

# BLAST & EXPLOSIVE INJURIES

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# Job Security



# Caveats, Disclaimers

- ▣ I am NOT a bomb technician
- ▣ This is NOT an explosives class
- ▣ I really do like this stuff!

# Goals and Objectives

- ▣ Community Awareness
- ▣ Basic Understanding of Explosives
- ▣ Types of Blast Injury
- ▣ Treatment Considerations

# Why discuss the topic?

*“Improvised explosive devices (IEDs) remain one of the most accessible weapons available to terrorists and criminals to damage critical infrastructure and inflict casualties, as was demonstrated in the attempted bombing of Northwest Flight 253 on December 25, 2009, the October 2010 air cargo plot, and the wars in Iraq and Afghanistan.”*

Countering Improvised Explosives Devices  
Office of the President of the United States  
February 26<sup>th</sup>, 2013

# Community Awareness

What's in your 1<sup>st</sup> due area?

# Military Bases

MCB Quantico

West Point

Fort AP Hill

NAB Little Creek

Fort Belvoir

Watervilet Arsenal

# Pyrotechnics





# Industrial



- ▣ Vulcan Quarry
- ▣ “Our quarrying process typically begins with drilling and blasting the rock into smaller pieces.”

# Criminal Acts



- ▣ December 5, 2012
- ▣ Fredericksburg, VA
- ▣ Attempted robbery

# Criminal Acts



# Explosives 101

How does it happen?



# Combustion vs. Explosion

- ▣ Combustion
  - Fuel + Oxygen + Ignition



+ Air (Oxygen) + Spark =



“vroom, vroom, vroom”

# Combustion vs. Explosion

▣ Fuel Source



▣ Oxidizer

+



# Combustion vs. Explosion

Ignition Source





# EXPLOSIVE

Fuel Source + Oxidizer + Ignition Source =





# Types of Explosions

- ▣ Mechanical
  - Fuel-Air, BLEVE, Pressure Cooker
- ▣ Nuclear
  - Fission versus Fusion
- ▣ Chemical

# Fuel-Air Explosive

- ▣ Fuel source is deployed, sparked
  - uses oxygen from the surrounding air
- ▣ Staying power
  - Bunker busters
- ▣ Grain Bin Explosions

# Fuel Air Explosion



# Pressure Cookers

## PRESSURE COOKER

The use of pressure cookers as an improvised explosive device is a technique commonly taught in Afghan terrorist training camps, according to a 2003 bulletin by the Department of Homeland Security. "Pressure cooker bombs are made with readily available materials and can be as simple or as complex as the builder decides," DHS says.

### WHEN A PRESSURE COOKER IS USED IN COOKING:

#### Normal use

Pressure cookers cook food by using an airtight lid to trap steam, raising its effective cooking temperature to about 250 degrees Fahrenheit.

### WHEN A PRESSURE COOKER IS USED AS A MAIMING WEAPON:

1

#### Detonation

Explosive material is substituted for food. An electrical charge ignites the material, which is surrounded by shrapnel such as nails and ball bearings.

2

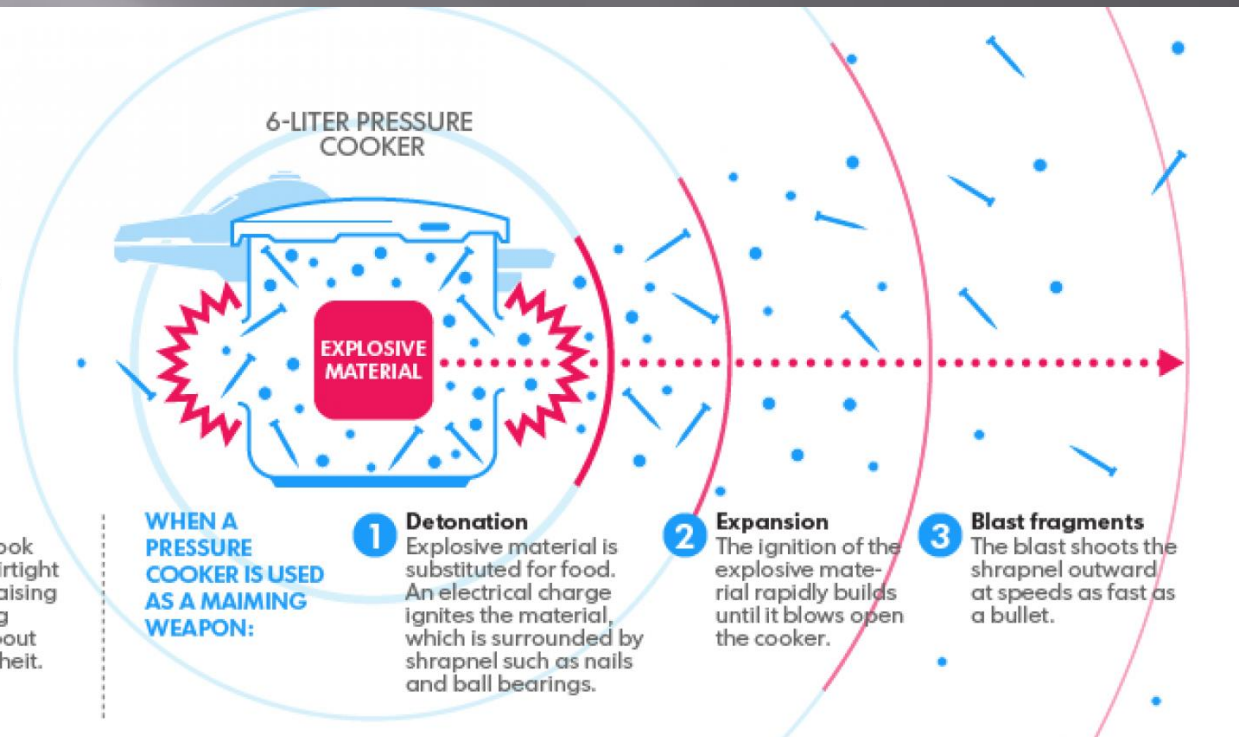
#### Expansion

The ignition of the explosive material rapidly builds until it blows open the cooker.

3

#### Blast fragments

The blast shoots the shrapnel outward at speeds as fast as a bullet.

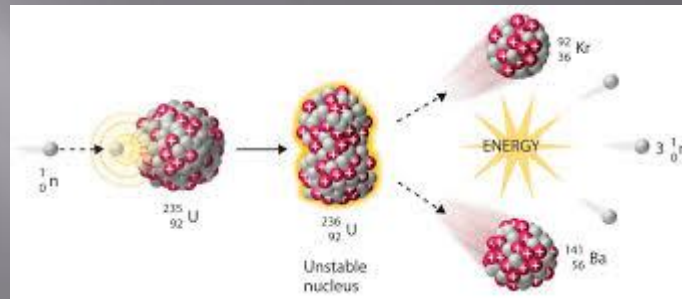


# Types of Explosions

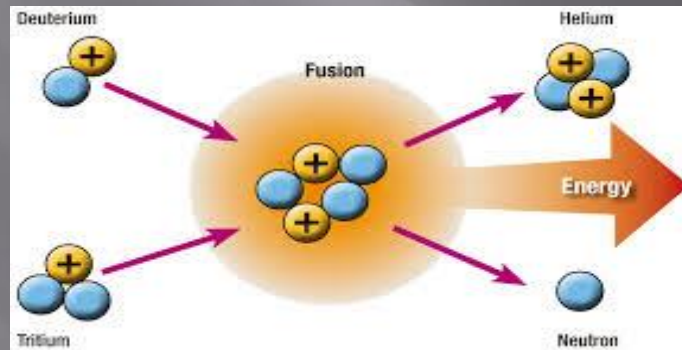
- ▣ Mechanical
  - ▣ Fuel-Air, BLEVE, Pressure Cooker
  
- ▣ Nuclear
  
  
  
  
  
  
  
  
  
  
- ▣ Chemical

# Nuclear Explosion

## ▣ Fission



## ▣ Fusion



- ▣ Do Not confuse with a Radiological Dispersal Device (RDD), also known as a Dirty Bomb.

# Types of Explosions

- ▣ Mechanical
  - Fuel-Air, BLEVE, Pressure Cooker
- ▣ Nuclear
  - Fission versus Fusion
- ▣ Chemical

# Chemical Explosives

## ▣ Deflagration

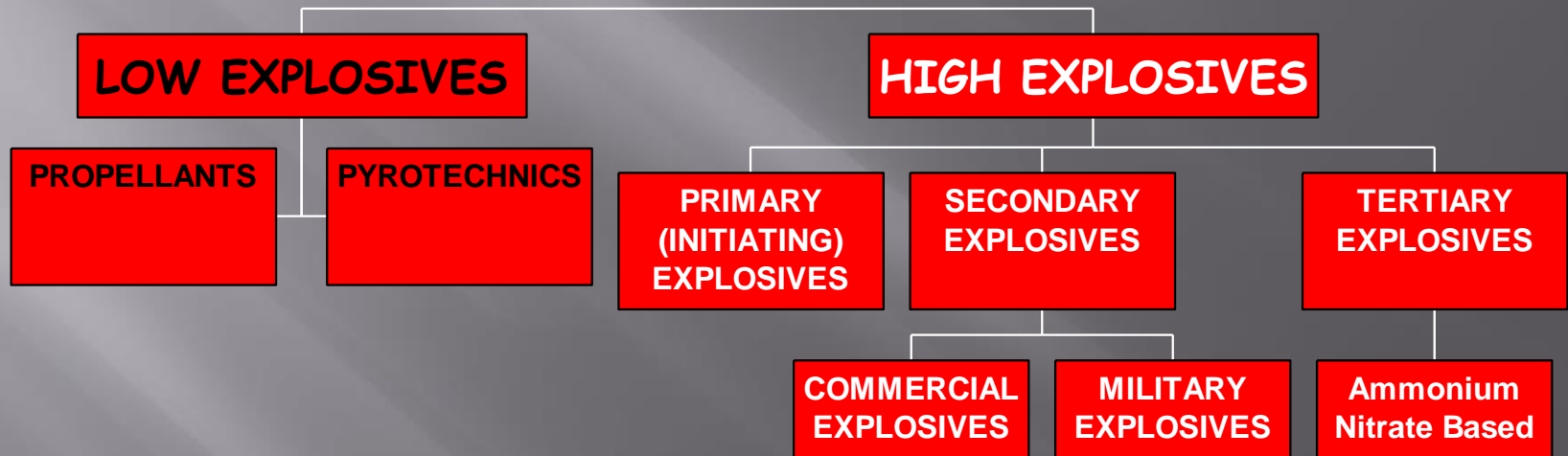
- A rapid combustion that moves through the explosive material at a velocity less than the speed of sound
- Uses internal or external oxygen source

## ▣ Detonation

- A reaction that moves through the material at a velocity greater than the speed of sound in the unreacted material
  - Instantaneous combustion as it uses internal oxygen



# Chemical Explosives



# Low Explosives

## “Propellants”

- ▣ Black Powder
- ▣ Nitrocellulose
  - ▣ Smokeless powder
- ▣ Match heads



# High Explosives (HE)

- ▣ Nitroglycerine- “Dynamite”
- ▣ TNT
- ▣ Ammonium Nitrate
- ▣ PETN – ‘det’ cord.
- ▣ C-4 – familiar to all military
- ▣ Semtex- commercial use



# Improvised Explosive Device

- ▣ Radio Controlled
  - ▣ Command Wire
- ▣ Time Delay
  - ▣ Victim Operated
- ▣ Personnel Borne
  - ▣ Vehicle Borne

# Radio Controlled

POSITIVE CONTROL OVER THE DEVICE TO CAUSE MAXIMUM DAMAGE AND INFLICT MAXIMUM CASUALTIES.

CONSISTS OF A TRANSMITTER AND RECEIVER THAT ARE OFTEN ENCODED TO PREVENT ACCIDENTAL INITIATION.



# Time Delay

May be utilized to set off any electrically initiated device or provide safe separation.





# Victim Operated

Requires a specific action by the victim that changes the environment seen by a switch controlling the device causing it to function.



# Personnel & Vehicle Borne IED





# BANG!

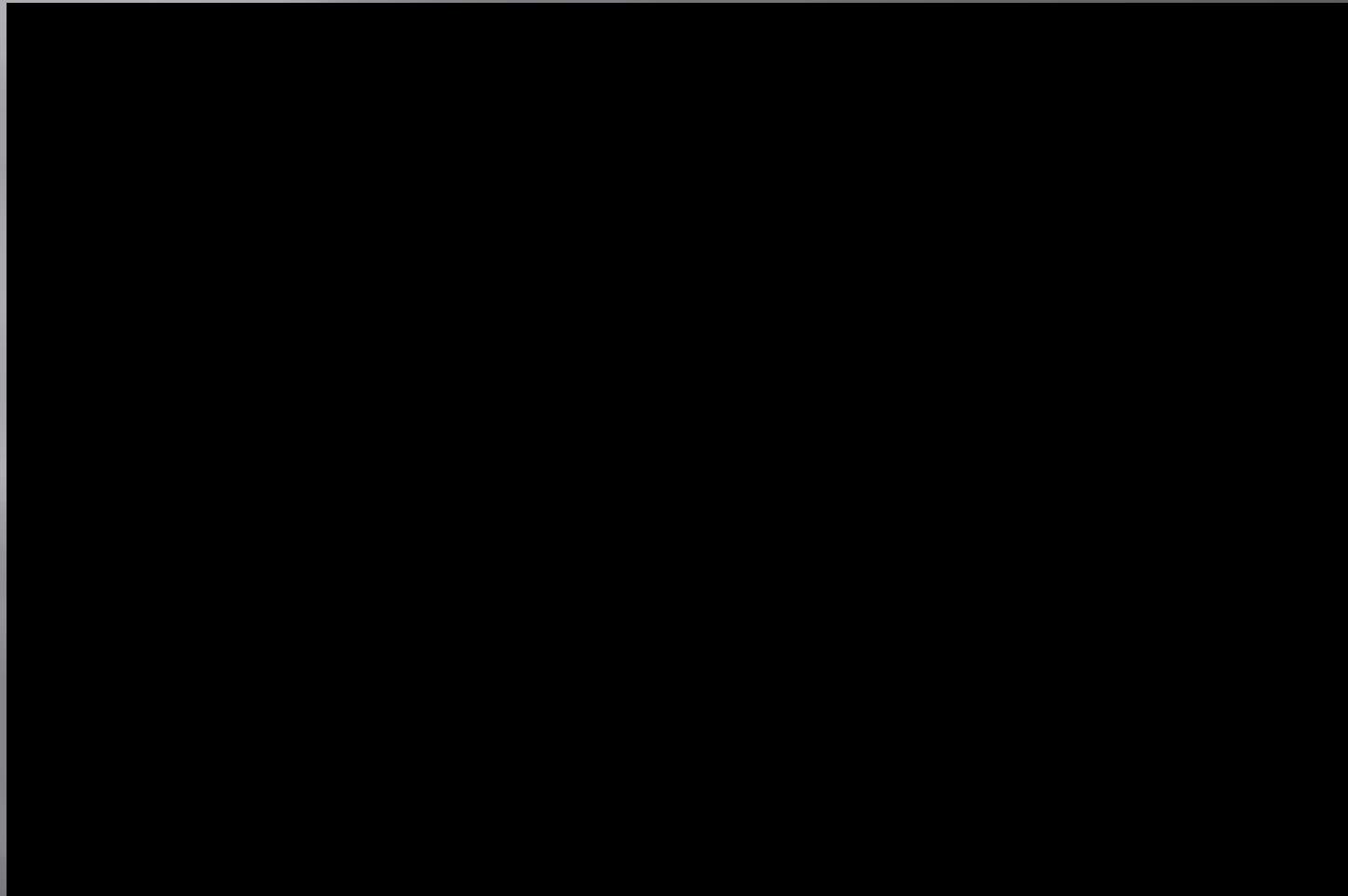
Produces a shock wave in the air

Creates high pressure outwards

Creates a vacuum from the seat of explosion



Ka-BOOM



# Explosive Injury

- ▣ What are you going to expect to see?
- ▣ What are you not going to see...
  - But should be watching for?
- ▣ What does your scene size-up tell you?
- ▣ What information does a receiving hospital want to hear?

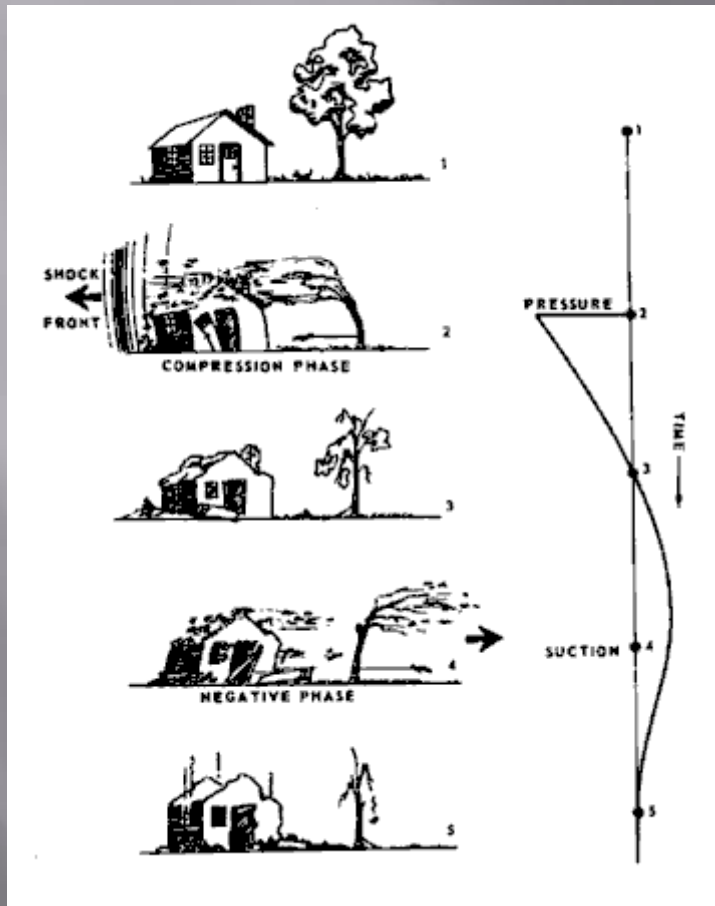
# Explosive Effects

- ▣ Pressure

- ▣ Fragmentation

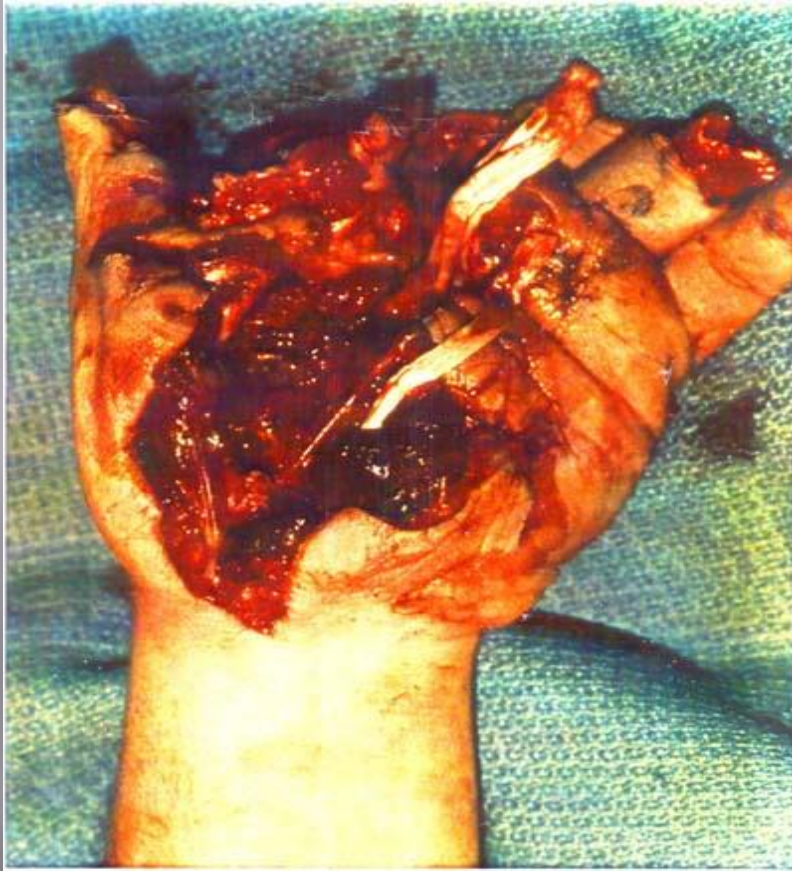
- ▣ Heat/Thermal

# The Explosion



- Blast Occurs
  - Fast, strong pressure wave
  - “Positive Phase”
  - Objects get thrown away from blast
- Air fills in vacuum
  - Longer, weaker pressure wave
  - “Negative Phase”
  - Objects get pulled towards blast

# Little Bang...Big Injury



**Blasting cap injury**



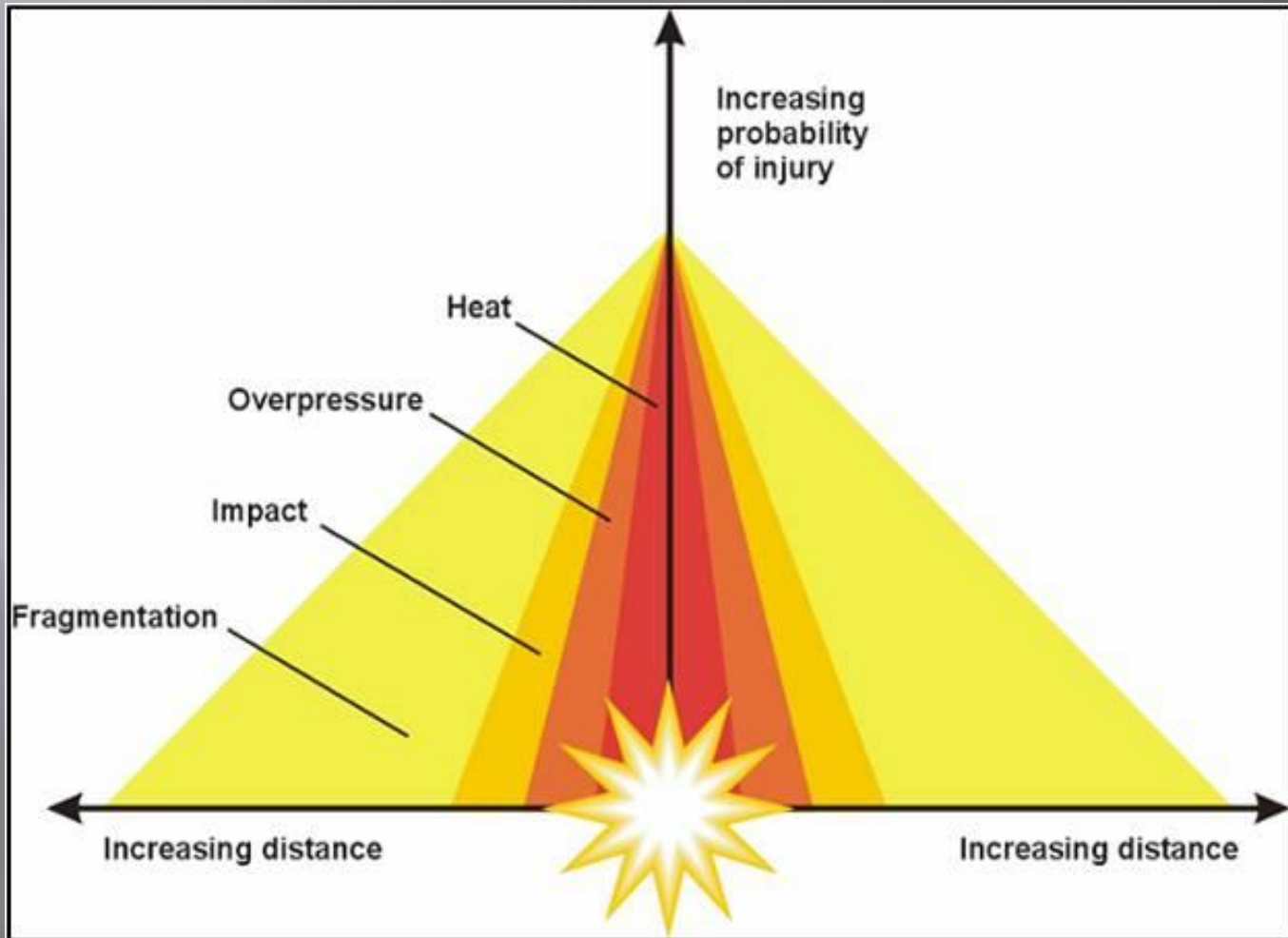
**Effects of improvised fireworks**

# Blast Injury

- ▣ Primary
  - The direct effect of the blast
- ▣ Secondary
  - Due to projectiles from the blast
- ▣ Tertiary
  - The victim is thrown by the blast wind
  - “Flying People!”
- ▣ Quaternary
  - All other effects – burns, building collapse, etc.



# Mechanics



# Variables affecting blast injury

- ▣ "Blast Environment" is a very important factor determining the extent of injuries.
- ▣ Nearby structures may either act as a shield or may reflect the blast wave onto a casualty.
  - ▣ Think- Rubber Bouncing Ball
- ▣ Confined environment increases damage
  - ▣ Foxhole or shelter is a confined environment
  - ▣ Inside the bus is bad...

# Blast in enclosed space

- ▣ A blast wave that is reflected can create a peak pressure **10X greater** than that of the incident wave.
  - Blast waves inside buildings are repeatedly reflected creating a “complex blast wave”
  - Marked increase in injuries related to primary blast effects when explosion occurs in a closed space

# Primary Blast Injury

- ▣ Biggest concern is Proximity
- ▣ Organs most sensitive to blast effects are air filled
  - middle ear: ear drum rupture @ 5 psi
  - the respiratory system –
    - ▣ lungs and bronchi: lung damage at 15 psi
    - ▣ upper airways (trachea, pharynx and larynx)
    - ▣ nasal passages and sinuses
  - Bowels
  - Stomach
  - Bladder

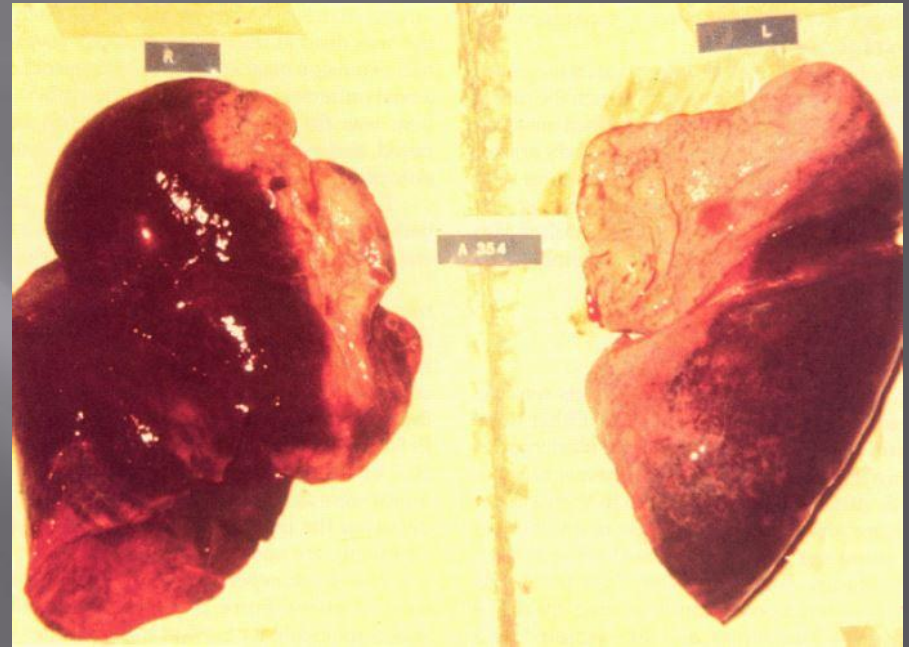
# Primary Blast Injury: Ear

- ▣ Middle ear:
  - Ruptured tympanic membrane (TM)
  - Temporary conductive hearing loss
  
- ▣ Inner ear:
  - Temporary sensory hearing loss
  - Permanent sensory hearing loss



# Primary Blast Injury: Respiratory

- ▣ Hemorrhage:
  - Pulmonary contusion
  - Hemoptysis
  - Hemothorax
  
- ▣ Escape of Air:
  - Pneumothorax
  - Pneumomediastinum
  - Arterial gas embolism (AGE)
  
- ▣ Consider epithelial damage to tract





# Primary Blast Injury, cont.

- ▣ Brain
  - Concussion
  - TBI
  - Signs and symptoms include headache, fatigue, poor concentration, lethargy, anxiety, and insomnia
  
- ▣ Digestive Tract
  - Gastrointestinal hemorrhage / perforation
  - Retroperitoneal hemorrhage
  - Ruptured spleen and / or liver



# Secondary Blast Injury

- ▣ Injury caused by fragment or propelled objects
- ▣ Most visible type of injury
- ▣ Be mindful of size of fragmentation
- ▣ Often results in the majority of casualties

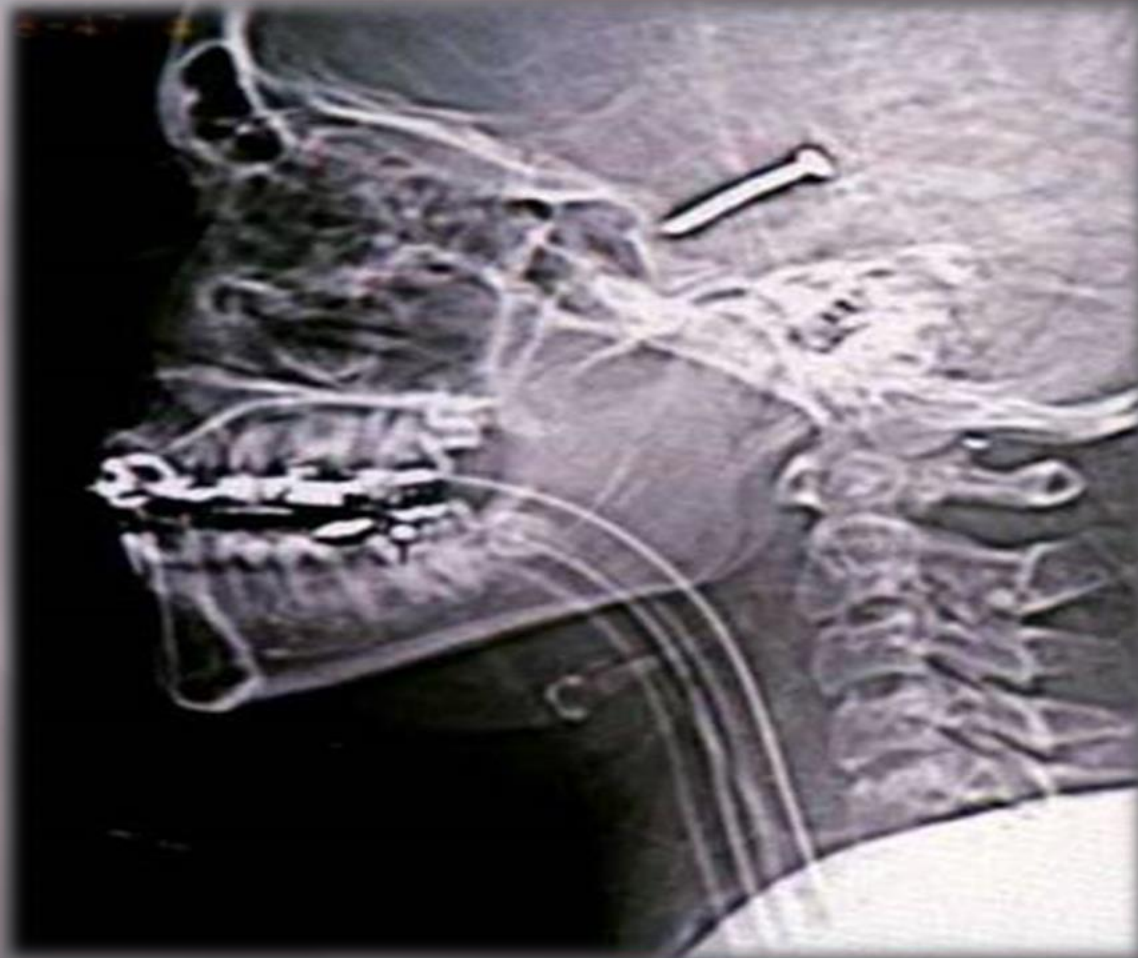
# Fragmentation



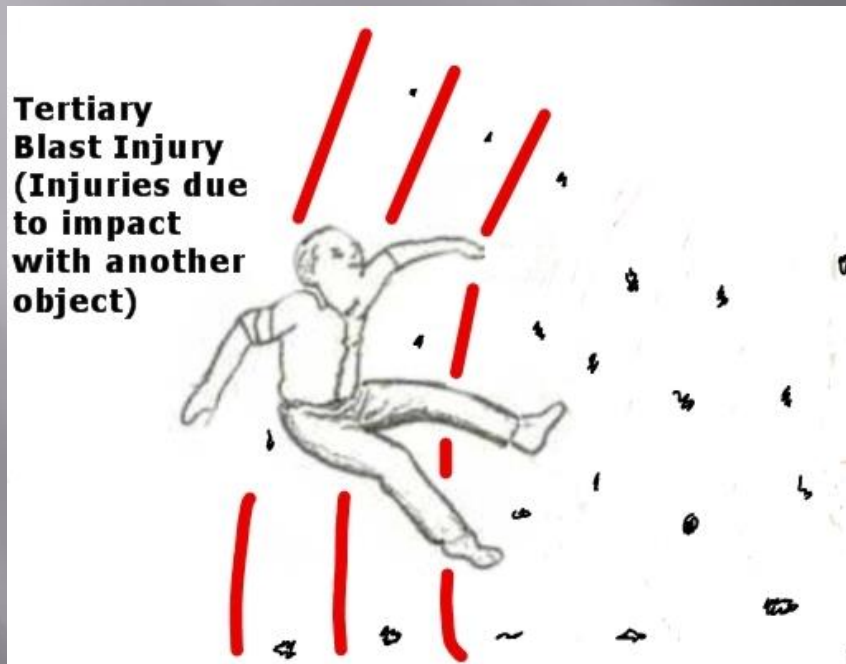
- ▣ Primary versus Secondary
- ▣ Can be anything!
- ▣ All shapes and sizes
- ▣ May require extension debriding



# Fragmentation can hurt



# Tertiary Blast Injury



- ▣ The blast wind pushes/throws the victim onto something else.
- ▣ The trauma is due to the impact.
- ▣ Blast wind occurs with both HE and LE explosions

# Quaternary Blast Injury

- ▣ The building collapses
- ▣ The products of the blast are poisonous
- ▣ Heat burns
- ▣ Exacerbation of underlying COPD, CAD, etc.

# Treatment Modalities

- ▣ Pre-planned operations
- ▣ Identify the elements if possible
- ▣ Go Back to the Basics: **Trauma is Trauma**

# Attacking The Trauma

- ▣ Tourniquets :
  - Use liberally for any significant extremity hemorrhage
  - No adverse events seen
  - Use early : “first resort not last resort”
  - Consider junctional tourniquets
  
- ▣ Aggressive control of the airway
  - Within protocol
  - Consider intubation if necessary



# Attacking The Trauma, cont.

- ▣ Consider additional therapies
  - Within protocol
  - TXA, Hextend
  
- ▣ Provide monitoring and support
  - Whether wanted or not
  - Consider transport for evaluation

# Be Prepared



So you see this guy... now what?



# Injuries to the bomb tech

- ▣ Blast pressure
  - Ear injury
  - Lung damage
  - Traumatic amputation
  - Internal hemorrhaging
- ▣ Fragmentation
  - Possibility of fragments traveling in excess of 8900fps
- ▣ Environmental
  - Heat
  - Cold



# Body Orientation



# Potential Hazards for Fire/EMS

- ▣ Secondary devices
- ▣ Fragmentation
- ▣ Chemical, biological, radiological exposure
- ▣ Exposure to residues
- ▣ Blast pressure

# BANG.... (now what)

- ▣ What is in your first due? Jurisdiction?
- ▣ Scene Safety
- ▣ Manage Trauma as Trauma
- ▣ Provide Support



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