

Approach to Blast and Burn Injuries

Jim Augustine, MD
Medical Director,
Assistant Fire Chief
DC Fire EMS

OBJECTIVES

- Common Scenarios of Blast and Burn
- Differentiate HE and LE Incidents
- Prehospital Emergency Management Strategies, Documentation Priorities
- Terrorist Incident Considerations

OUTCOME OF FIRE

- In the US, 1.1 million burns per year
- 45,000 persons hospitalized
- 4,500 deaths

The IED Issue

- **Blast +**
 - Radioactive Material
 - Chlorine
- **Trauma + Burn**
- **Burn + Shrapnel**



Timely Materials in Reference Libraries at cdc.gov

Burn Prevention = Capacity Issue

Journal of Burn Care & Rehabilitation

March / April 2005

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

Blast and Burn Incidents

■ Critical Scene Considerations

- Scene Safety a Priority
- Evidence a Priority
- Hot Zone Considerations

Blast and Burn Incidents

■ Victim Considerations

- Blast First, Burn Second
- Quiet is Bad
- Triage using no Equipment

Explosives

High-Order (HE)
Low-Order (LE)

High-Order Explosive (HE)

TNT

C-4

Semtex

Nitroglycerin

Dynamite

ANFO (Ammonium nitrate fuel oil)

Low-Order Explosive (LE)

Pipe bombs

Gunpowder

Pure petroleum-based bombs
(Molotov cocktails)

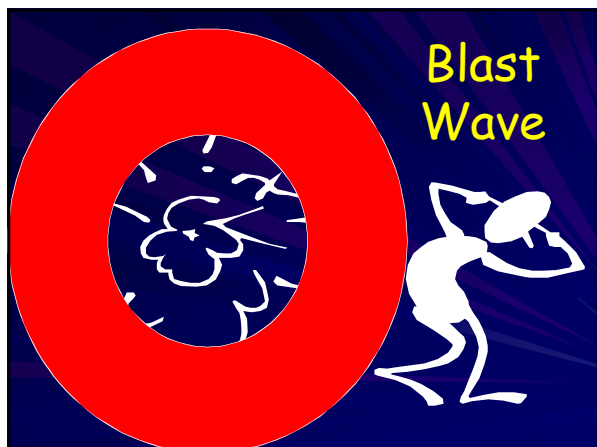
Aircraft improvised as guided
missiles

Blast Injury

- Primary from the BLAST WAVE
- Secondary from Flying Debris and Bomb Fragments
- Tertiary from Individual being thrown by Blast Wind
- Quaternary from later complications of all types

BLAST WAVE

- Expanding gas mass under high temperature and pressure
- Reaches velocities of 1500 miles per hour
- Increased force in a confined space
- More dense medium = more force, like water



Common Blast Injuries

- Air Filled Structures: Lungs, Ears, Intestines
- Head Concussion
- Globe Rupture
- Impalements

Blast Lung

- Pressure following path of least resistance
- Most common fatal injury among survivors
- Classic Triad
 - Apnea
 - Bradycardia
 - Hypotension
- Air emboli from torn lung tissue

Secondary Injury

- Flying Debris
- Bomb Fragments
- Shrapnel placed in bomb

Blast Wind Displaces Person

- Tertiary Injuries



Building Damage, Collapse, or Fire



EMS Responsibility

Notify Hospitals as rapidly as possible
Identify HE and LE incidents
Obtain info on potential "dirty bomb"
Relay this information to treating hospitals

Blast and Burn Victims

- Assess life threat ABCs
- Unconventional Positioning
- Prepare for Impalements
- ABC Treatment

Blast and Burn Victims

- Blast Injury = Consider Spinal Injury
- Shrapnel Injury = Spinal Injury very Unlikely. Position for airway
- Burn + Shrapnel = Position for airway and comfort

The Terrorism Blast Issue

- Experience from Iraq
- Experiences from Israel
- CDC Studying
- Dr Tim Davis

Environment Affects Injury Patterns

Open Space –

- Park, street, open market, stadium, roadway
- 10% fatalities
- Blast impulse weakens rapidly – unless reflected
- Nails still dangerous > 100 meters
- Blast lung not seen in immediate survivors
- Secondary device concern

Environment Affects Injury Patterns

Confined space

- Inside bus, train, or auditorium
- 20% fatalities
- Blast pressures intensified x 2-9
- Blast lung (<24") and abdomen (<48")
- More complicated rescue

Environment Affects Injury Patterns

Structural collapse (Enclosed space)

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

Casualty Benchmarks

Small (5 kg) Open Space Suicide Bombing

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

Severity

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

Injury patterns

- 1° Blast trauma < 5 meters – kill zone
- Occult nails < 100 meters – injury zone
- Victim considerations = **temporary deafness**, blinded, panic, Tetanus

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

Injury patterns

- 1° Blast trauma – anywhere within bus or train cabin
- Victims deaf and blinded, panic, risk of Tetanus

Complicated and delayed train rescue

Casualty Benchmark 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 – different pattern from Earthquake or structural collapse

- explosives pulverize building

Injury patterns

- Blast lung, blast abdomen

Rescuers must weigh risk vs benefit of rescue ingress

Asymmetric War requires

Asymmetric Triage

Standard Triage Will Not Work

- Cannot assume walking wounded are "minimals".
- Nails leave no or little external injury
- Casualty can be 100 meters from event
- T2-Delayed & T3 can become T1/Immediates
- Apneic casualties are dead.
- Critical-Expectant - evacuated only after T2 and T3

TE Davis, CY Lee

CDC Prep Summary

1. Preparedness is not rocket science
– but unfortunately neither is terrorism.
2. Terrorists take advantage of lessons learned
– few barriers to entry for small-scale attacks
3. Principles and trends evolve (drift)
4. Casualty patterns for explosions are predictable
5. Response and health assets -> the real targets?

Blast Events in America

Half of all initial casualties will seek medical care over a one-hour period

“Upside-down” triage

Less injured bypass EMS triage and go directly to the closest hospitals

Most severely injured arrive later by EMS

WHAT HAPPENS IN FIRE

- Immediate Trauma
- Inhalation of Smoke
- CO, cyanide poisoning
- Burns

IMMEDIATE REACTIONS

- Eyes and nose and throat irritated
- Cough uncontrollably
- Stand up and run
- Confused and disoriented

SKIN

The skin is a specialized protective layer, with a design to keep the body at a fairly constant temperature

The design of the skin leaves it prone to injury at certain levels

Injury by heat, cold, electricity, chemicals, and tearing all tend to occur at the same level

SKIN INJURIES

Resulting injuries are classified as partial thickness, and full thickness

Treatment tends to be the same for all these insults. This also means the injury is worsened by the same things. That is why we don't rub burns or frostbite

PARTIAL THICKNESS BURN

Sunburn or thermal burn from a hot object
Frostbite
Chemical burn from ammonia, hair chemicals
Blister agents
Strawberry from sliding in baseball
Road rash from a motorcycle accident

FULL THICKNESS BURN

Thermal burns
Frostbite
Chemical burns sulfuric acid, lye, or mustard gas
Road rash from a motorcycle accident
Degloving injuries from an industrial accident

COMPLICATING BURN INJURIES

- Superheated air and gases
- Soot
- Dangerous Chemicals

SMOKE INHALATION

- Inhaled poisons move through the airway to the lungs
- But on the way, damage to the throat, airway, and critical cells
- Dries those areas
- Airway swells and constricts
- Irritation causes intense cough
- Lungs very effective in moving CO and cyanide into the blood

BURNING THE SKIN

- At 150 degrees, water burns in a few seconds
- A child is burned even more quickly
- Worse injuries if steam or chemicals

PARTIAL AND FULL THICKNESS INJURIES

Infants have extremely thin skin

Children have thin skin

Adults have thick skin

Elderly have thin skin

BURN DEATH

- INHALATION
- UNDERLYING MEDICAL PROBLEMS
- SHOCK
- PENETRATING BURNS
- INFECTION RISK
- DEGREE OF BURN

START OFF PARTIAL THICKNESS, THEN PROGRESS

- High Voltage electrical injuries
- Hydrofluoric acid and concentrated alkali
- Steam burns

CHEMICAL AGENTS

Alkali much more dangerous than acid
Some agents are very bad players:
hydrofluoric acid the worst
Dust or blot off, then....
Irrigate like crazy with warm, clean water
Blister Agents

FIELD BURN MANAGEMENT

Avoid personal injury
Remove victim from further injury
Stop the burning process
Protect the patient from cooling,
shivering - remember the first job of
the skin is to keep the person warm!!

TREATMENT OF SMOKE INHALATION

Immediate placement of
100% oxygen in
suspected inhalation
MUST HAVE moisture
with their oxygen
Bronchodilator as well

CO POISONED

Treatment ultimately depends on
neurologic symptoms
CO keypoints
■ Single Digit CO typically not
symptomatic
■ Moderate symptoms 10 - 20%
■ Critical over 20%
Treatment is Flooding the Hemoglobin
and tissues with Oxygen

FIELD BURN MANAGEMENT

Treat other injuries

Clean Dressing

Let the Patient tell you what feels best

THE BIG QUESTION: WET OR DRY?

- The issue is hypothermia and patient comfort
- Small first and second degree burns managed with wet dressings at patient request
- Large burn areas, second or third degree, must not be cooled

TRIAGE OF MAJOR BURNS

- Moderate Full Thickness
- Airway compromise
- Second Degree, Large to Small
- Fatal Full Thickness, Severe Inhalation Injury
- First Degree

WRITE OFF IN OVERWHELMING MCI

- Obvious Fatal
- No Vital Signs
- Shock
- Breathing Compromise
- Airway Compromise

WRITE OFF IN MAJOR MCI

- Does not mean "Don't Treat"
- Warm
- Pain Control
- Comfort

DIRTY BOMBS

- Protocol Change
- Consider in a High Risk Location
- Rescuer Decon will be Necessary
- Don't Track off-scene
- Respect Hot Zone Border

Burn/Blast Events

- Evidence Preservation
- Document in as much Detail as Possible
- IN MOST STATES:
- All Burns must be Reported

SUMMARY

The best burn = one that is Prevented
Blasts have predictable injury patterns
IED Incident Prep Needed
Scene Safety
Evidence Preservation
Documentation
