

# BLAST INJURIES

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## INTRODUCTION

Blast injury is a threat to both civilians and soldiers alike. Blast injury can occur from industrial or home accidents, wartime explosives, or terrorist incidents. Recently, there has been an explosive pressure cooker bombs in Boston, a West Texas fertilizer plant explosion, New Jersey house explosion, and pipeline explosion at a campsite in New Mexico all causing a mass casualty incident (MCI). The injuries from blast are divided into primary (blast overpressure), secondary (fragmentation), tertiary (blunt trauma), and quaternary (burns, toxic exposures) effects. The systems most commonly injured are the lungs, brain and extremities. Brain damage may be subtle but can be a source of long-term impairment.

### Classification of blast effects

|            |   |
|------------|---|
| Primary    | Injuries caused directly by blast overpressure wave                         |
| Secondary  | Fragmentation injuries  |
| Tertiary   | Blunt trauma caused by displacement of the casualty, or structural collapse |
| Quaternary | Burns, toxic inhalation, chemical exposure, or radiation exposure           |

## PRIMARY BLAST EFFECTS

- Caused by the overpressure wave of the explosion
- Blast wave propagates in 3 dimensions and decreases in force with distance from the source
- Blast wave can be subject to complex and unpredictable changes in its destructive force, such as encountering a building or object
- Proximity to the blast does not always correlate to the severity of the injury
- Orientation of the causality (ie, facing or sideways) can influence the injuries
- Organs frequently injured in primary blast injury (PBI) include lungs, tympanic membranes (TM), intestines, and brain
- External signs of injury may be absent
- PBI occur primarily in air-filled organs and at air-fluid interfaces
- Barotrauma is common even in solid organs
- Cardiac dysfunction may occur from myocardial depressant effect or arrhythmias
- Vascular endothelium may cause diffuse plasma leakage and resultant hemoconcentration and hypovolemic, even in the absence of other injuries causing blood loss
- TM rupture is a marker for blast severity while the absence of rupture signifies a low risk for PBI

## SECONDARY BLAST EFFECTS

- Caused by fragments propelled by the initial explosion
- Fragments may be from the explosive device or near the epicenter

- Secondary blast injury (SBI) result in severe bone and soft tissue wounds
- Biological material from the blast (ie, human fragments) can be a source of infectious disease transmission

## **TERTIARY BLAST EFFECTS**

- Blast wave causes propulsion of casualties away from the blast site resulting in blunt force trauma
- Crush injuries may occur from building or object collapse

## **QUATERNARY BLAST EFFECTS**

- Blast impact of burns, toxic inhalants, and other exposures
- Can be a significant source of morbidity in blast survivors
- There are significant long-term health concerns to both survivor and rescuer

## **AN EXAMPLE OF SPECIFIC INJURIES THAT CAN OCCUR FROM BLAST**

### Lungs

- Diffuse alveolar and parenchymal hemorrhage is the hallmark on autopsy
- PBI may not have external findings, therefore EMS must be suspicious for PBI in the event of pulmonary decline
- Characteristic butterfly appearance of central bilateral infiltrates on plain radiographs or CT scan is common in presentation of worsening hypoxia
- Treatment is supportive
- Adequate oxygenation at 2 hours post event, rarely show further deterioration
- Low tidal volume ventilation works better for these patients based on randomized trials
- Refractory patients may benefit from oscillatory ventilation or ECHMO
- Simple pneumothorax, pneumomediastinum, or air embolism that may cause stroke, MI, acute abdomen, and many other injuries

### Extremity Wounds

- Tissue damage can be from all 4 phases of blast injury with injury from PBI showing high mortality
- Tourniquets should be used liberally to control active hemorrhage and recurrent and sometimes latent hemorrhage from arterial vasospasm
- Prophylactic antibiotics for open fractures
- All penetrating injury should be treated with tetanus if not updated
- Biological fragments in patient require immunization for Hep B and serum samples drawn for Hep C and HIV testing

### Brain Injury

- Penetrating injury and tertiary blast effects can cause closed head injuries similar to blunt trauma
- Focal neurologic deficits can be caused by air embolism from lung injury

- Primary blast waves can cause sinus fractures, intracranial cavitation and shear injuries that can cause neuronal damage and disrupt the capillary blood-brain barrier
- Concussive effects from PBI may have significant long term quality-of-life effects including headaches, confusion, retrograde amnesia, altered executive function/decision making, mood disturbances, and sleep alterations

## Summary

Blast injuries can occur in both civilian and wartime attacks or from industrial or civilian accidents. Injuries can be both visible and invisible from PBI, penetrating trauma or even tertiary blast injury resulting in blunt or crush trauma. Quaternary blast injury can be broad ranging from burns to radiation or chemical injury. Recognition of PBI can prevent later patient deterioration.

## References

R.N. Lesperance, T.C. Nunez, et al. **Blast Injury: Impact on Brain and Internal Organs**. Critical Care Nursing Clinics of North America. 27 (2) (2015), pp. 277-287

Z.R. Matthews, A. Koyfman, et al. **Blast Injuries**. The Journal of Emergency Medicine. 49 (4) (2015), pp.573-587

<http://www.cdc.gov/masstrauma/preparedness/primer.pdf>