# Preventable Death Analysis in Civilian Mass Casualty Terror Attacks


Brian Eastridge, MD, FACS (COL, USAR, MC)

Professor of Surgery

Chief, Division of Trauma, Surgical Critical Care, and Emergency General Surgery

Jocelyn and Joe Straus Endowed Chair in Trauma Research

University of Texas Health San Antonio

# Disclosure / Disclaimer

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*None*

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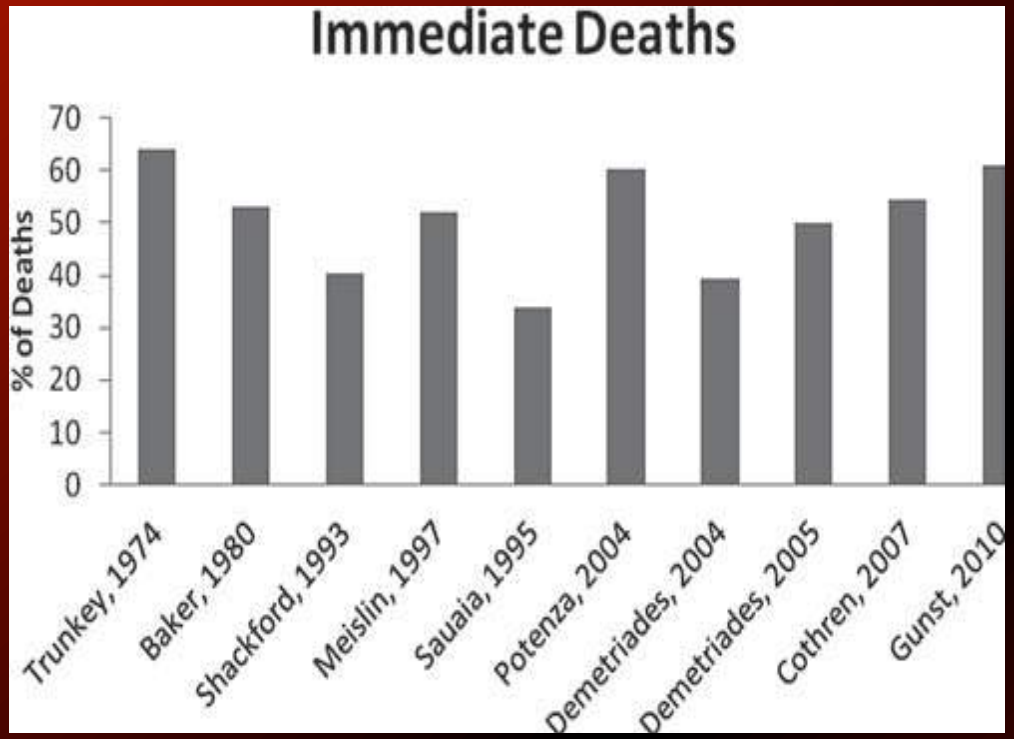
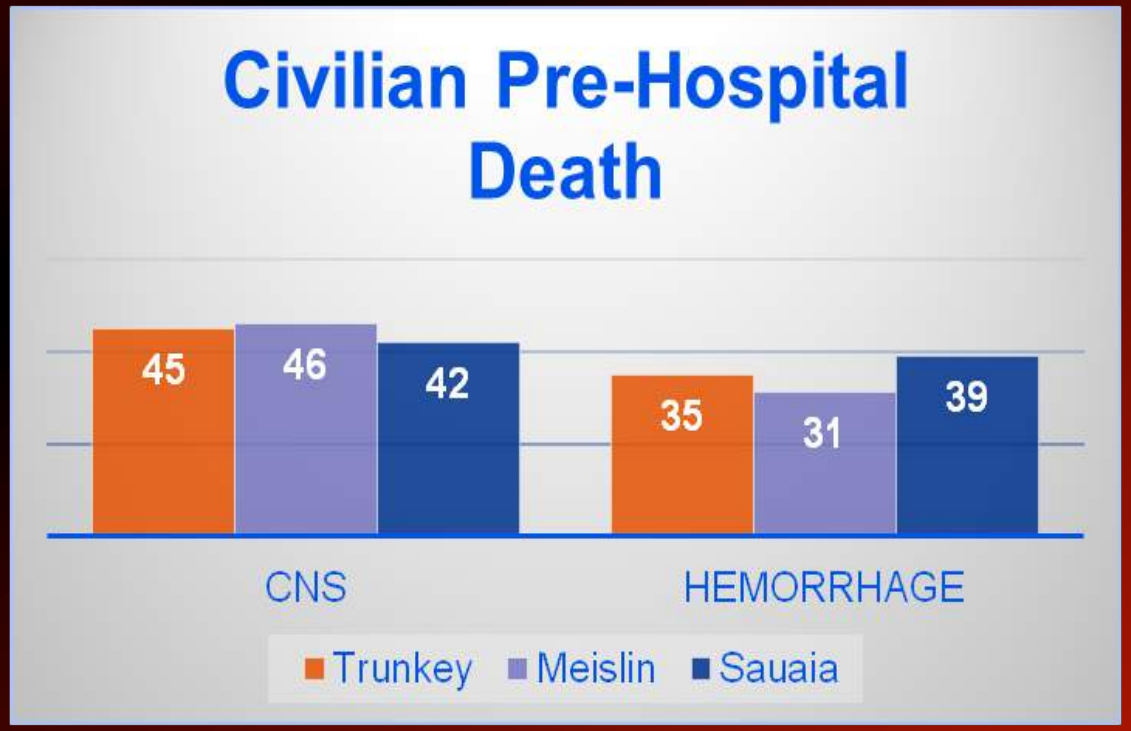
*The opinions or assertions contained herein are the private views of the author and are not to be construed as official or as reflecting the views of the Army Medical Department, Department of the Army, or the Department of Defense.*

# Data Sources

- Medical literature
- Government investigative reports
- Court transcripts
- Personal reports from trauma surgeons / medical examiners
- Media coverage reporting on specific injuries and / or causes of death

# Civilian Injury Death Pre-Hospital



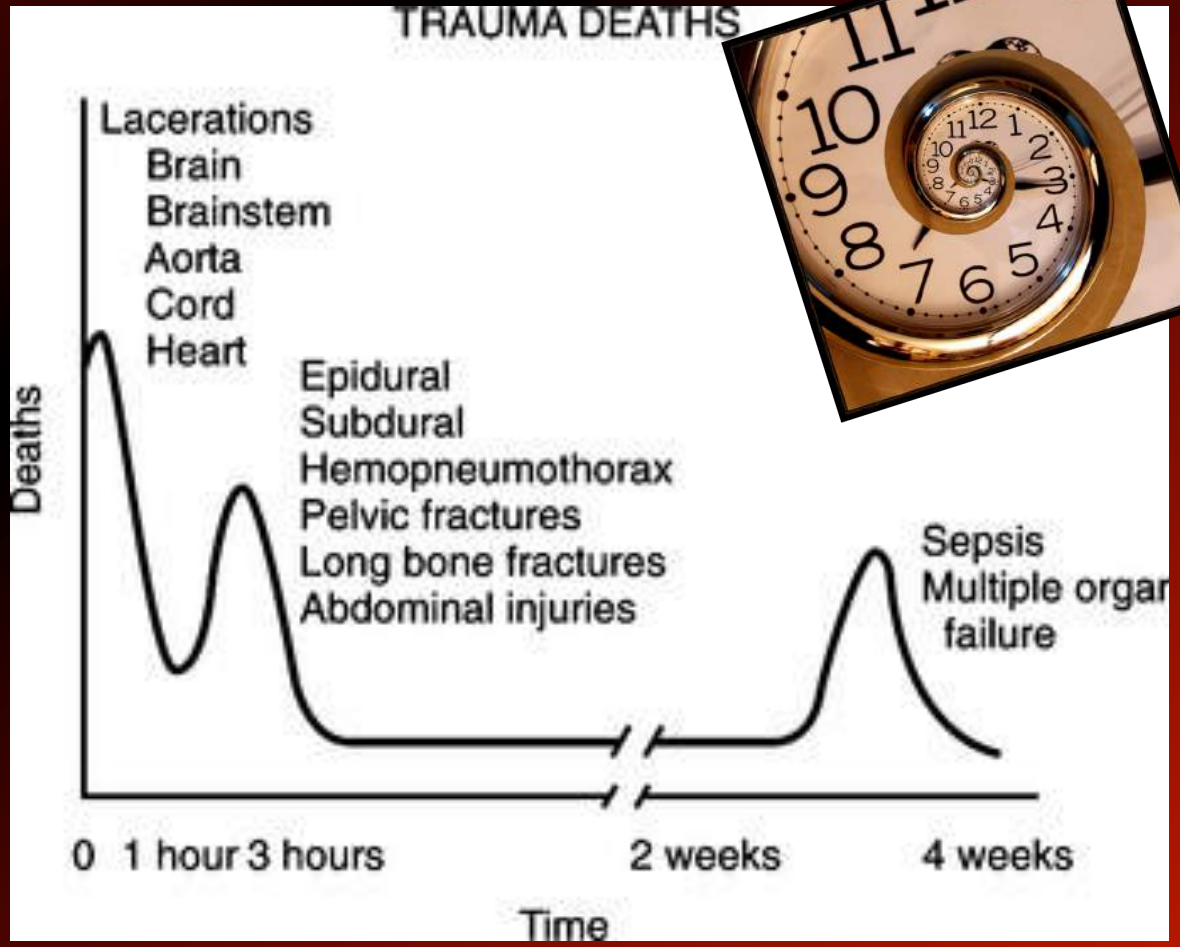





Sauaia A, Moore FA, Moore EE, Moser KS, Brennan R, Read RA, Pons PT. Epidemiology of trauma deaths: a reassessment. *J Trauma*1995;38(2):185–193.
Meislin H, Criss EA, Judkins D, Berger R, Conroy C, Parks B, Spaite DW, Valenzuela TD. Fatal trauma: the modal distribution of time to death is a function of patient demographics and regional resources. *J Trauma*
1997;43(3):433–440.
Trunkey DD, Lim RC. Analysis of 425 consecutive trauma fatalities: anautopsy study. *J Am Coll Emerg Phys* 1974;3(6):368–371.

# Timing of Death After Injury

Survivable?




Civilian Trauma deaths occur in a trimodal distribution:

Death within minutes ~ 50%

Neurologic and vascular injuries.

Death within hours ~ 30%

Hypoxia and hypovolemia.

Death within days ~ 20%

Sepsis, MODS

# Survivability (OptimalAnatomic / Physiologic)
## Assumption: Optimal Resuscitative / Surgical Conditions

**Non-Survivable**

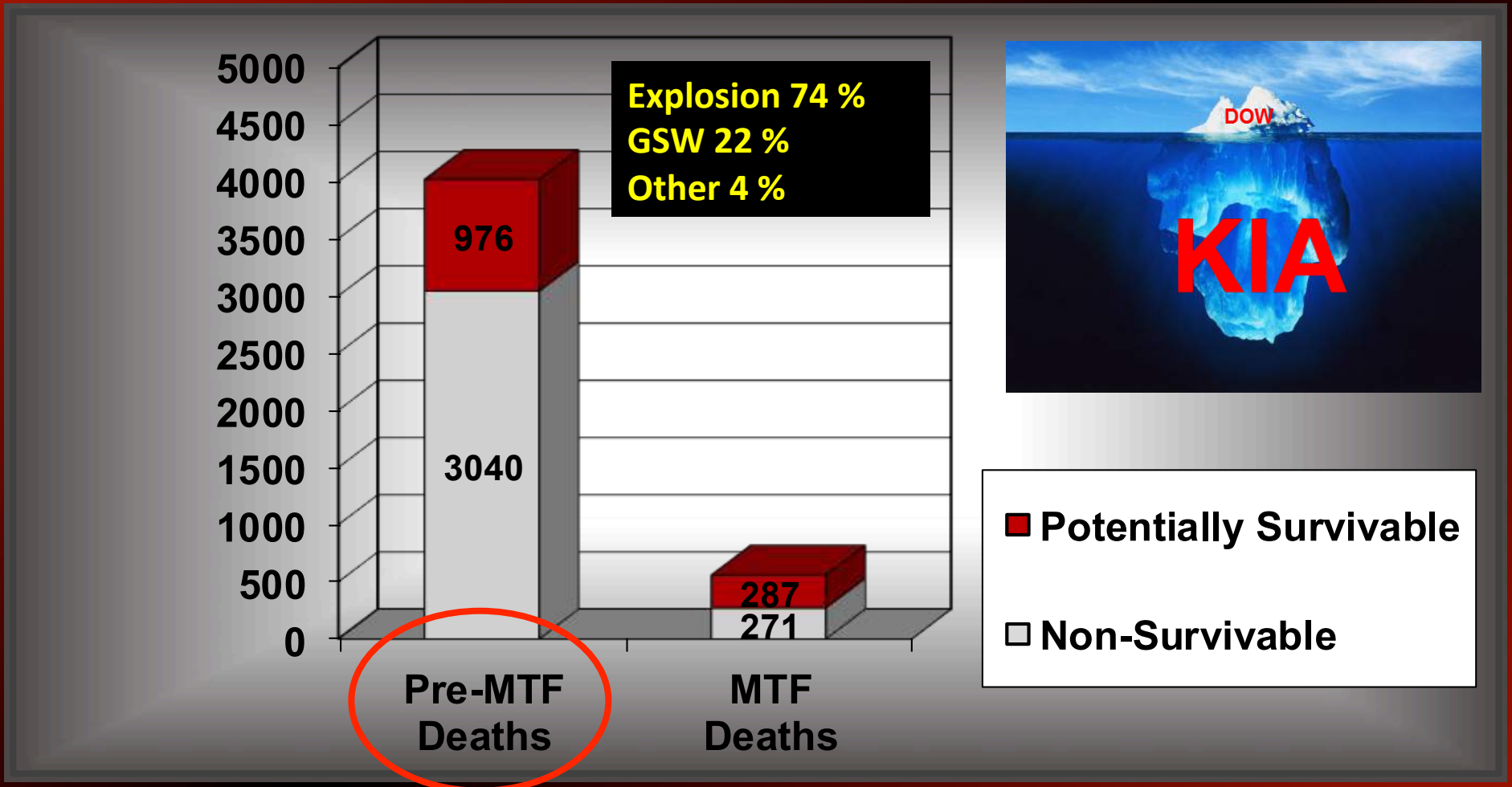
### Head / Neck

- Decapitation
- Brain evisceration
- Head crush with skull fragmentation and extensive parenchymal brain destruction
- Transection spinal cord C3 and above

### Torso

- Torso dismemberment
- Torso crush with extensive injury / loss of investing soft tissue associated with massive internal organ injury / avulsion
- Cardiac avulsion
- Aortic injury, uncointained by mediastinum
- Liver avulsion
- Massive open pelvis with major vascular injury / hemi-pelvectomy

# US Military Pre-MTF Mortality

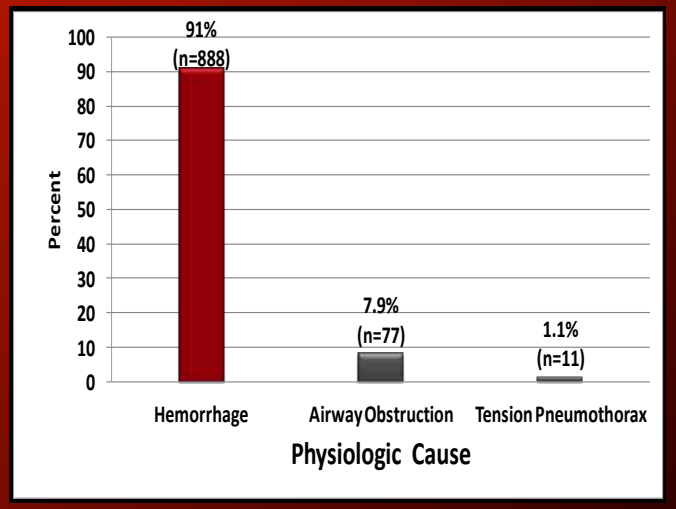


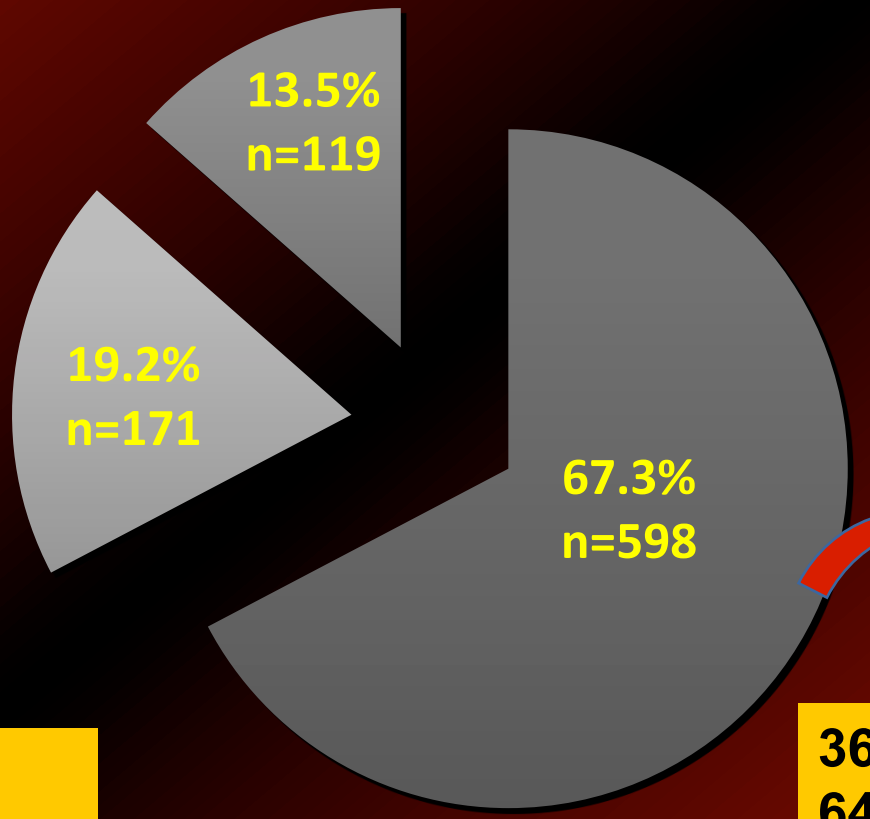


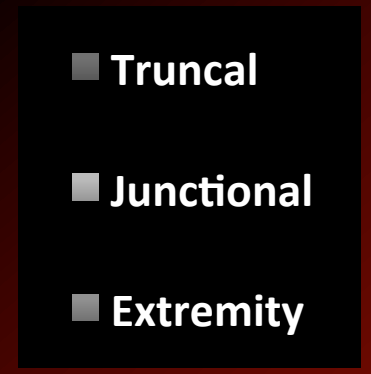
Eastridge BJ, Mabry RL, Seguin PG, et al. Death on the battlefield (2001-2011): implications for the future of combat casualty care. Journal of Trauma, 2012.

Eastridge BJ, Hardin M, Cantrell J, et al. Died of wounds on the battlefield: causation and implications for improving combat casualty care. Journal of Trauma, 2011. 71(Suppl 1):4-8.

# Anatomic / Physiologic Cause of Death



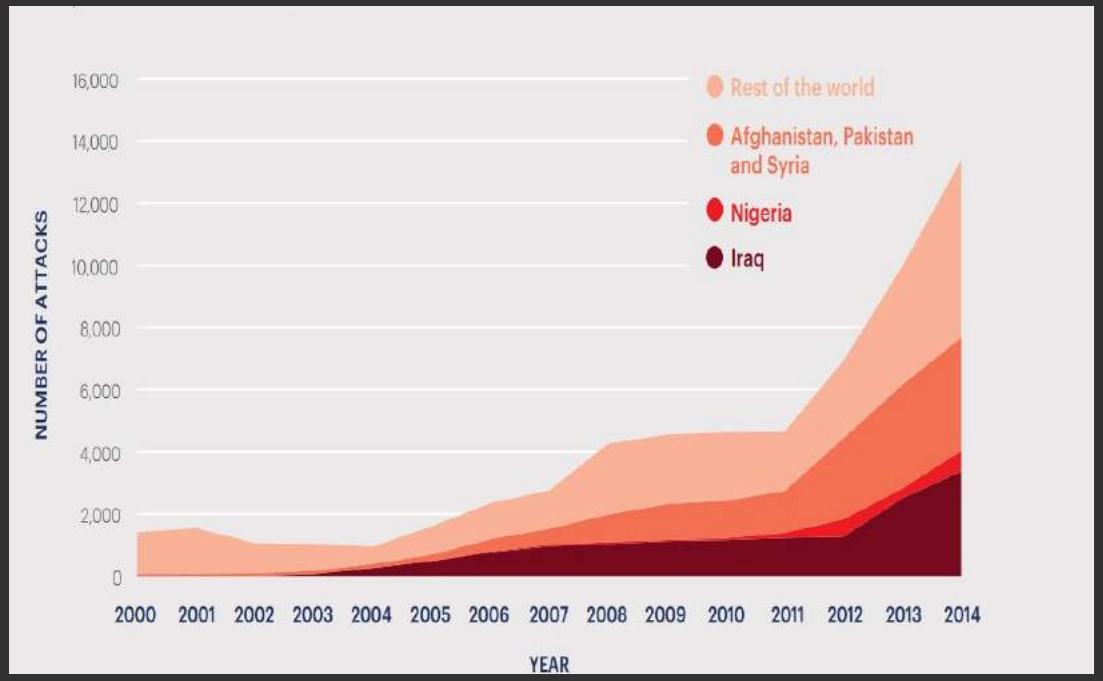



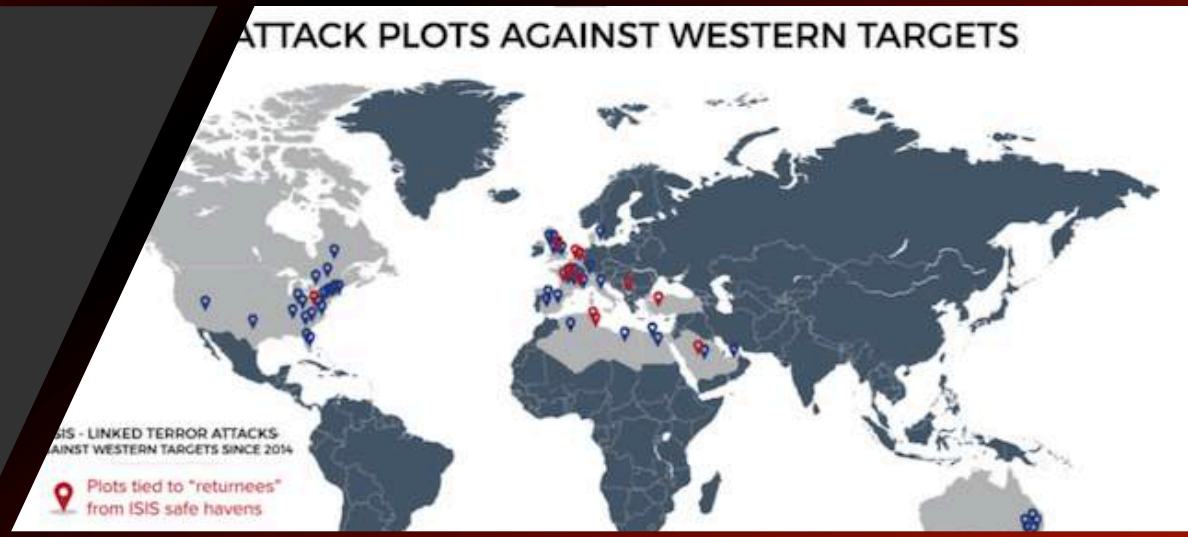

**39% Cervical**
**61% Axilla and Groin**

**36% Thoracic**
**64% Abdominopelvic**

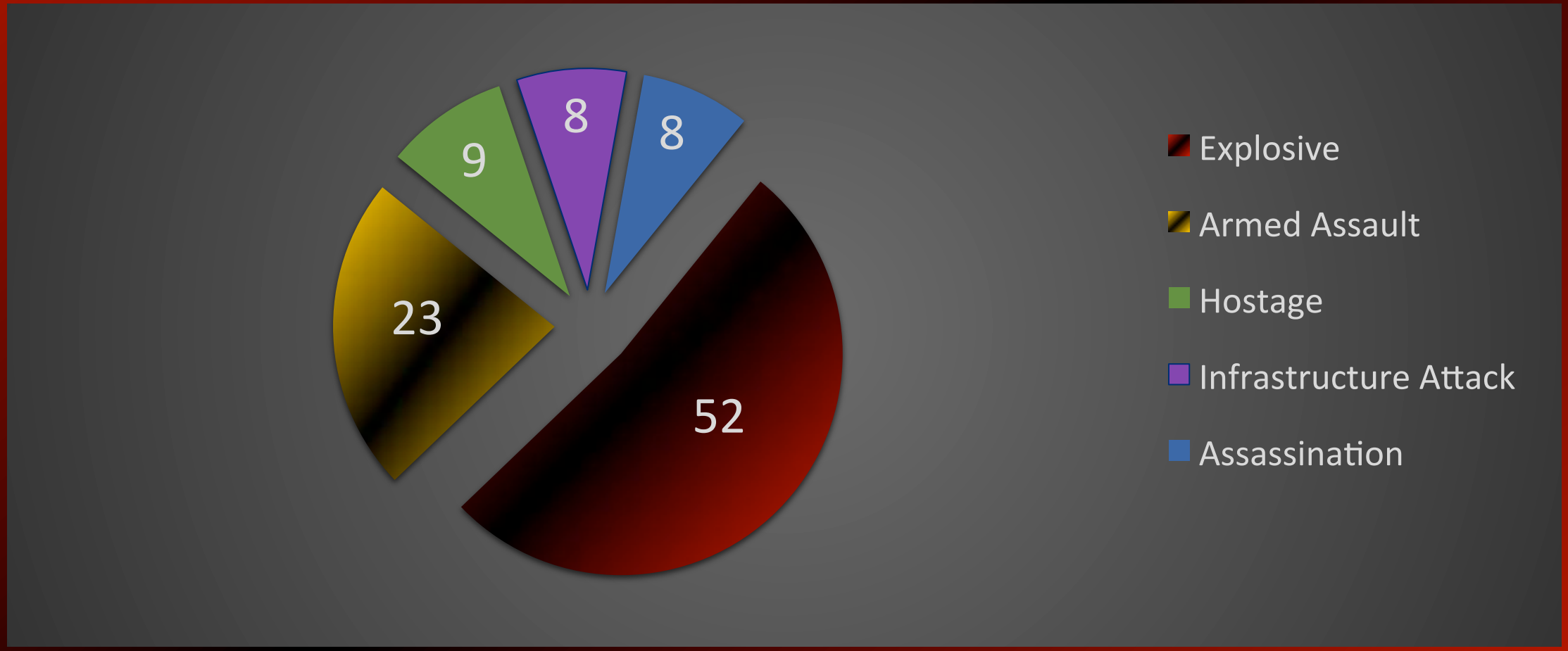
Eastridge BJ, Mabry RL, Seguin PG, et al. Death on the battlefield (2001-2011): implications for the future of combat casualty care. Journal of Trauma, 2012. In press.

# Terrorist Plot / Activity




# Terrorist Mode of Attack

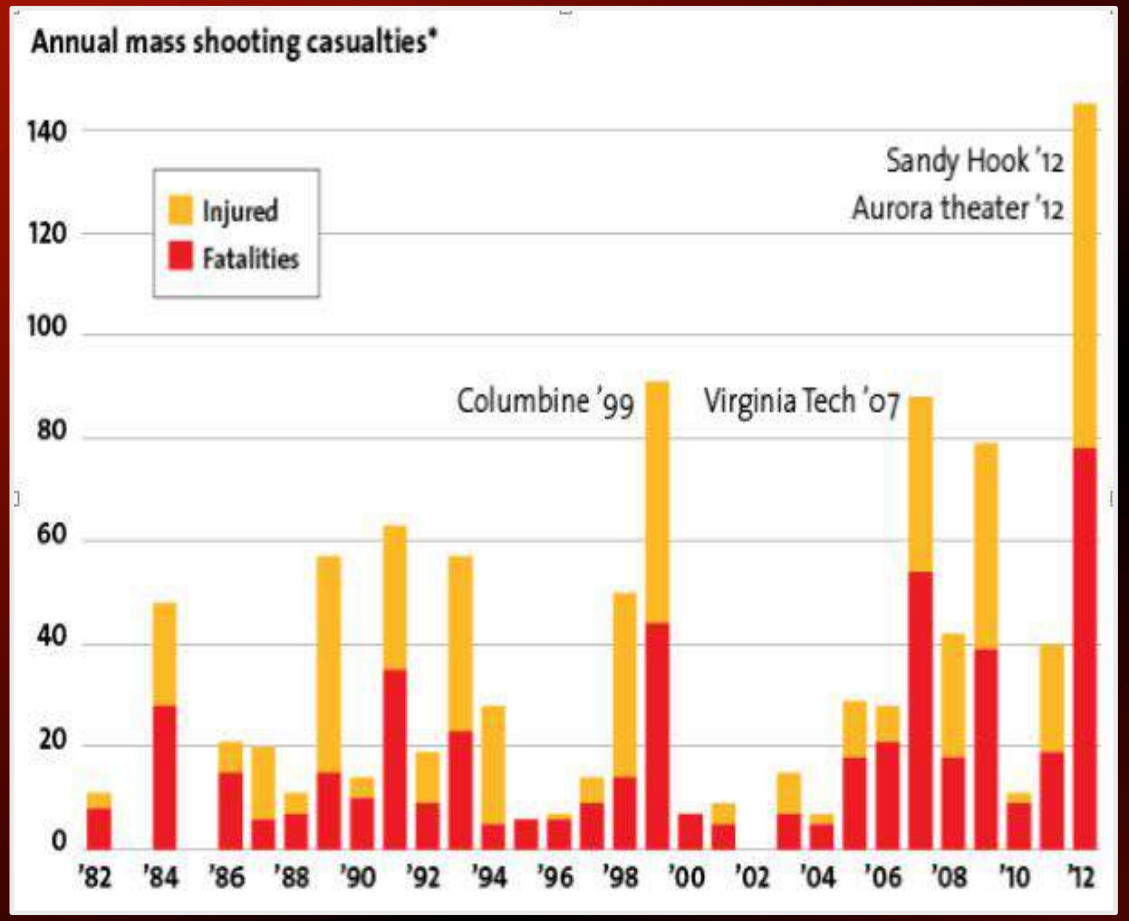


# Armed Assault

# Active Shooter / Lone Wolf Terrorist Event

- Injured: Kill ratio ~ 3.4 : 1
- Higher relative incidence of higher lethality injuries
  - Torso
  - Head
- Timing first radio call of *"Shots Fired"* to the last call of *"Shooter Neutralized"*
  - Majority 8 to 12 minutes in duration.
  - Less than 5 minutes 37 %
- Prolonged access to potential victims associated with greater number injuries and greater lethality
- The next Active Shooter / Lone Wolf incident is already in progress

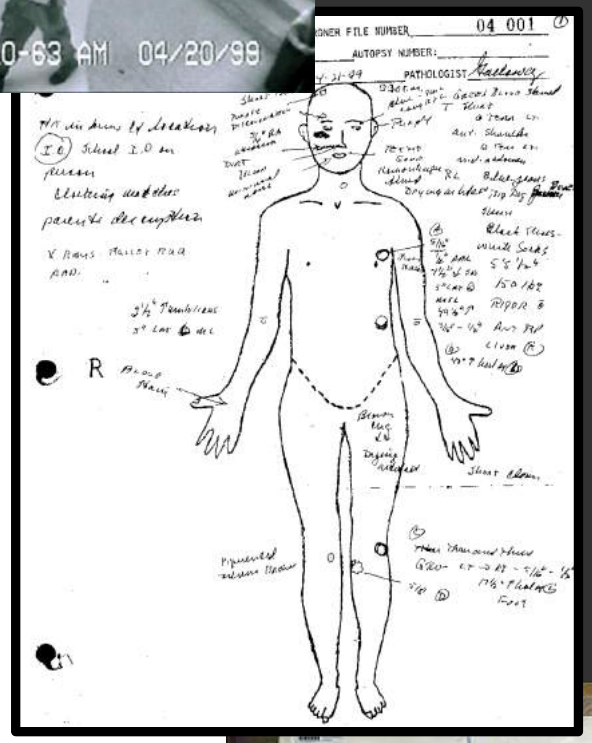
# US Mass Shootings: Active Shooter Events




## US INCIDENTS WITH THE HIGHEST CASUALTY COUNTS:

- Columbine High School (47 minutes)
  - Littleton, CO
  - 13 killed, 21 wounded
- Virginia Polytechnic Institute and State University (11 minutes)
  - Blacksburg, Virginia
  - 32 killed, 17 wounded
- Pulse Nightclub (149 minutes)
  - Orlando, FL
  - 49 killed, 53 wounded

# Columbine High School 1999



Perpetrators: Dylan Kleibold
Eric Harris

High school shooting

Multiple weapons

Changed paradigm of law enforcement / EMS response response

Scene Fatalities: 13 GSW

- Nonsurvivable: 9
  - Most shot at point blank range
- Potentially survivable: **4**
  - Noncompressible torso hemorrhage with concomitant junctional hemorrhage: 3
  - Noncompressible torso hemorrhage (isolated): 1

# Virginia Tech Mass Shooting 2007

Perpetrator: Seng Hui Cho

Mental health diagnoses

GSW

Scene Fatalities: 30 + 2

- Nonsurvivable: 32
  - Wounds 1-9 / casualty
  - All had at least 1 close range GSW head


# Pulse Nightclub Mass Shooting 2016

Perpetrator: Omar Mateen

Claimed allegiance to ISIL

Nightclub shooting Orlando, FL

Prolonged access to victims

(182 minutes)

- Scene Fatalities: 49
  - Nonsurvivable (Medical): Unknown
  - Nonsurvivable (Context): 49

# Paris 2015 (Bataclan)

Perpetrator: ISIS

Multiple terrorists

Bataclan theater shooting spree / explosives

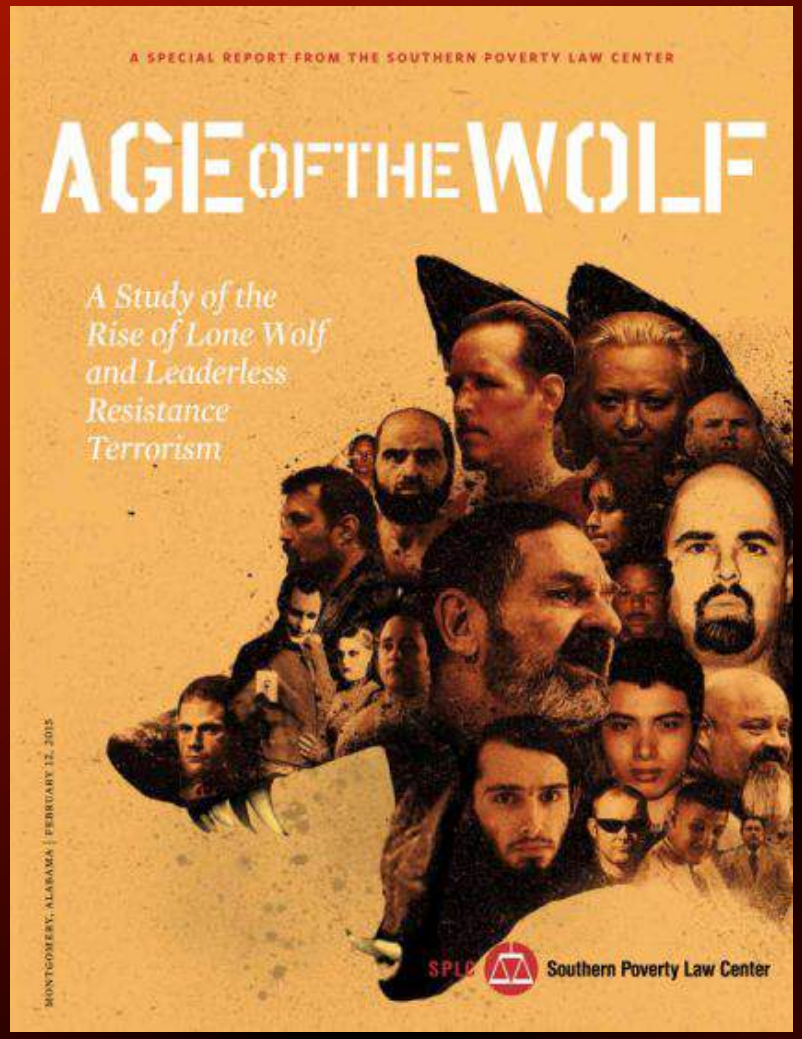
Prolonged access to victims

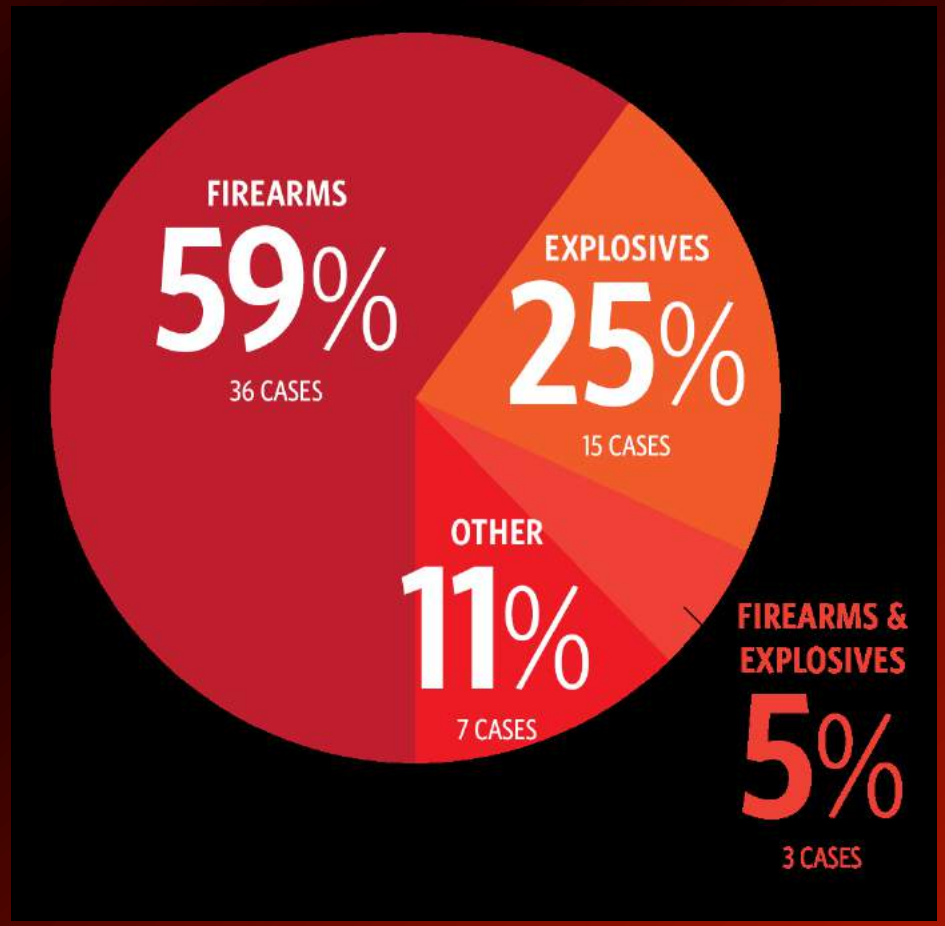
(198 minutes)

Scene Fatalities: 89

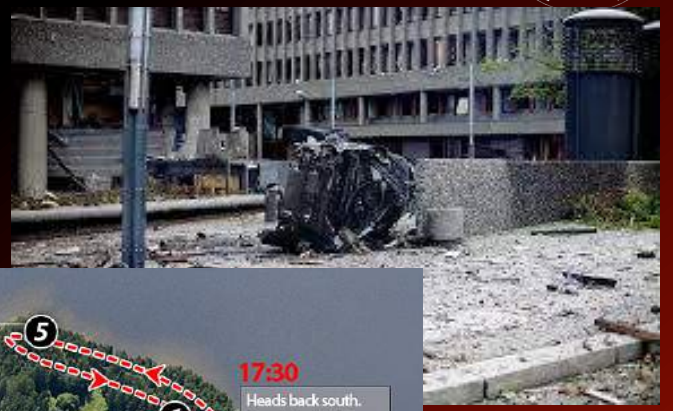
- Nonsurvivable (Medical): Unknown
- Nonsurvivable (Context): 89


# Lone Wolf Terrorist



# Oslo Bomb / Utoya Massacre 2011



Perpetrator: Anders Behring Breivik (Lone Wolf)

VBIED detonates in Oslo

Utoya Island shooting spree

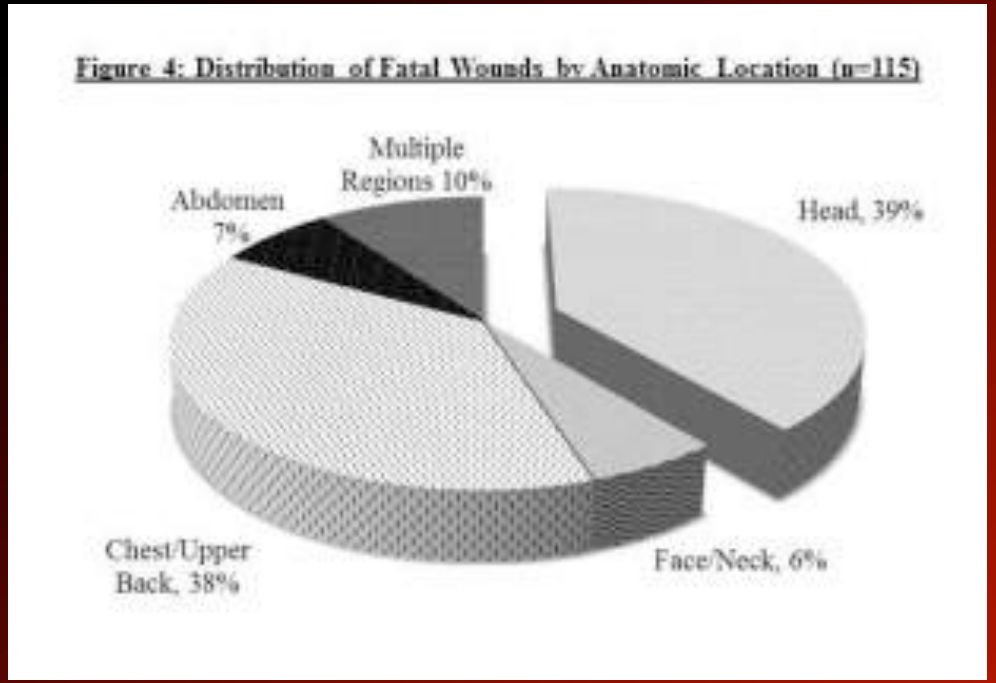

Scene Fatalities: 8 VBIED & 68 GSW

- Nonsurvivable VBIED: 8
- Nonsurvivable Utoya: 62
- Potentially survivable: **6**
  - Noncompressible torso hemorrhage 6

# Civilian Mass Shooting Fatality Study

- Retrospective study of autopsy reports for all victims involved in civilian public mass casualty with available records
- Nonsurvivable defined as follows:
  - Penetration of the heart
  - Injury to any non-extremity major vasculature structure
  - Transcranial, mid-brain or brainstem injury
  - Multiple solid organ injury
  - EMS within 10 minutes
  - Trauma center access within 60 minutes

N=115
Potentially survivable injury 7%




**Limitations:** **Definition too liberal**
**Not consistent with other definitions in literature**

Smith, ER: **The profile of wounding in civilian public mass shooting fatalities. J Trauma. 2016**

# Explosions

# Closed Space Explosions


Madrid 2004 / London 2005

Perpetrator: Islamic Extremists

Backpack / suitcase bombs on enclosed transport carriers

Rapid acces to advanced EMS / trauma centers

Scene Fatalities: Madrid 177
London 52

- Nonsurvivable : 229

# Enclosed Space Explosions

Confined space – inside bus, train, or auditorium

Blast pressures intensified x2-9,

20% fatalities

# Israel Experience

- 28 Terror attacks Jerusalem 200-2003
- Casualties: 2,328
- Deaths: 273 (11.7%)
- Scene Mortality
  - Explosion 87%
    - Mortality > closed space
  - GSW 77%
- Survivability: Indeterminate


# Explosions Associated with Structural Collapse

# Beirut Embassy Bombing

Marine Barracks Bombing / French Paratrooper Barracks
Perpetrator: Islamic Jihad
VBIED
2,000 lb improvised thermobaric high yield explosive (butane / PETN)
Complete structural collapse

Scene Fatalities: US Marines 241
French

Paratroopers 58
Nonsurvivable: 299


# Bali Nightclub Bombing

Perpetrator: Jemaah Islamiyah Extremist Terror Cell

VBIED

1,000 chlorate bomb

Scene Fatalities: 202
Nonsurvivable: 202

# Oklahoma City Federal Building

Perpetrator: domestic terrorist Timothy McVeigh

4,000 lbs ANFO

VBIED

Front face of 9 story building collapsed

Scene Fatalities: 162

Nonsurvivable (blast / crush)

- Multiple 122
- Thorax  13
- TBI 24
- Cervical spine 3

Potentially survivable: **3**

- Nonspecified hemorrhage 3

# US Embassy Nairobi

Perpetrator: al Quaeda Network

~5-10 metric tons high explosive

VBIED

Massive structural collapse

- Scene Fatalities: 198
  - Nonsurvivable (Blast / crush)
    - Multiple 93
    - Thorax  31
    - TBI 61
  - Potentially survivable: **14**
    - Nonspecified hemorrhage from penetrating wounds 14

# Mumbai Terrorist Attacks 2008


**Perpetrators: Lashkar-e-Taiba, Islamic Militant (10 –12 militants (split into four cells)**

**Coordinated attacks (10 sites)**

**Attacked targets on foot, taxi, or motorcycle; AK-47s, handguns, pistol, grenades, large amount of**

**Scene Fatalities: 166 (98 postmortem exams)**

# Mumbai Terrorist Attacks 2008

**GSW**

Nonsurvivable 51

- GSW
  - Multiple 17
  - Thorax 18
  - TBI 16

Potentially survivable: **17**

Abdomen 8

Extremity / soft tissue 9

**Explosion**

- Primary 2
- Secondary 12
- Tertiary 4
- Quartenary 12

Nonsurvivable: > 14

Potentially survivable: UTD

# Open Space Explosions

# Boston Marathon Bombing 2013

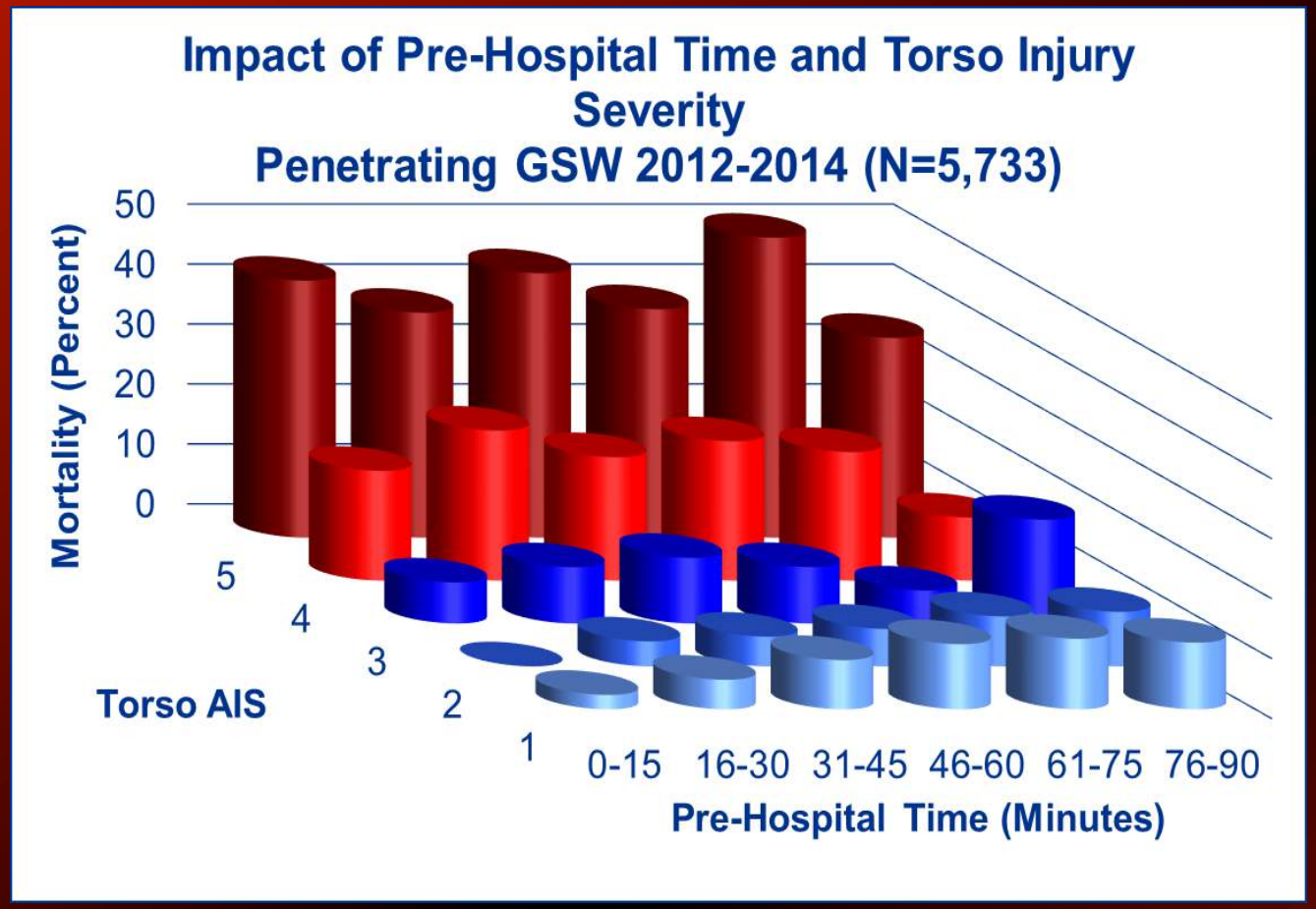
Perpetrators: Tsarnaev Brothers
Radicalized Islamists

Two low yield pressure cooker IED

Detonated in large crowd at finish line

- Scene Fatalities: 3
  - Nonsurvivable 1
    - Near dismemberment
  - Potentially survivable: **2**
    - Hemorrhage 2
      - Extremity amputation / severe peripheral soft tissue injury

# Time is the Enemy
# Prehospital Time in Noncompressible Torso Hemorrhage (GSW)

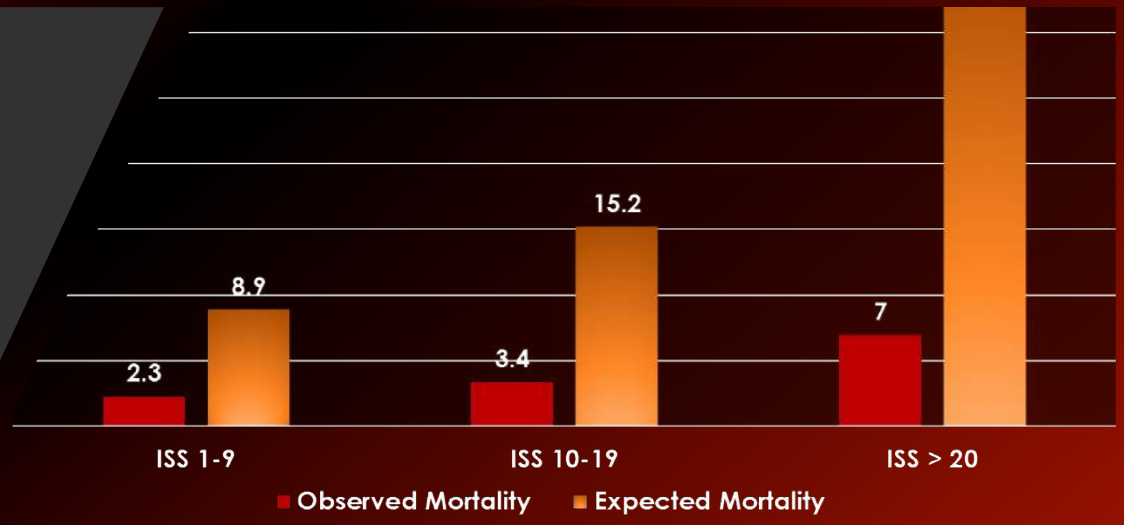



- High grade torso injury, AIS grades ≥ 4, associated with significant hemorrhage.
- Rise in patient mortality was exhibited in high grade injury demonstrated at prehospital times < 30 minutes
- Highlights critical nature of prehospital time in patients with non-compressible torso hemorrhage.
- Evacuation times < 30 minutes not realistic, particularly in rural or austere environments,
- Future efforts should be directed toward the development of therapies to increase the window of survival in the prehospital environment.

Alarhayem, Eastridge, et al: Mortality in Trauma Patients with Hemorrhage from Torso Injury Occurs Long Before the "Golden Hour" Am J Surg 2016

# DCR Forward

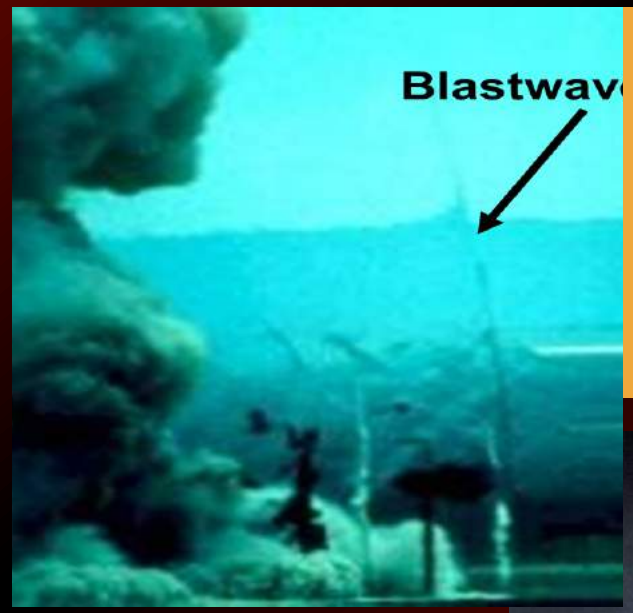
- Scoop and Run or Stay and Play?
- Advanced providers
- Critical care capabilities
- Blood products
- Surgical capability enroute




# Explosions Summary / Challenges

Explosions are highly variable events

- Explosive yield variable results
- Superimposed to blast wave is fragmentation debris
- Dependent on many variables: geometry, height, obstacles, distance, explosive type
- Open vs. Closed space
- Structural collapse




# Conclusions

- Needs better prehospital mortality data
- Consensus definitions
  - Military / civilian translation
- Value
  - Injury prevention
  - Mitigation strategy
  - Trauma system development

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

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

CNTR
Coalition for National Trauma Research