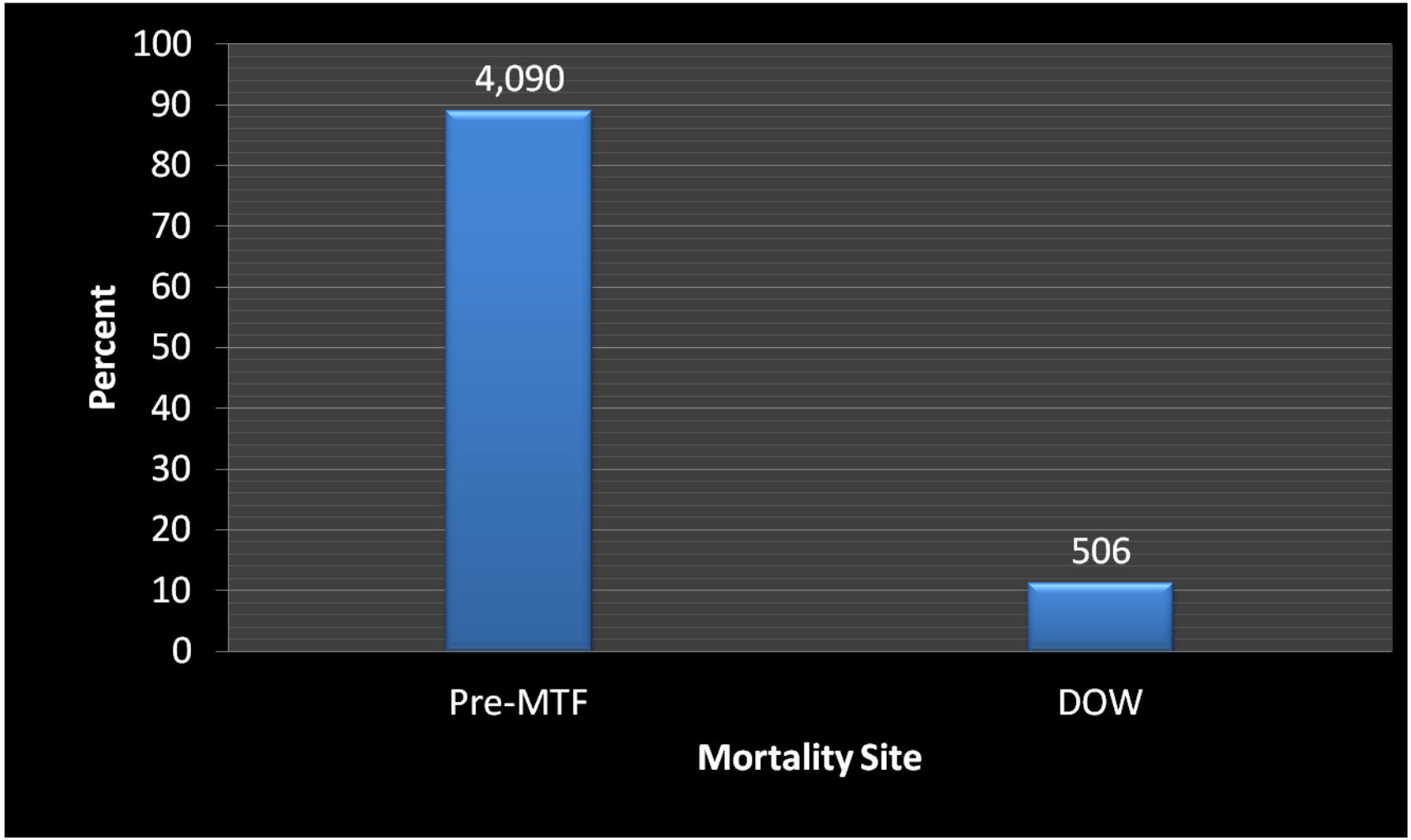
KIA Analysis

- 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

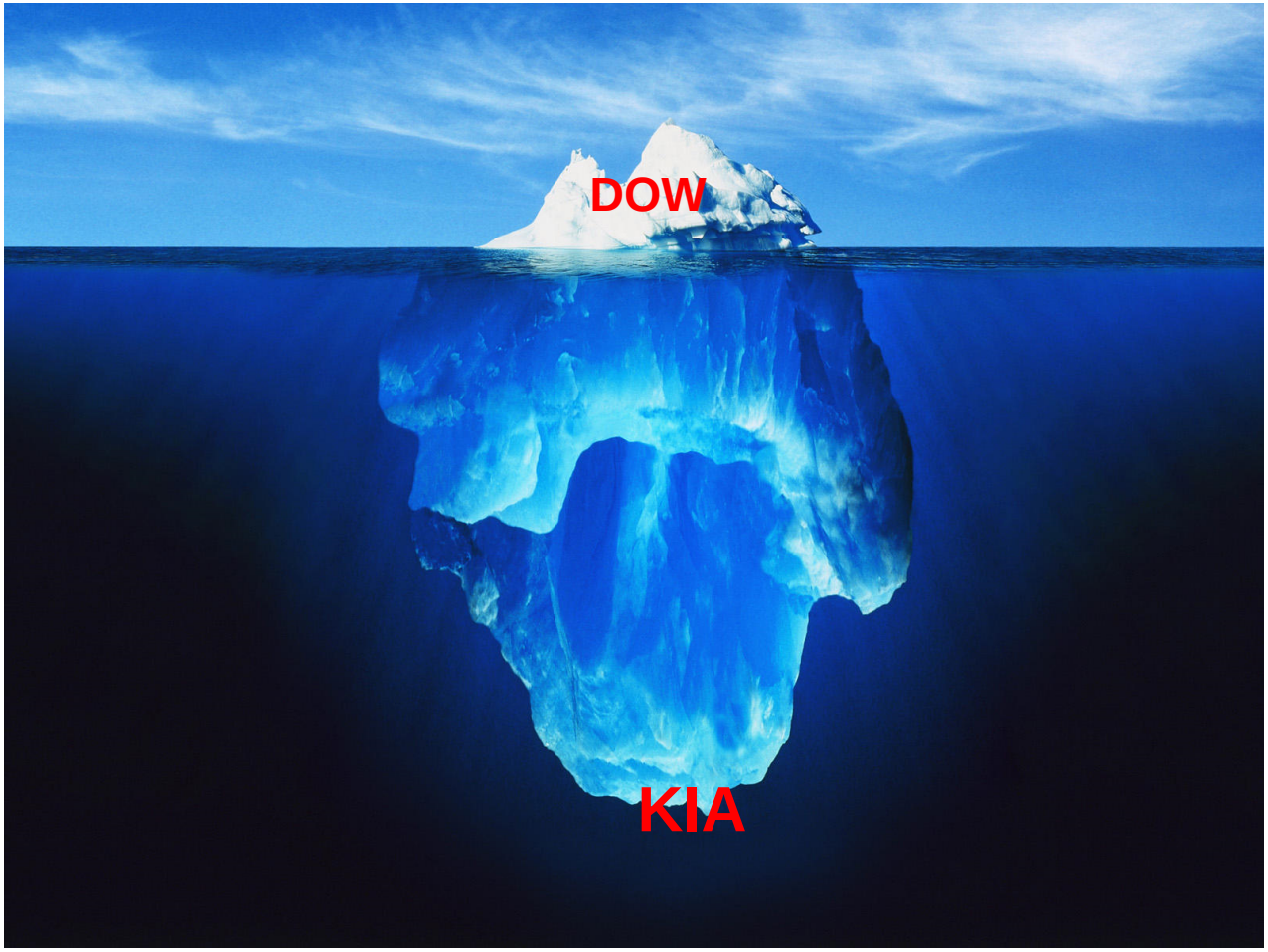
KIA Analysis

- Potentially survivable
  - All other injuries

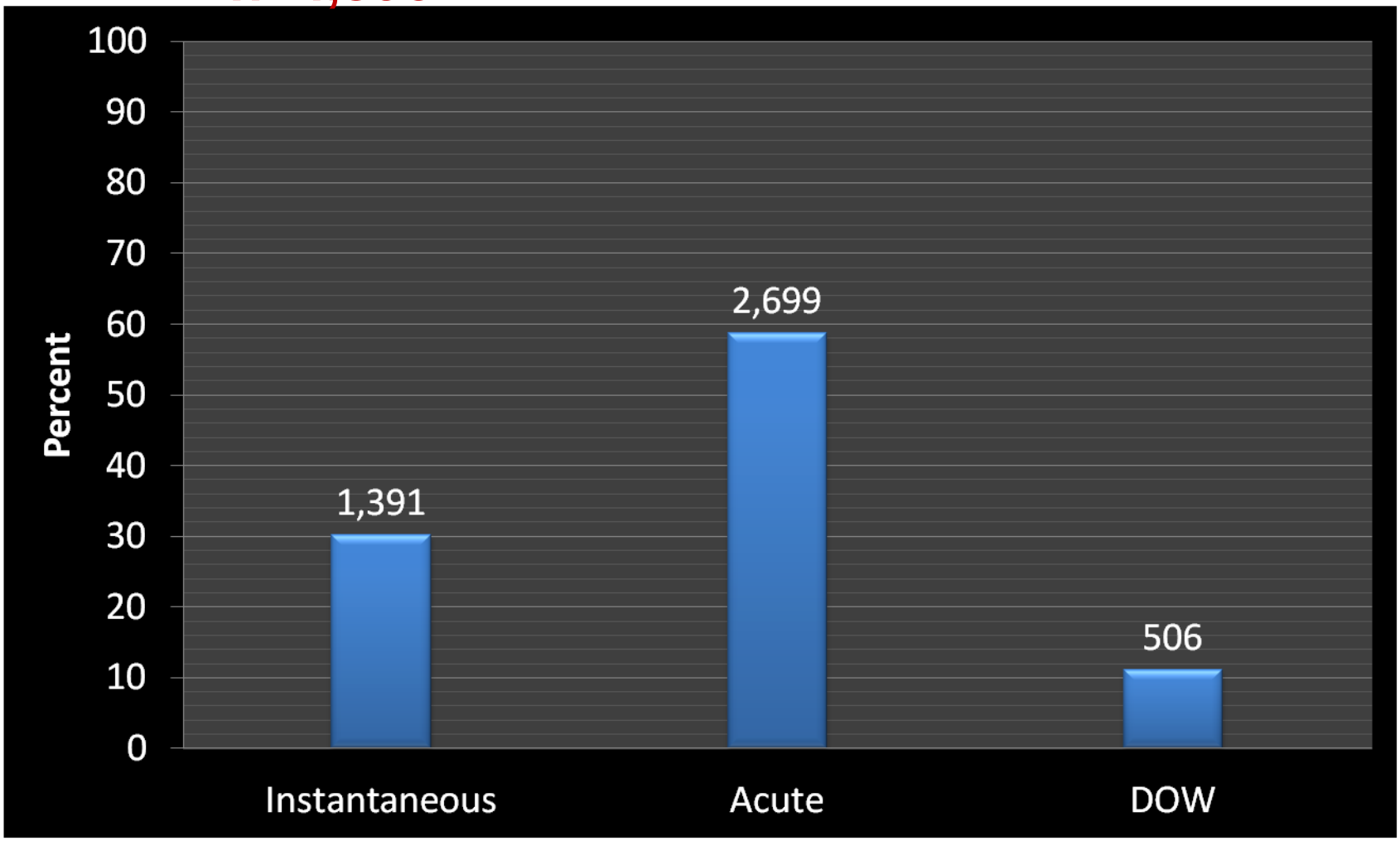
Where Battlefield Casualties Die n=4,596



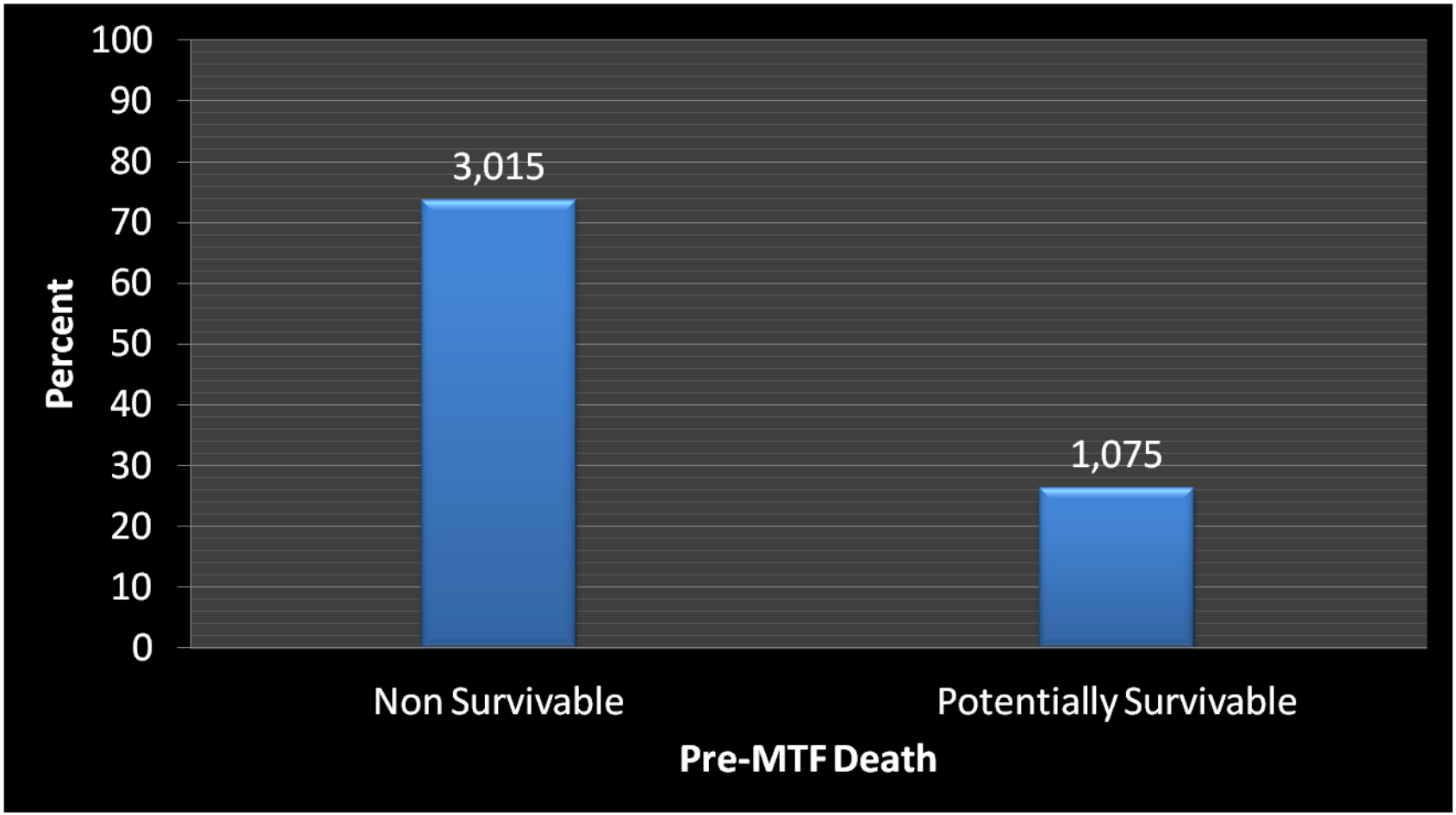
Putting it in Perspective



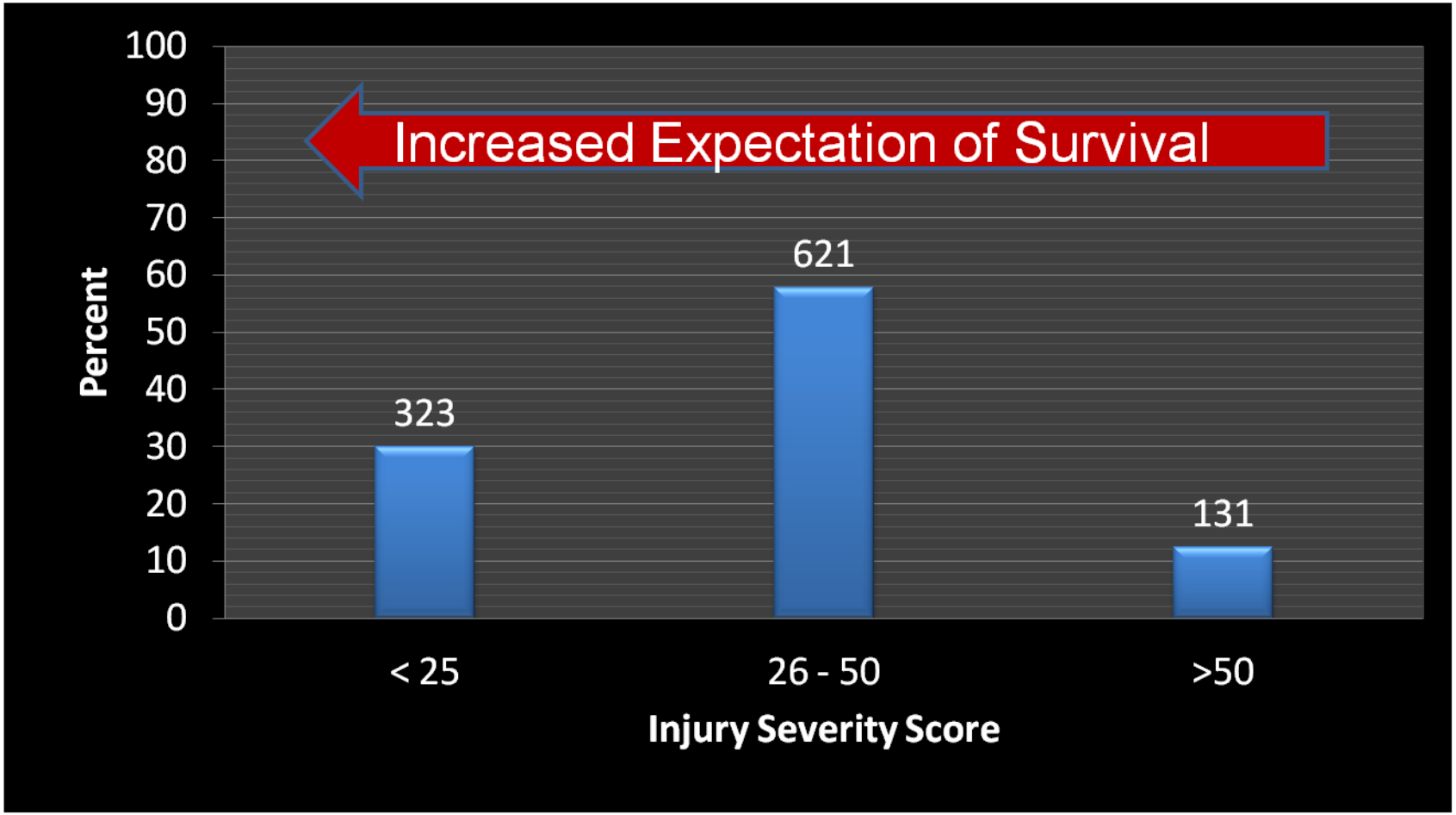
Distribution of Battlefield Death n=4,596



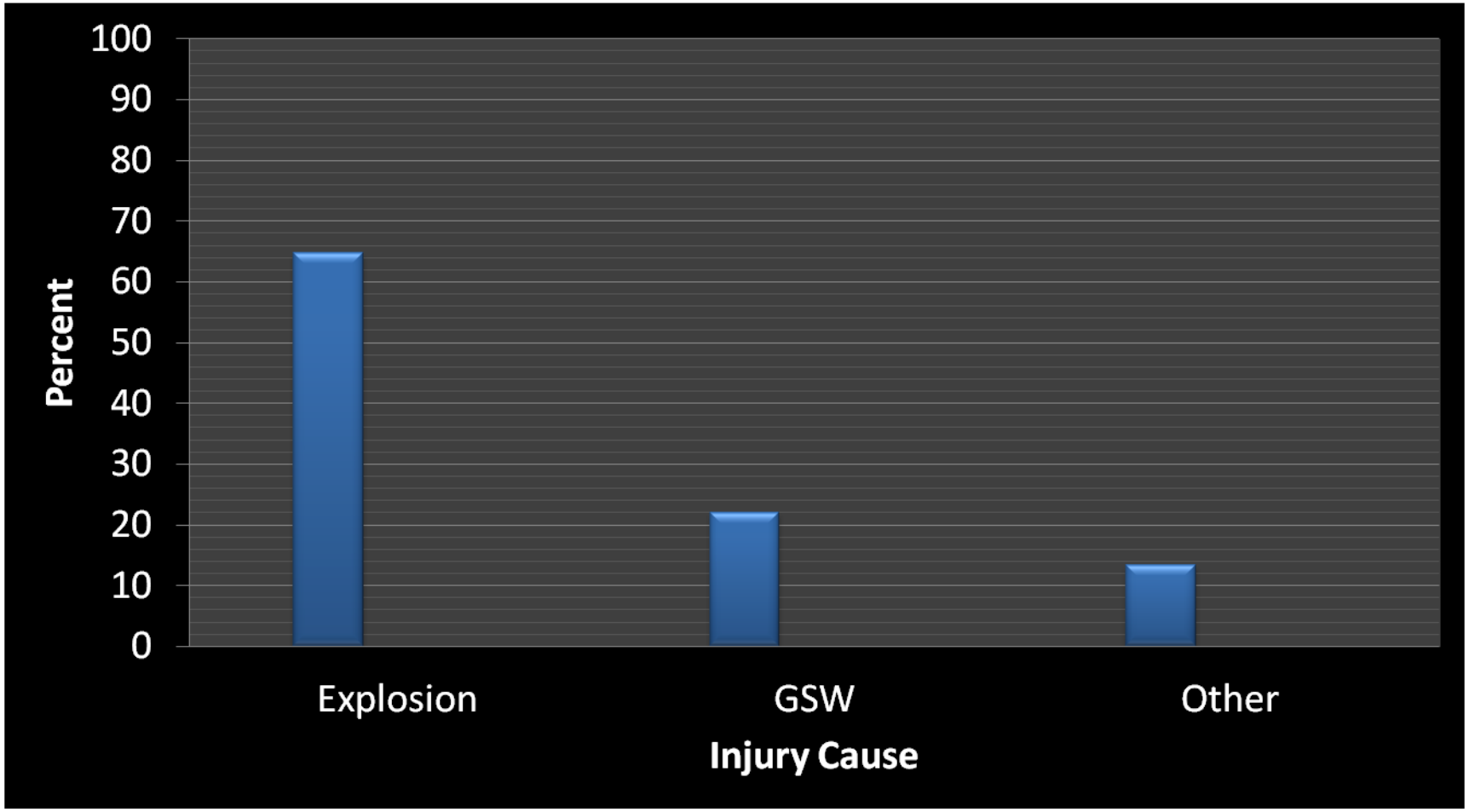
Battlefield Pre-MTF Death Analysis n=4,090 (DOW excluded)



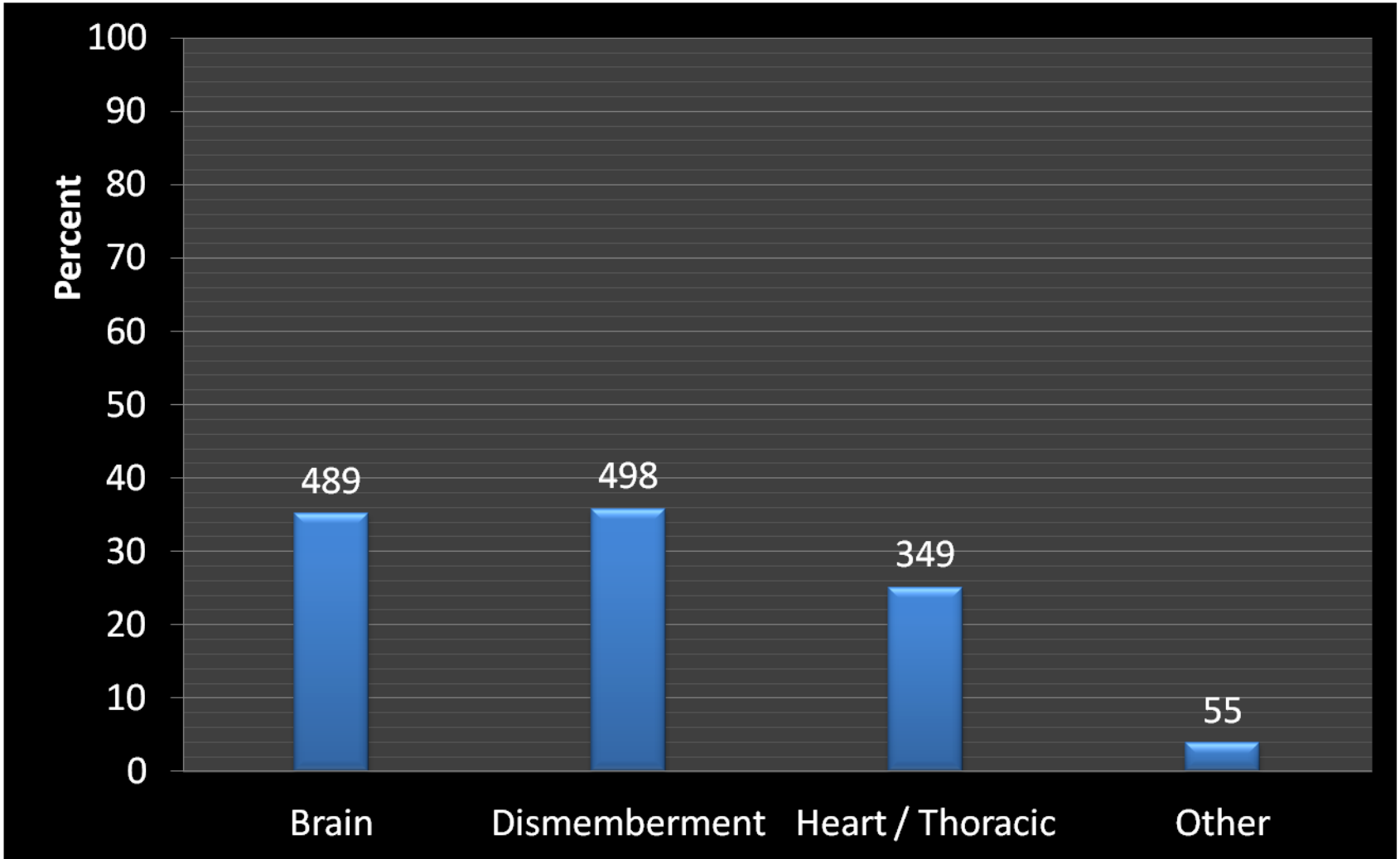
Potentially Survivable Pre-MTF Death Analysis (n=1,075)



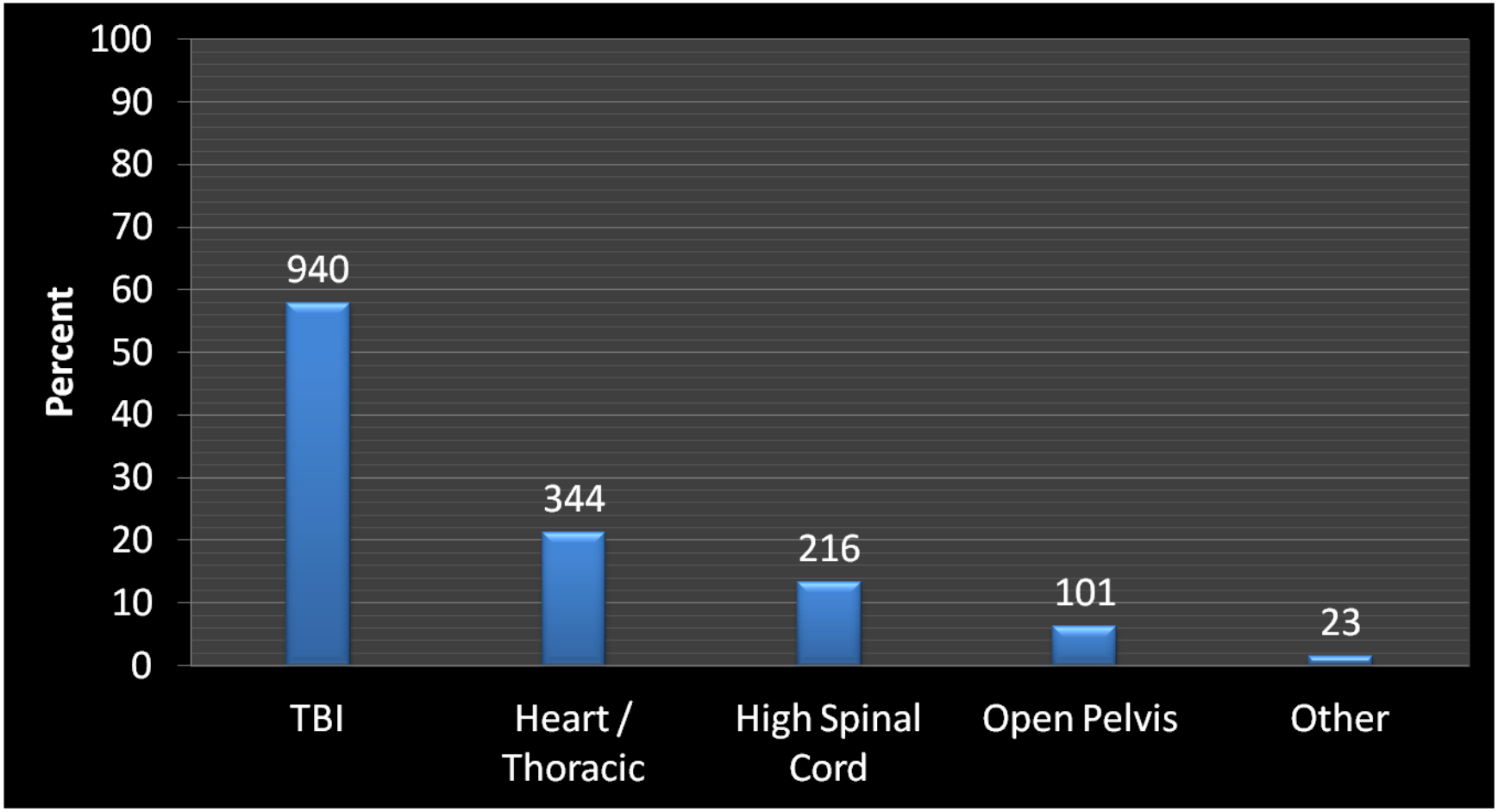
Battlefield Pre-MTF Mortality Cause n=4,090



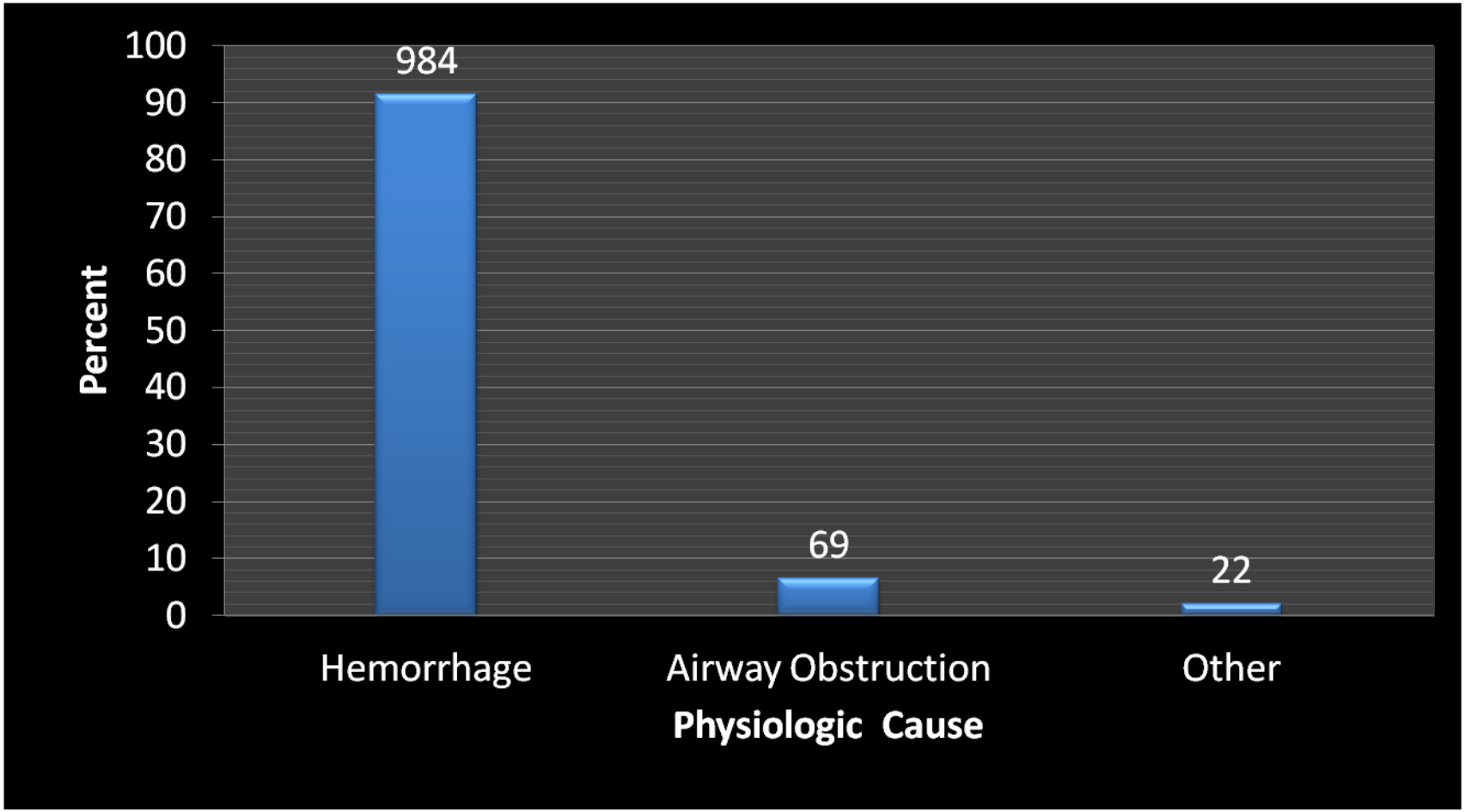
Battlefield Instantaneous Lethality n=1,391



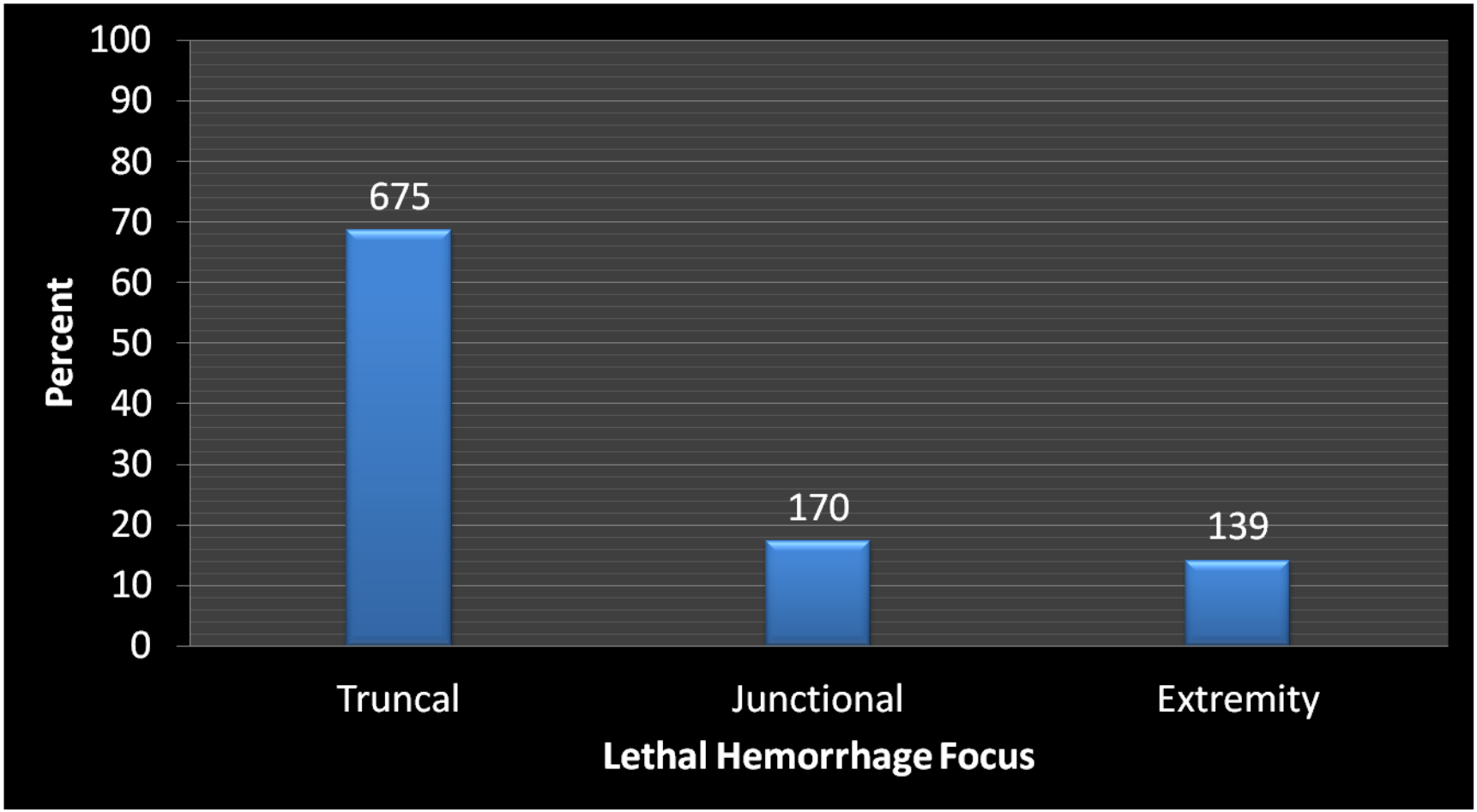
Battlefield Acute Lethality Non Survivable (n=1,624)



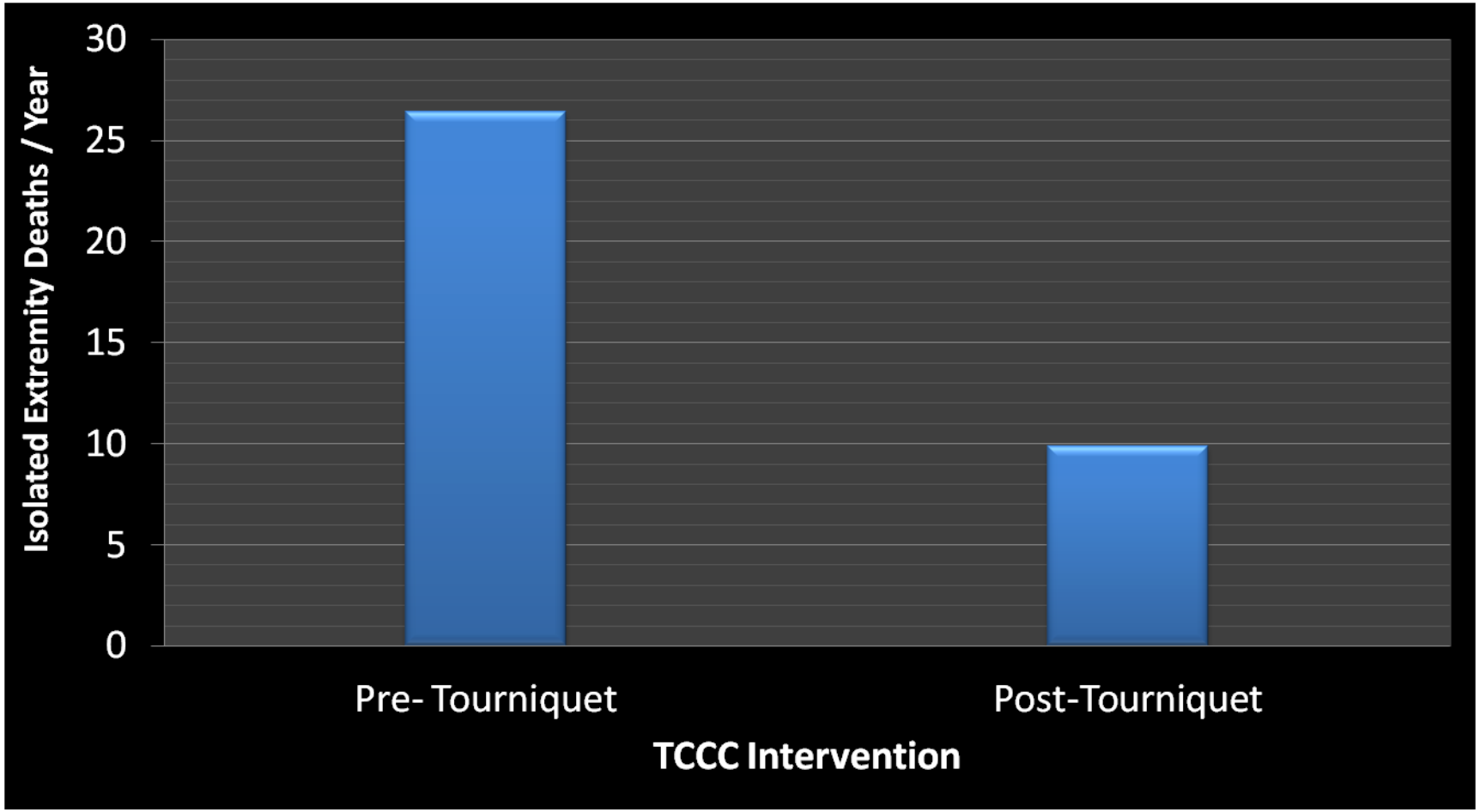
Battlefield Acute Lethality Potentially Survivable n=1,075



Hemorrhage Focus (n=984)



Can We Have An Impact?



Conclusion

- Most battlefield casualties (88.9 %) die on the battlefield
- Majority of battlefield deaths (73.7%) are non-survivable
  - Mitigation strategy: prevention
- Hemorrhage is the major mechanism of death in (91.5 %) 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

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
    - Kotwal et al, Arch Surg, 2011
  - Equipment and materiel

Questions ?