



Part I



Asymmetric War (Terrorism) and the Epidemiology of Blast Trauma

Timothy E. Davis, MD, MPH

Lt. Commander, USPHS Commissioned Corps
Asst. Professor of Emergency Medicine
Emory University

Catherine Y. Lee, MPH

Faculty Associate
Center for Disaster Medicine
New York Medical College

SAFER • HEALTHIER • PEOPLE™



Rules of Engagement (ROE)



"... directives ... under which military forces initiate engagement with belligerent forces..."

1. Developed from open source information (OSINF)
 - health, engineering, intelligence, security, and military.

2. Area of study is problematic
 - a. Lack of data standards - definitions, analyses, reporting
 - b. Prone to propaganda and misinformation

3. Opinions are those of the presenter and cited sources.
 - does not constitute an endorsement by any Agency or University.



Agenda



1300	Asymmetric War, Blast Trauma Public Health and Safety	Tim Davis
1400	Blast Trauma and the Evolving Tactics of Terrorism	Catherine Lee
1500	Children, Special Needs, and Asymmetric War	Sherlita Amler
1600	First Receiver – Capacity Multiplier	Tim Davis
1630	Panel Discussion	Amler-Davis-Lee



Objectives

Blast Epidemiology

1. Understand asymmetric war and at-risk populations
2. Introduce blast trauma terms, trauma patterns, and environment
3. Identify likely scenarios and patterns of mortality, critical casualties, and treat and release



Weapons of Mass Destruction



Make-shift bombs are WMD

“... any explosive, incendiary, or poison gas -
(i) bomb, (ii) grenade, (iii) rocket ..., (iv)
missile ..., (v) mine, or (vi) ... similar ...
devices”

– U.S. Code, Title 18, Part I, Chapter 113b,
Sections 2332a and 921a

Alternative terms for WMD

CBRNE – chemical, biological, radiological, nuclear, explosive

BNICE – biological, nuclear, incendiary, chemical, explosive



Bombings in the U.S.



CDC, FBI, State – Bomb-related data, 1988-1997

17,579 criminal bombings in U.S, 1988-1997 (FBI)

- ★ Average of 5 bombings per day
- ★ Bombings doubled over the 10-year period

214 U.S. Embassy bombings, 1988-1997 (State)
- Average ~ 2 per month

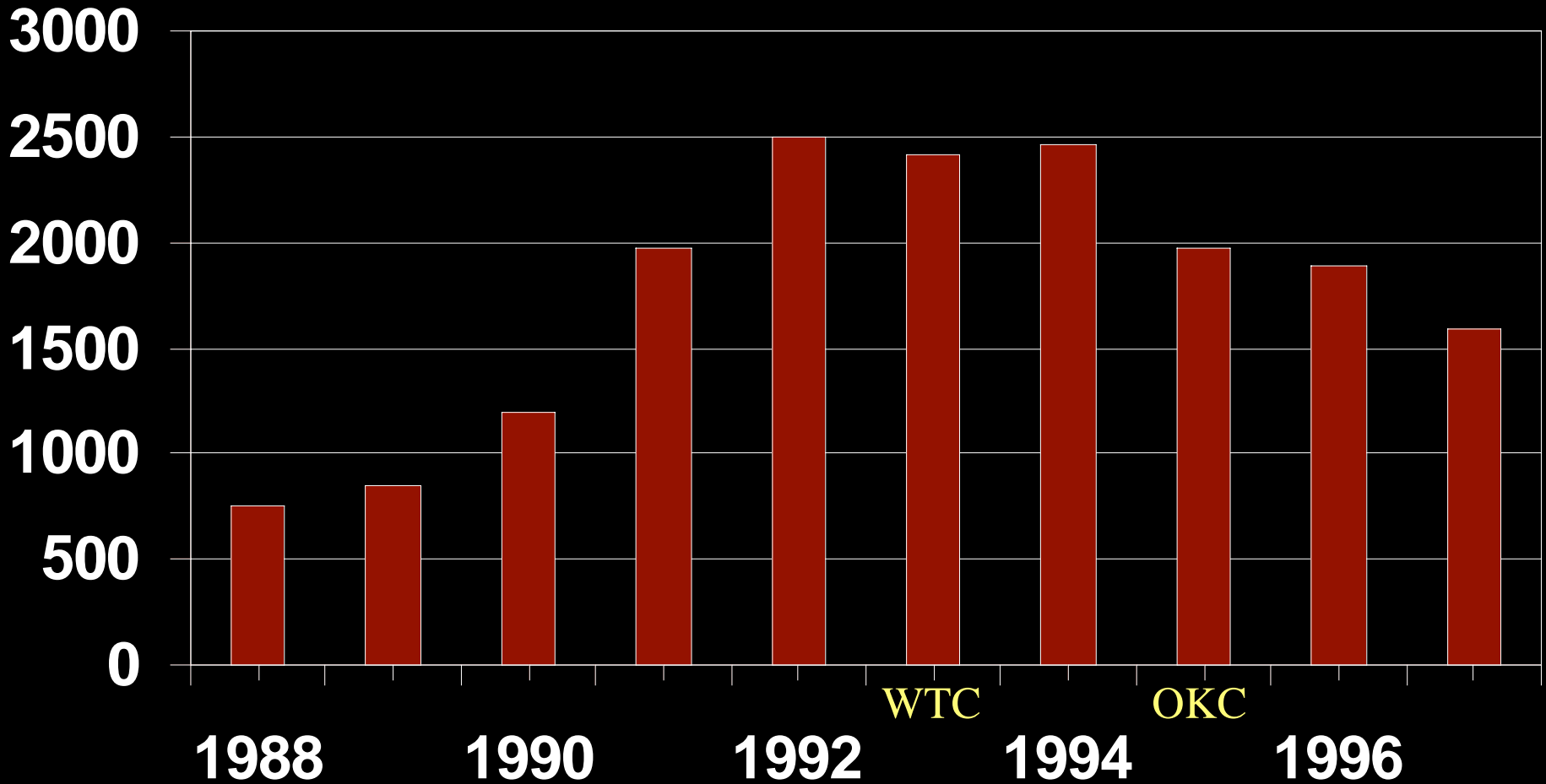
830 bomb-related deaths, 1988-1997 (CDC/NCHS)

US bombing death counts exceed deaths for most US disasters - floods, hurricanes, lightening. (NOAA)

4,063 bomb-related injuries (FBI)

SAFER • HEALTHIER • PEOPLE™

FBI Reported Bombings, 1988-1997



SAFER • HEALTHIER • PEOPLE™



Selected Causes of Deaths, United States, 1988-1997



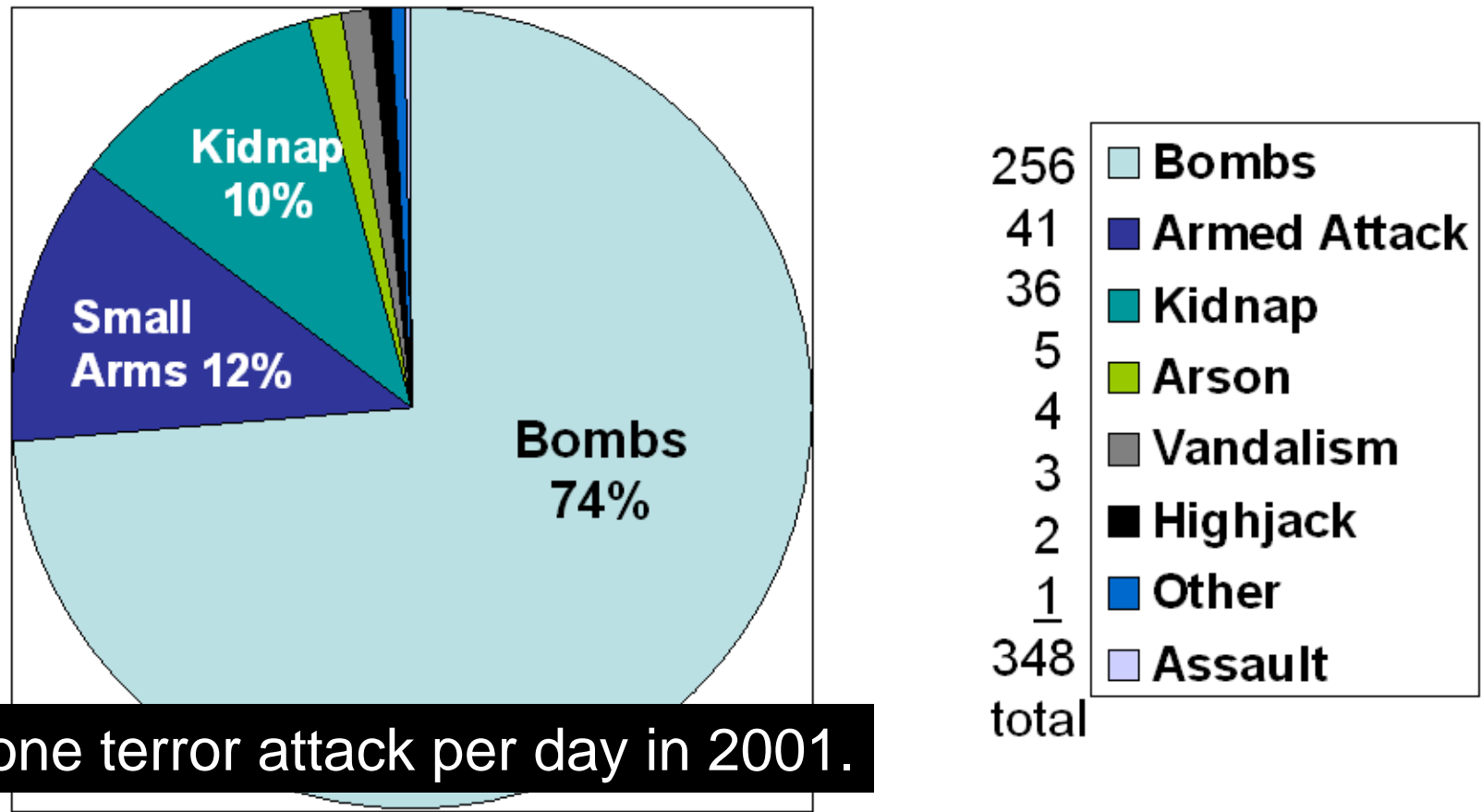
Cause	Count	Data source
Floods	903	NOAA
<u>Bombs</u>	<u>830</u>	NCHS
Lightning	712	NCHS
Tornadoes	437	NOAA
Earthquakes	276	NCHS
Hurricanes	224	NOAA



2001 Worldwide Terror Against U.S. Concerns



Bombs were used in of the 348 terror attacks in 2001
98% of terror attacks used conventional weapons.



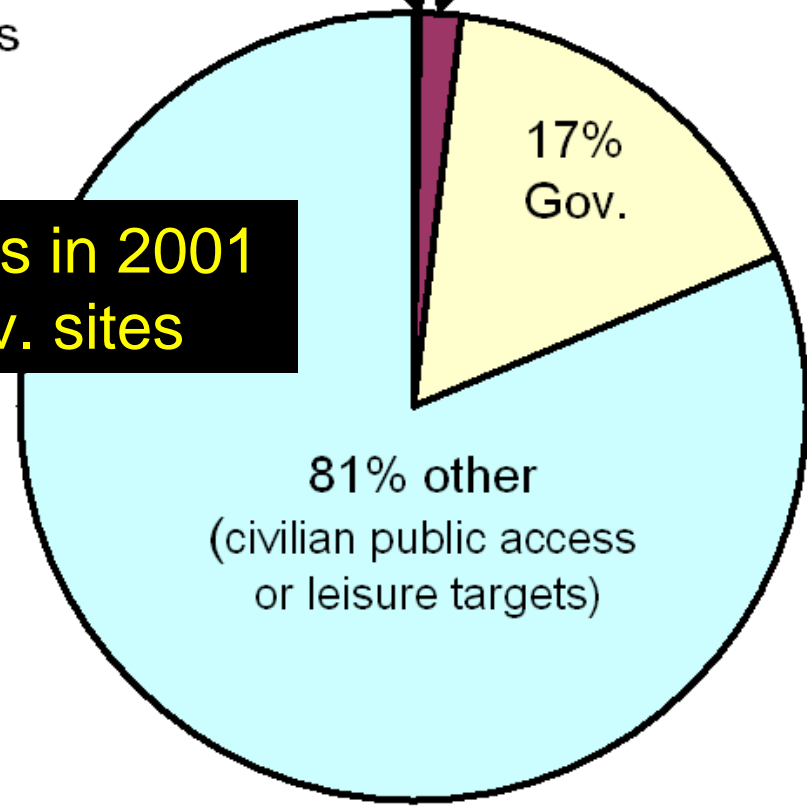
Almost one terror attack per day in 2001.



2001 Total U.S. Worldwide Terror Casualties



0.3% business 2% military



Majority of casualties in 2001 occurred at non-Gov. sites

Business	5
Military	25
Government	277
Other	<u>1348</u>
	1655

Excludes 9/11 deaths and injuries

Access to bomb making advice – only a click away.

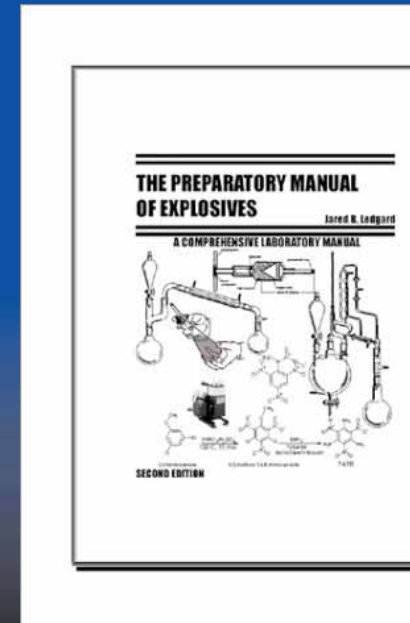
Poor Man's James Bond: Homemade Poisons,
Explosives, Improvised Firearms

by [Kurt Saxon](#)

Price: \$600.00



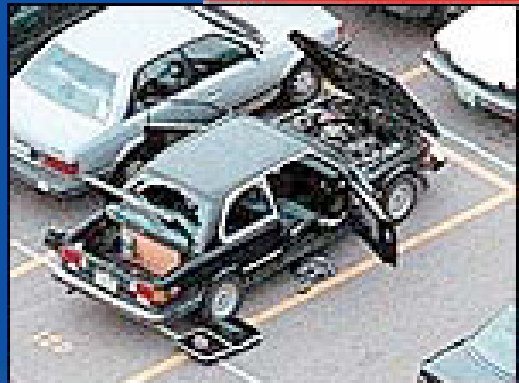
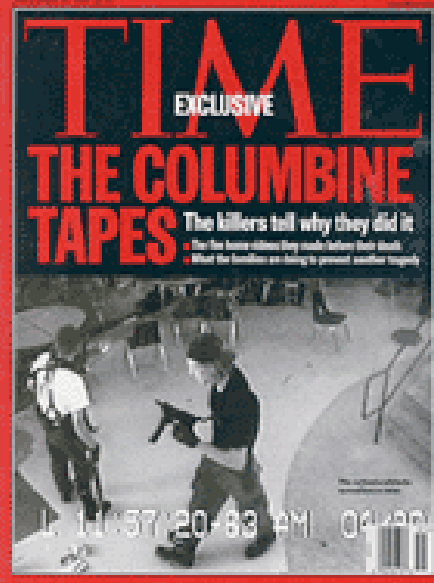
“All Items ships for **FREE** with
Super Saver Shipping”



SAFER • HEALTHIER • PEOPLE™



99 bombs were recovered at Columbine High School delayed access to casualties by Paramedics



Dennis Schroeder © News Photo



Propane bomb in the wrecked cafeteria.
Blue duffel bag bomb in the background.
Just two of the 99 bombs found at Columbine.
Car bomb timer mis-set – detonated 12 hours after event.



Terrors' Perfect Storm



1. Available – 5 billion pounds legally made in U.S.
2. Low tech – Literacy helpful
3. Scalable – 1 kilogram to 1 kiloton TNT-equivalents
4. Simple delivery - hand-carried, truck, plane, train, ship
5. Simple Guidance – placed, thrown, or suicide
6. Human factors – available financing and volunteers

SAFER • HEALTHIER • PEOPLE™



Understanding Terrorism



- 1. Induce fear** in someone other than its casualties
 - goal to change an entity’s political behavior.
- 2. Independent** of the cause that motivates it
 - unjust or righteous – the end justifies the means.
- 3. NOT spontaneous or random**
 - staged psychological act conducted for an audience.
- 4. No DIRECT personal gain** – targets may be financial
 - political, religious, or ideological objectives.
- 5. Requires escalating “shock and awe”**
 - to maintain sense of helplessness



Where is Terrorism Used?



- Terrorism targets free-press countries
 - ◆ Representative governments
- Russia
 - ◆ Chechens use suicide tactics against free-press Russia – not against totalitarian USSR
- Kurds – “Kurdistan” – parts of Iran, Iraq, and Turkey
 - ◆ Terror tactics only against Turkey
 - ◆ Not used against Iran or Iraq





Target → Governments



At-risk → us

- Worldwide – 60-70% are 15-29 year olds
 - ◆ Greater exposure, naïve, genocide, or multi-generation impact?
 - ◆ Soft targets will likely increase as security of GOV targets improves
- U.S. Experience
 - ◆ Government workers and persons working in government-affiliated buildings
 - ◆ WTC, OKC Murrah Building, Embassies, USS Cole, Hart Senate Building, Pentagon, mail-handlers, Judges, Police, Fire, EMS



Three Distinct Tactic - Eras



The 1980s – The “IRA era”

- ◆ Large placement bombs
- ◆ “Gentlemen’s agreement” - limits casualties
 - advanced warning - evacuations, & staging of medical resources

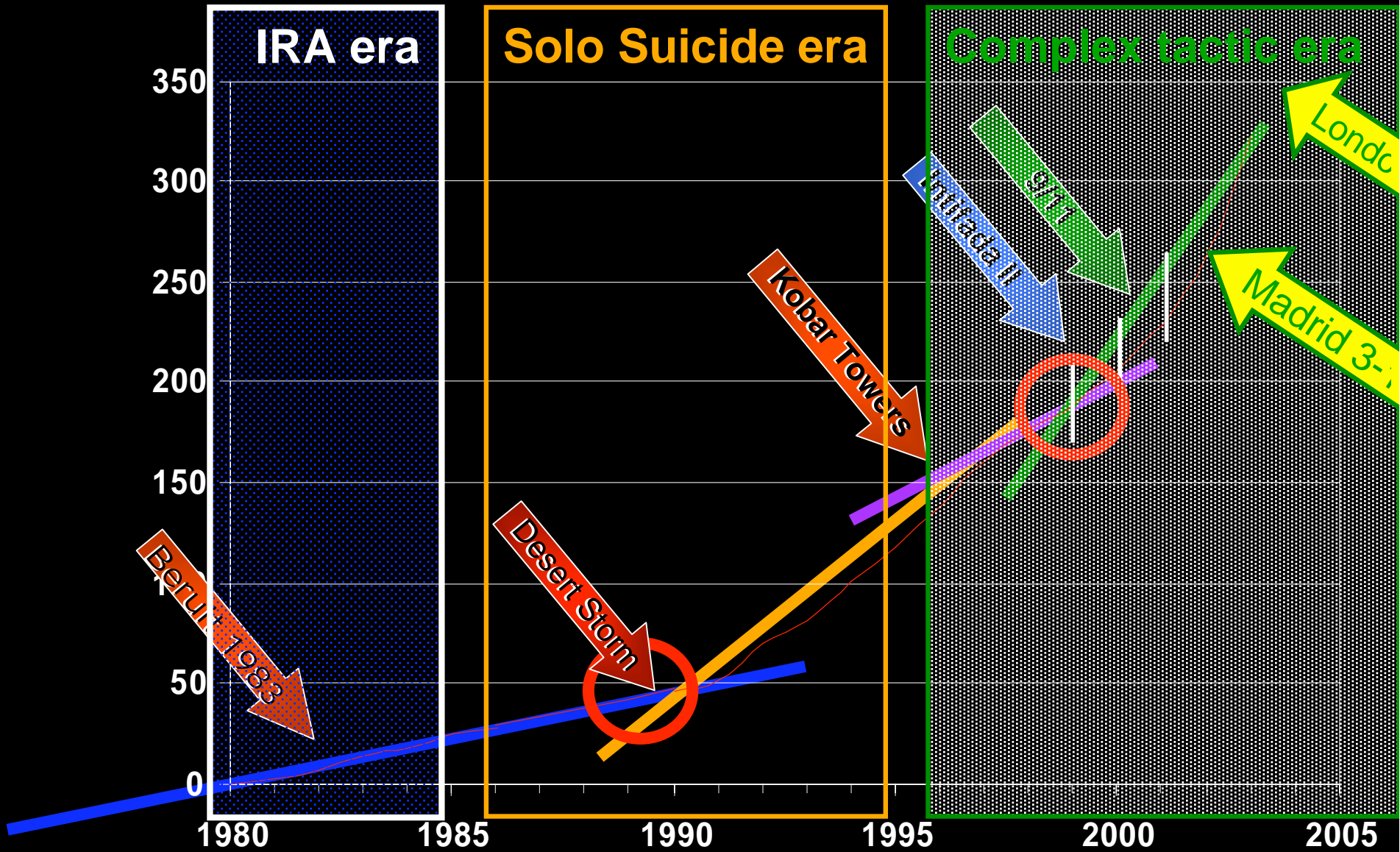
The 1990s – The Suicide bomber era

- Small, but deadly, human “smart bomb”
- maximum casualties, against “soft” civilian targets

The 2000s – Complex tactics era

- couples mega-bombs with multiple synchronized attacks
- often suicide – pioneered in 1983 Beirut
- large or multiple suicide “smart” bombs against “soft” targets

Success Breeds Escalating Trends





Why Is Terror Growing?



Because it works

- 6 of 11 suicide campaigns successful (55%)
 - ◆ terrorists achieved at least partial victory
 - ◆ airpower or economic sanctions < 15% success
- Targeted states
 - ◆ Fully or partially withdrew from territory
 - ◆ Began negotiations
 - ◆ Released a terrorist leader
- Suicide campaigns - successful against even hawkish governments
 - ◆ Reagan
 - ◆ Netanyahu

} Succeeded despite military raids to kill or arrest terrorist leaders



Why Is Terror Growing?



Because it works

- Democratic leaders publicly confirmed terror attacks forced concessions
- Examples
 - ◆ U.S. left Lebanon after 1983 - Marine barracks bombing
 - ◆ Israel followed in 1985 after > 800 IDF deaths / 18 mo.
 - ◆ Spain left Iraq after March 2004 Madrid bombings

“We couldn’t stay there and run the risk of another suicide attack on the Marines.”

-- Ronald Reagan, *An American Life*



Traditional Public Health Applied to Asymmetric War



- 1. Assess needs**
 - a. acute - immediate post-event needs
 - b. long-term - Gap analyses
– information and management needs

- 2. Assure access** to health care & vital services
 - a. at-risk and special needs populations
 - b. Resources – e.g., SNS, training, surge capacity

- 3. Collect, analyze, and report** information
 - a. Decision-makers and managers
 - b. Providers and the Public



Traditional Injury Control Applied to Asymmetric War



Haddon Matrix – classic injury model - useful, but can be limited for rapid evolving tactics

- Pre-Event
- Event
- Post-Event

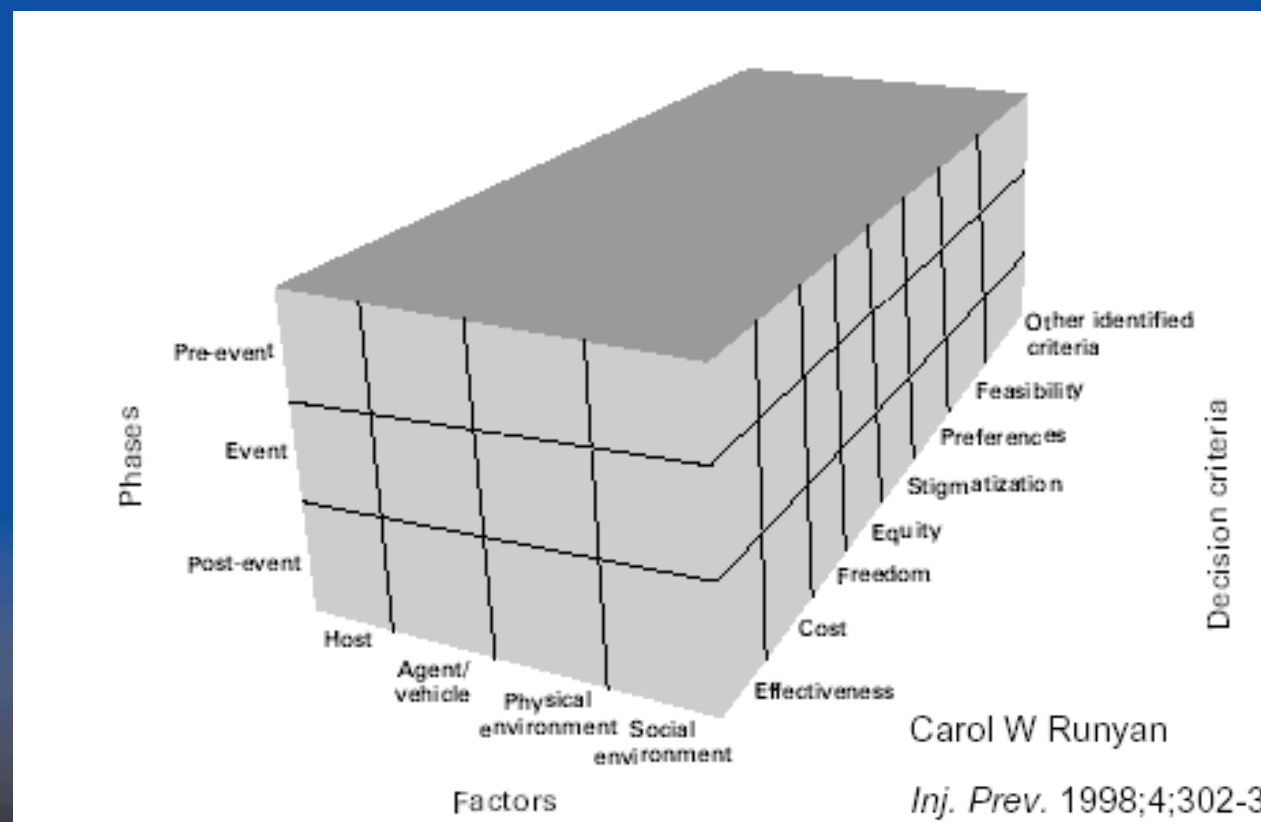


Figure 1 Proposed three dimensional Haddon matrix.

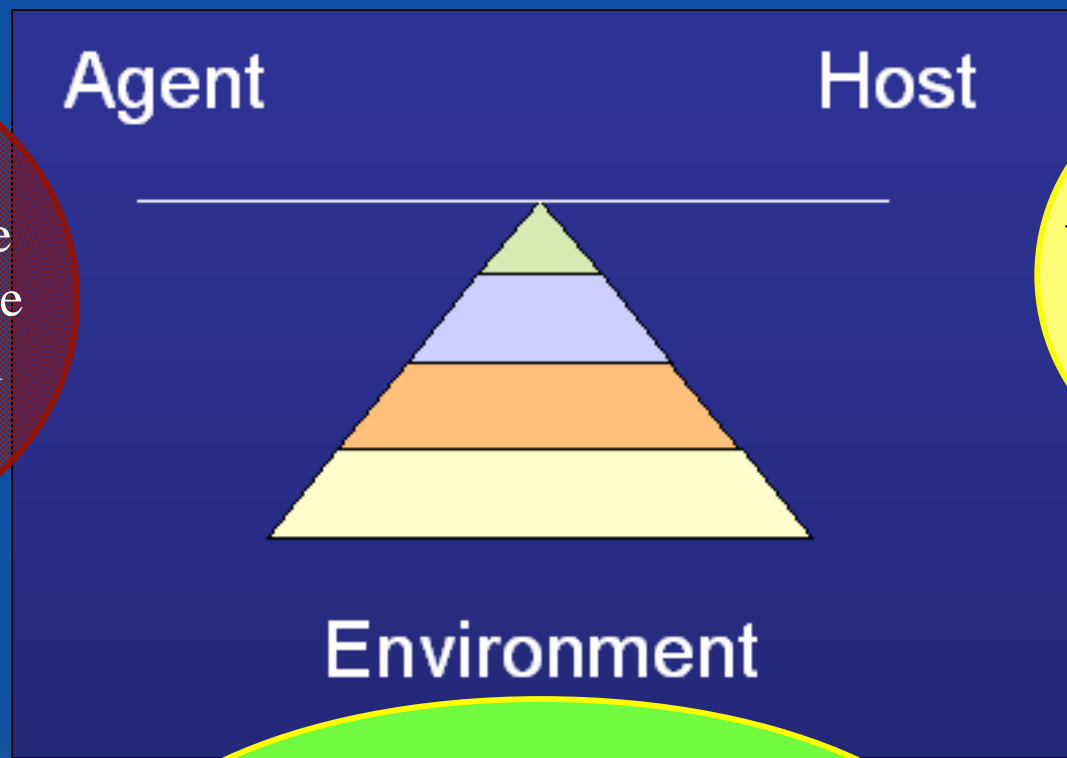
Carol W Runyan
Inj. Prev. 1998;4;302-307



Bomb-Injury Threat Model



Bomb
 Size & weight
 Explosive choice
 Purpose & Source
 Delivery system
 Adulterants
 Tactic



Human
 Age, sex, & weight
 Fitness, PPE
 Nutrition, health
 Access to care

**Open Space, Confined Space,
 Structural Collapse
 Reflecting or Shielding surfaces
 Building and non-structural debris
 Air and liquid hazards**

Lee-Davis



Semper fidelis



History not always Helpful



	Military Combatant	Civilian
Host	Mostly male, healthy, athletic, 18-35 years	More young, older, female, poor health
Personal Protective Equipment (PPE)	Helmet, armored vest, armored vehicles	No PPE or armor
Agent (weapon type)	Manufactured high-order (HE) military ordnance	Makeshift low- and high-order bombs
Injury Patterns	Well-studied High tech shrapnel	Poorly studied Nails, bolts, glass
Access (Environment)	Organized trauma care - long-term rehab., comp., life-long assist., Pres.-Cabinet advocate	Variable access to care, rehabilitation, and assistance. Ad hoc advocacy

TE Davis, CY Lee

J Trauma. 2004;56: 1033-1041

A Survey Assessment of the Level of Preparedness for Domestic Terrorism and Mass Casualty Incidents among Eastern Association for the Surgery of Trauma Members

David L. Ciraulo, DO, MPH, FACS, Eric R. Frykberg, MD, FACS, David V. Feliciano, MD, FACS, LTC Thomas E. Knuth, MD, MC, FACS, Charles M. Richart, MD, Christy D. Westmoreland, RN, BSN, CEN, and Kathryn A. Williams, BS

Assure Access
– provider capacity
27% of trauma surgeons
unprepared to treat
blast trauma

response to catastrophic events. With the exception of cyanide (50%), less than 30% of the membership was prepared to manage exposure to a nerve agent, less than 50% was prepared to manage illness from intentional biological exposure, and only 73% understood and were prepared to manage blast injury. Mobile medical re-

Assure Access – provider capacity

Journal of Surgical Research

October 2004

Galante et al (UC Davis): Are surgical residents prepared for mass casualty incidents? J Surgical Research 121(2):273;Oct 2004

- **Residents' knowledge of Mass Casualty Events**
- Questionnaire of 28 Chief Residents in Surgery, EM & Anesthesiology.
- Surgical residents showed significantly less formal teaching and personal comfort in treating victims of MCI, trauma triage, CBRNE events.

Assure Access – facility capacity

Journal of Burn Care & Rehabilitation

March / April 2005

Tracking the Daily Availability of Burn Beds for National Emergencies

David J. Barillo, COL, MC, USAR,* Marion H. Jordan, MD, FACS,†
Richard J. Jocz, MS,* Donna Nye,* Leopoldo C. Cancio, LTC (P), MC, USA,*
John B. Holcomb, COL, MC, USA*

Medical planning for Operation Iraqi Freedom included predictive models of expected number of burn casualties. In all but the best-case scenario, casualty estimates exceeded the capacity of the only Department of Defense burn center. Examination of existing federal–

Beds that could have been made available or converted to burn use for a national emergency ranged from 196 to 584 beds per day, with a mean of 407 beds. Intensive care unit beds that potentially could have been used ranged from 83 to 239 beds per day,

Average 400 burn beds available in the US on any given day.



Objectives



Blast Epidemiology

1. Discuss terrorism and asymmetric war
 - a. coercion of a strong state by a weak stateless entity*
2. Review the epidemiologic data and the limits
 - a. bombings occur daily in the U.S.*
 - b. terrorists use bombs > 98%*
 - c. No standard terms, analyses, reporting*
3. Why is conventional weapon terrorism (blast trauma) both a public health and healthcare system problem?
 - a. Unanticipated and adversely affects public's health*
 - b. potentially overwhelms regional health infrastructure.*



Part II



An Introduction to Explosives and Blast Trauma

Timothy E. Davis, MD, MPH

Lt. Commander, USPHS Commissioned Corps
Asst. Professor of Emergency Medicine
Emory University

Catherine Y. Lee, MPH

Faculty Associate
Center for Disaster Medicine
New York Medical College

SAFER • HEALTHIER • PEOPLE™



Objectives



Basics of Bomb Blast Trauma

1. Introduce blast trauma are affected by
 - a. terminology
 - b. trauma patterns
 - c. environmental impact on trauma pattern

2. Suggest four basic scenarios
 - a. 1 kg suicide bomber
 - b. 10 kg backpack bomb
 - c. 100 kg car bomb
 - d. 1,000 kg truck bomb



Bomb-Injury Threat Model

Lee-Davis

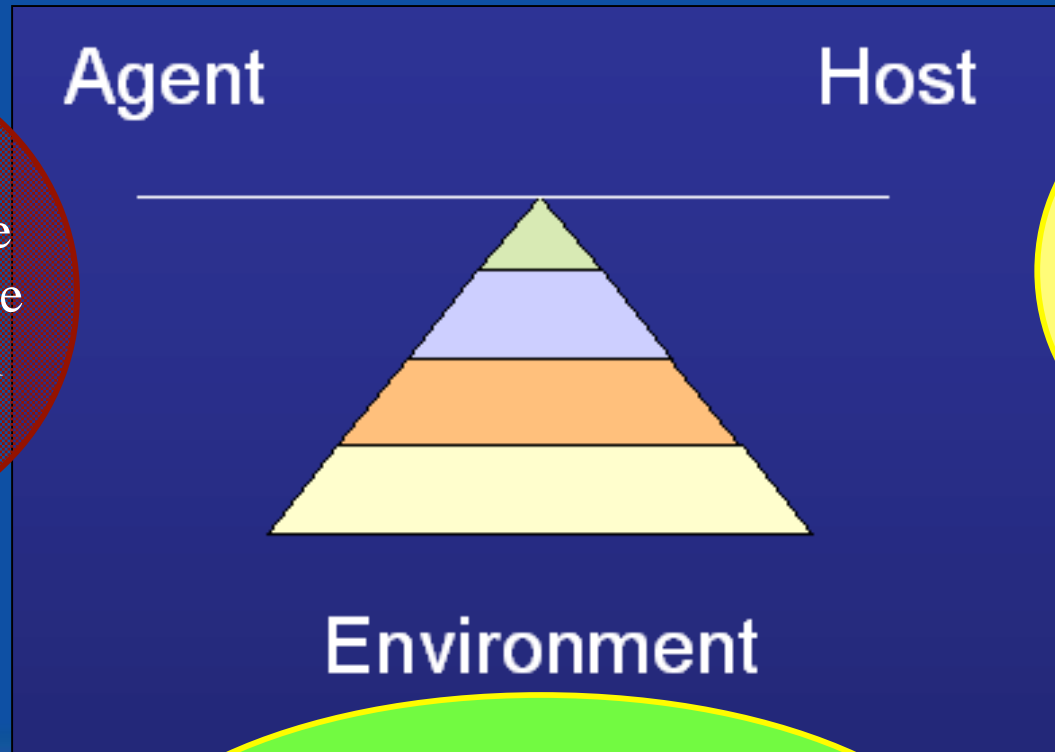


Bomb

- Size & weight
- Explosive choice
- Purpose & Source
- Delivery system
- Adulterants
- Tactic

Agent

Host



Human

- Age, sex, & weight
- Fitness, PPE
- Nutrition, health
- Access to care

Environment

- Open Space, Confined Space, Structural Collapse
- Reflecting or Shielding surfaces
- Building and non-structural debris
- Air and liquid hazards



Explosives Are Ubiquitous



1. Legally made – illegally obtained explosives
from commercial and military sources

- 5 billion pounds produced legally



2. Explosive “recipes” available in libraries, bookstores, www

- ANFO fertilizer, acetone-H₂O₂, Molotov cocktail

3. Commandeered fuel-laden commercial vehicles

- Plane, train, fuel oil truck, LNG fuel super tanker ship





Explosives Classified by the Speed of Explosion

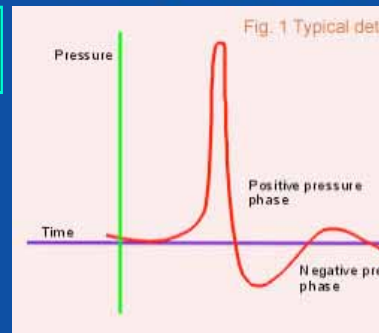


High-order (HE) versus Low-order (LE)

- High-explosives (HE) = detonation
 - ◆ Supersonic – Explosion is faster than the speed of sound
 - ◆ Blast over-pressurization impulse wave
 - ◆ **HE does not mean “large”** – a hand grenade is a HE
 - ◆ HE blast injuries can be characterized as
 - a) Primary, b) Secondary, c) Tertiary, d) Quaternary
 - ◆ E.g., all military bombs, TNT, Dynamite, Semtex, ANFO



Idealized blast overpressure waveform seen only in high-order explosives (HE)



PRESSURE

PEAK OVERPRESSURE

POSITIVE PHASE OVERPRESSURE DURATION

NEGATIVE PHASE

0 ATM
Zero
Atmospher
e
Pressure

Zero ATM

Detonation

VACUUM

TIME
(microseconds)

Horrocks, CL. Blast Injuries: Biophysics, Pathophysiology and Mnaagement Principles.



Explosives Classified by the Speed of Explosion



Low-order explosives (LE) = deflagration

- ◆ Subsonic – explosion occurs < the speed of sound
- ◆ **NO** blast over-pressurization wave
- ◆ Not detonation

- ◆ **LE does not mean “small”** – 9-11 attacks involved LE

- ◆ LE injuries can be characterized as
a) shrapnel, b) blunt, c) crush, d) burn

- ◆ E.g., Napalm, gunpowder, Molotov cocktail,
many petroleum-based (but ANFO is HE)



Classified by Portability



1. Small Arms – 1-person carry

- hand grenades, rocket propelled grenades (RPG),

2. Light Arms – 1 or 2-person carry

- makeshift bombs < 10 kg gross weight,
some landmines, surface mines, grenades



3. Heavy Weapons – mechanized

- makeshift car bomb, truck, plane, train, or ship bomb



Classified by TNT-equivalents



TNT-eq = the amount of TNT needed for the same effect

Black Powder	Dynamite	TNT	Plastic	NTG	Anti-matter
-2	-1	0	+2	+2	+35

TNT-eq calculations – very imprecise based on damage

A measure of energy – not of raw weight

- a 10 kg (TNT-eq) backpack bomb = 2 kg weight

Open space shock & heat waves decrease rapidly $\sim \pm 1 / r^3$



Classified based on Adulterants



■ **“Dirty Bomb” - add bio-chem-rad agent**

- ◆ Reported: Cyanide, Warfarin, Hepatitis, Nitrate-hypotension
- ◆ **Radiologicals** are not affected by heat

Nitrogen-based explosives -> prolonged hypotension

■ **Shrapnel and fragments**

- ◆ Lack access to high tech fragments or canisters
 - ★ Use less efficient bolts, nails, glass
 - ★ **Compensate with excess bulk explosives**



Size Does Matter






Explosives Lethal Blast Serious Injury
 in Kg TNT-eq. Range (meters) Range (meters)

Suicide bomber	1– 5 kg	5 meters	10-30 meters
Compact car	227	30	450
Sedan	455	60	530
Passenger van	1,180 (~ OKC)	80	840
Panel truck	4,545 (~ Khobar)	91	1,150
Fuel truck	13,636 (~ Beirut)	140	1,980
Semi-trailer	27,273 kg	180	2,130

1000kg Car Bomb Blast



LEGEND

-  Lung Damage
-  Ear drum rupture
-  High hazard glass breakage

Kill Zone

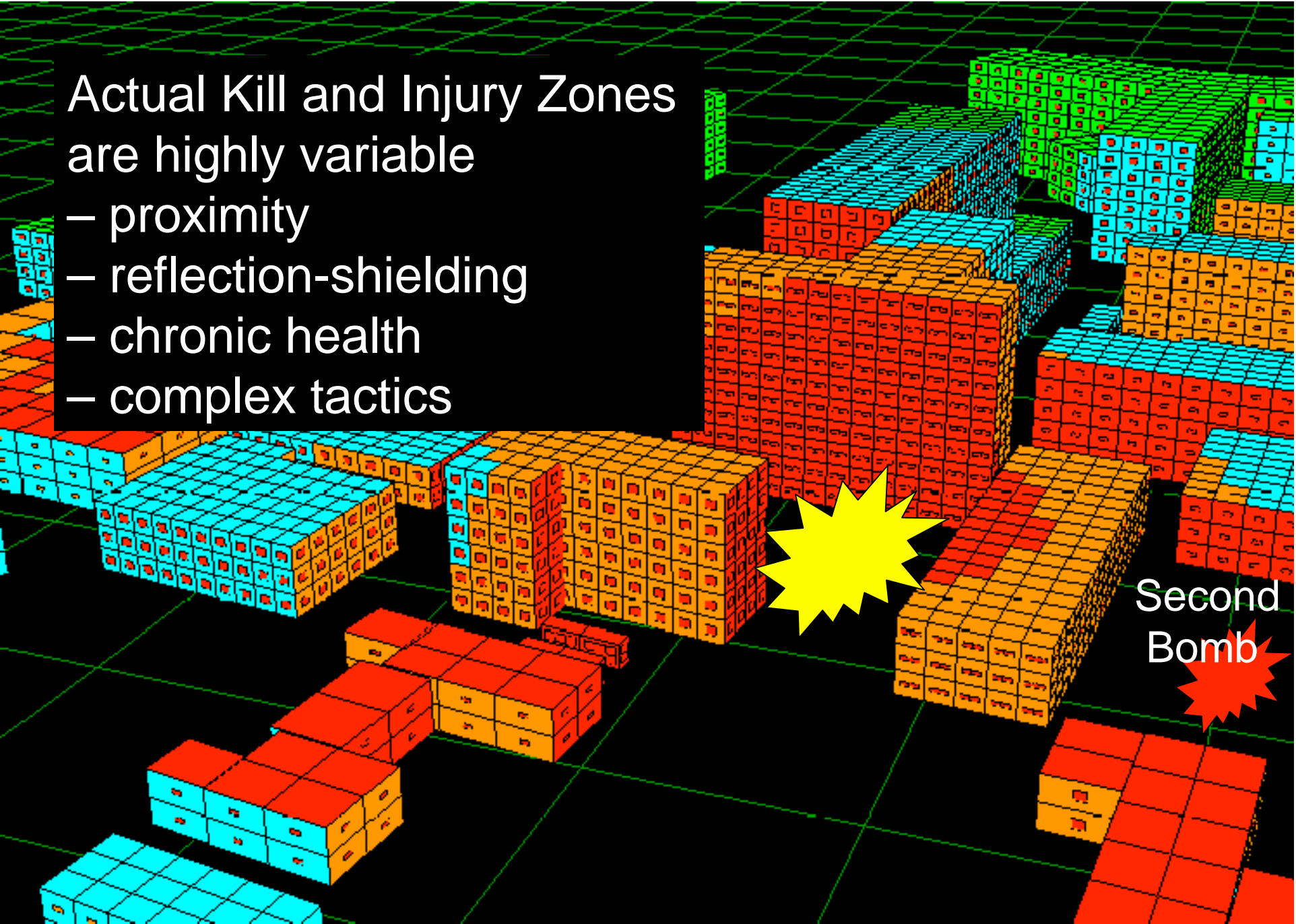
Injury Zone

Critical Trauma Zone

**Debris in every meter²
marks Kill Zone**

Actual Kill and Injury Zones
are highly variable

- proximity
- reflection-shielding
- chronic health
- complex tactics





Environment Affects Injury Patterns



Open Space –

- street corner, open market, stadium, roadway
- 10% fatalities
- Blast impulse weakens rapidly – unless reflected
- nails > 100 meters
- blast lung not seen in immediate survivors
- straight-forward rescue and transport





Environment Affects Injury Patterns



Confined space

- Inside bus, train, or auditorium
- 20% fatalities, 70% DOS
- Blast pressures intensified x 2-9
- Blast lung (<math><48^\circ</math>) and abdomen (<math><48^\circ</math>)
- More complicated rescue





Environment Affects Injury Patterns



Structural collapse (Enclosed space)

- Inside a reinforced multi-story building
- 20% fatalities, 90% DOS
- Complex reflections
- Blast pressure up x 2-9
- Complicated rescue
- Delayed care





Blast-Injury Vocabulary



Specific for High-order Explosives (HE)

- 1. Primary (1°) Blast Injury** (e.g. blast lung)
– over-pressurization impulse wave – often fatal
- 2. Secondary (2°) Blast Injury** (e.g. glass shards)
– penetrating shrapnel and debris
- 3. Tertiary (3°) Blast Injury** (e.g. traumatic amputation)
– blunt - blast wind throws the individual
- 4. Quaternary (4°) Blast Injury** (miscellaneous)
– burns, fume poisonings, suffocation, building collapse, crush injuries, chronic disease flare, mental health



Blast Injuries – Not in Isolation



“Total Body Disruption”

A Casualty with “Blast Lung” (1°) will also have

1. Penetrating glass shards (2°)
2. Traumatic amputation (3°)
3. Burns, inhalation injury, deafness (4°)

The Injury Severity Score (ISS) grossly under-measures – complexity & resource utilization

Other typical confined space (bus) injuries

- (1°) Blast lung, bowel rupture, TM rupture
- (2°) Penetrating foreign body to globe, chest, abdomen
- (3°) Traumatic amputations, Fx to face, pelvis, ribs, spine
- (4°) crush injuries, 1° & 2° burns



Multi-system and Multi-region Trauma = 65%



160 casualties < 18 years, 41 MCEs, 2000-2002

Head or face injury in 66% of casualties

Injury	
Fracture	67 (45%)
Int. Organ	41 (27%)
Open wound	84 (56%)
Burns	13 (9%)

Site of Injury	
Brain	32 (21%)
Other head	74 (49%)
Spinal column	4 (3%)
Chest	25 (17%)
Abdomen	25 (17%)
Pelvis, back	25 (17%)
Arms	58 (39%)
Legs	70 (47%)

HEENT

Y Waisman, L Aharonson-Daniel, M Mor, L Amir, K Peleg



Primary Blast Injury



= high-order (HE) explosives

1. Caused by the over-pressure blast wave
 - ★ Invisible, supersonic
2. Lethal radius diminishes in theoretical open space
 - ★ $1 / \text{radius}^3$. Lethal radius is 3x in water
3. Air filled structures affected most
 - ★ Lungs, GI tract, Sinuses, Middle ear (TM rupture)
 - ★ But also brain – “shell shock”

*Courtesy: Battlefield Wounds,
JR Mechtel, RN, MSN – DMRTI*

"Blast Lung"

White Butterfly Sign



1. **NO universal applied definition**
 - a. widely reported in middle east, rare in Iraq
 - b. A clinical diagnosis, confirmed with X-ray, **70% fatal** – best case
 - c. Severe pulmonary contusion from air compression – re-expansion
2. **Symptoms** – exposure + SOB, cough, hemoptysis, retrosternal pain
3. **Signs** – Tachypnea, cyanosis, decrease BS, dull to percussion, rales / crackles, hemo/pneumo-thorax, subcutaneous emphysema, retro-sternal crunch, air emboli, retinal artery emboli



CL Horrocks, Wounds of Conflict

Blast Lung: radiological picture may vary significantly

X-rays courtesy of P Halpern, Tel Aviv Medical Center



4. Management – Cannot blindly accept guidelines developed off worldwide experiences

-> treatment can be region specific

- a. approach as a severe pulmonary contusion
- b. complex fluid management
- c. Cautious mechanical ventilation (increases chance of air emboli)

Blast Abdomen

1. **Delayed onset > 8-36 hours** – more common in submersion
 - a. Intestinal intra-wall hemorrhages
 - b. Shearing of local mesenteric vessels
 - c. Sub-capsular and retroperitoneal hematomas,
 - d. Fracture of liver and spleen, and testicular rupture
 - e. Zero in Madrid (?)
2. **Symptoms** – exposure + abdominal pain, nausea, vomiting, hematemesis (rare), rectal or testicular pain and tenesmus
3. **Signs** – abdominal tenderness, rebound, guarding, absent bowel sounds, signs of hypovolemia
4. **Management** – Resect small bowel contusions > 15 mm, and large bowel contusions > 20 mm

“Blast Brain”

a.k.a., concussion, TBI, shell shock,
mis-diagnosed behavioral disorder (e.g., PTSD)

- Blast over-pressure wave – not always a straight path
 - ◆ Dampened, reflected, or amplified off solid surfaces
 - ◆ Helmets, Kevlar stop shrapnel, may intensify blast wave
- Exposure + abnormal behavior = TBI
 - ◆ Do not assume all dysfunctional actions are behavioral
- Future treatment for IC bleed may be rF VIIa
 - ◆ Human recombinant Factor VIIa used in Israel under a humanitarian protocol
 - ◆ Not U.S.-FDA approved or recommended

J Neurosurgery Jan 2002



Secondary Blast Injury



1. Penetrating injury from shrapnel or debris.
2. Open-space bombings
 - nails out to 100 meters from 5 kg bomb
3. Makeshift bomb shrapnel unpredictable path
 - high use of CT and X-ray in Israel
 - consider metal detectors for rapid screening
4. Treat as dirty grossly contaminated
 - delayed primary closure

*Courtesy: Battlefield Wounds,
JR Mechtel, RN, MSN – DMRTI*



Tertiary Blast Injury

1. Caused by force of blast wind
 - displacement of body, or body parts
 - includes traumatic amputations
2. Blunt trauma – solid object strikes, or victim is thrown against solid object
 - includes impalement
3. Care follows standard blunt trauma protocols

Courtesy: Battlefield Wounds, John R. Mechtel, RN, MSN – DMRTI



Quaternary Blast Injury



Classified by some disciplines as “miscellaneous”

1. **Crush injuries**
2. **Poisonings** – hypotension from nitrate-based bombs
2. **Suffocation** from dust, smoke, fumes
3. **Burns**
4. **Exacerbation of chronic disease**
 - ◆ Asthma, COPD, diabetes, hypertension, CAD, PUD, alcohol and drug abuse, mental health
5. **New behavioral problems**



Low-order Explosives (LE)

use "clear text" mechanism descriptions



Low-order explosives (LE) differ in mechanism:

1. Deflagration not detonation (HE)
2. Subsonic "slow burn" versus supersonic explosion
3. No over-pressurization and blast wave impulse

1. Ballistic effect – shrapnel and debris
2. Thermal effect – burns from the heat generation
3. Suffocation – all oxygen is consumed

Also -> fume poisonings, crush injuries,
exacerbation of chronic disease (asthma, COPD,
diabetes, hypertension, MI, PUD, mental health)



Blast Trauma

"total body disruption"



70-90% of fatalities are DOS.

Blast Trauma does not occur in isolation

1. HE and LE produce dirty contaminated wounds
2. Combined blast, blunt, and penetrating trauma
3. Burns, head, neck, and airway injuries

Survivability depends largely on

1. Bomb size, characteristics, and tactic
2. Personal proximity, vulnerability, & health
3. Environment, building construction, evacuation proficiency, and luck.



Benchmarks Small (5 kg) Open Space Suicide Bombing



Casualties – 1-30 (Israel - average 23, range 1-99)

Severity

- killed 1-5
 - admitted 5-10
 - treat & release 20
- } **1/3rd killed or admitted**
- } **2/3rd outpatient treatment**

Injury patterns

- 1° Blast trauma < 5 meters – kill zone
- occult nails < 100 meters – injury zone
- temporary deafness
- risk of Hepatitis, Tetanus, HIV
- hypotension from nitrate-based explosives



Benchmark



Small (10 kg) Confined Space Backpack Bomb

Casualties – 20-50 bus and 150-200 train / bomb
- 70% of fatalities are Dead on Scene (DOS)

Severity

- killed 20%
 - admitted 20%
 - treat and release 60%
- } **Simplified Severity Benchmark**
= 1/3rd killed or admitted > 24°.

Injury patterns

- 1° Blast trauma – anywhere within bus or train cabin
- temporary deafness, risk of Hepatitis, Tetanus, HIV
- hypotension from nitrate-based explosives

Complicated and delayed train rescue



Structural collapse bombing



(100-1,000 kg TNT-eq)

Casualties – 100 – 3,000

- largely based on bomb size, time of day, warning, building structure, and evacuation proficiency
- 90% of fatalities are DOS

Severity – follows pattern of Earthquake or structural collapse

- killed if in the wake
- treat and release if nearby, but not in direct path
- small percentage admitted (<1-5%)

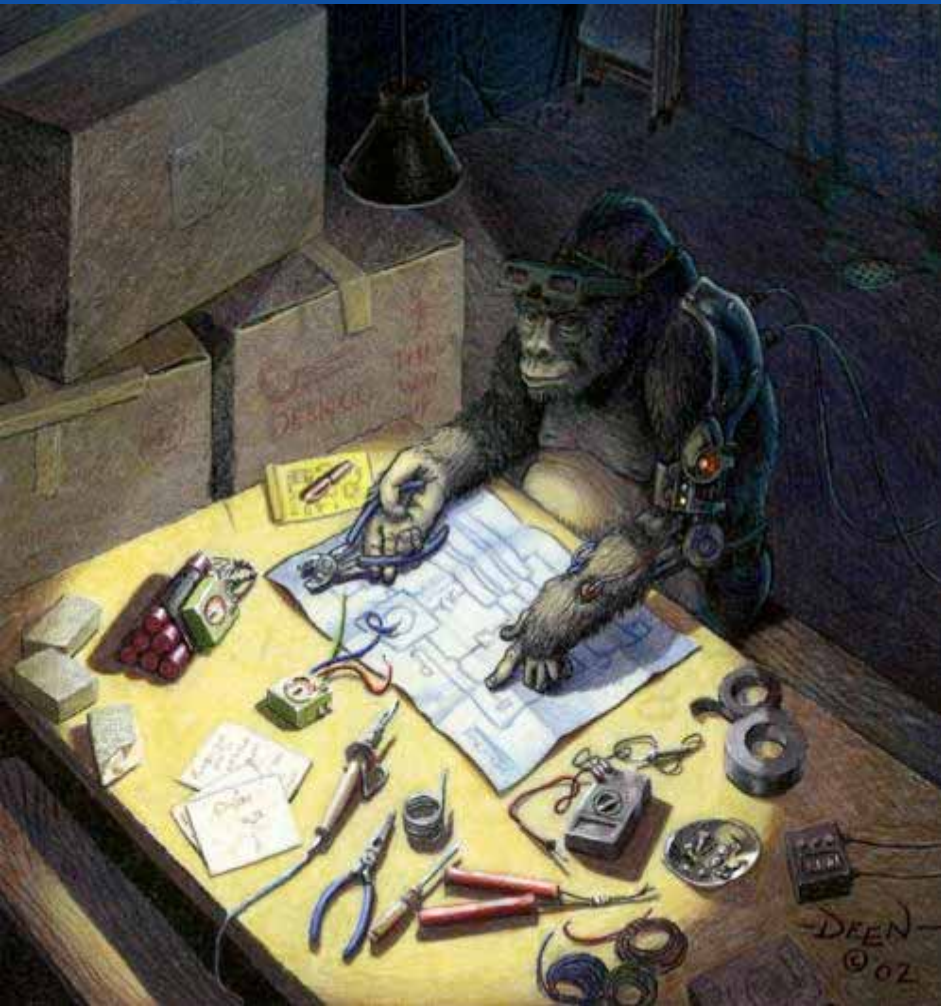
Injury patterns

- respiratory problems, temporary deafness

Rescue must weigh risk versus benefit of rapid ingress



Questions ?



Sherlita Amler, MD

Health Commissioner

Putnam County, NY

sherlita.amler@putnamcountyny.com

Tim Davis, MD, MPH

Asst. Professor of Emergency Medicine

Emory University

tdavi02@emory.edu

Catherine Y. Lee, MPH

Faculty Associate

Center for Disaster Medicine

New York Medical College

catherine_lee@nymc.edu



Semper fidelis

Questions ?



Tim Davis, MD, MPH Catherine Y. Lee, MPH Sherlita Amler, MD
tdavi02@emory.edu catherine_lee@nymc.edu sherlita.amler@putnamcountyny.cc