# Ballistic Extremity Trauma

Tuesday Fisher, MD

Orthopedic Trauma Fellow

Atrium Health Carolinas Medical Center

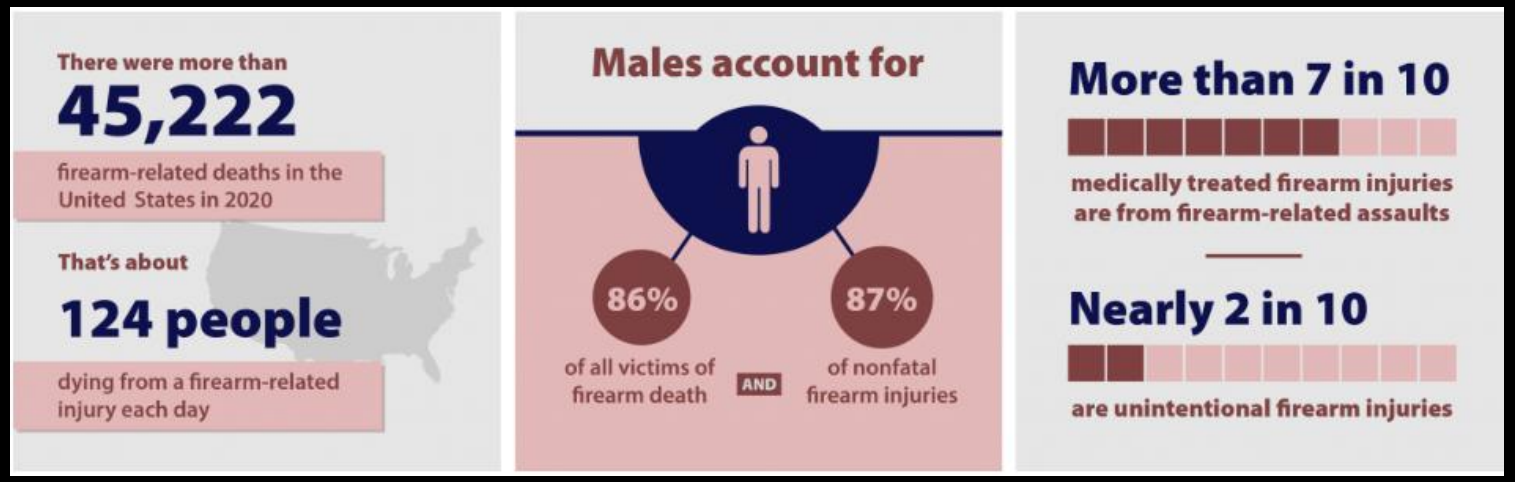
Atrium Health
Musculoskeletal Institute

# Summary

1. Understand basic ballistics
2. Do a complete neurovascular exam
3. Low energy → closed (like)/ High energy→ open ( like)

# Demographics

- **175, 459** Non-fatal firearm related injuries in 2020 [1]
- Most commonly assaults
- Injuries occur most often in males[1,2]
- Significant cause of morbidity in children [3]




Ballistic fractures[2]

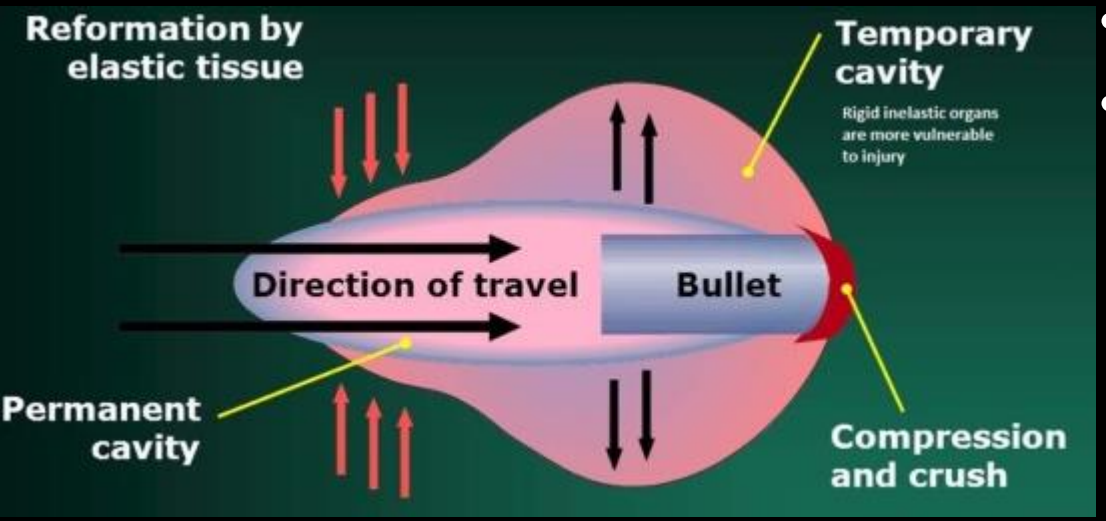
1.Lower extremity 46%

- Diaphyseal femur fractures most common ballistic fracture [2]

2. Upper extremity fractures 33%
3. Non-spine axial fractures 16%
4. spine fractures 5%


1. CDC. WISQARS Fatal and non-fatal injury reports.https://www.cdc.gov/violenceprevention/firearms/fastfact.html
2. Lyons, GJ. Epidemiologyof ballistic fractures in the United States: a 20-year analysis of the Firearm Injury Surveillance Study Injury. 2022.
3. Perkins C., et al. Orthopedic firearm injuries in children in adolescents: an eight- experience at a major urban trauma center. Injury. 2015

# Ballistics




- Kinetic energy of projectile determines wounding *potential*
  - KE= 1/2M**V²**
- Other Factors→ efficiency of KE transfer
  - passage of missile in body
    - penetrating higher energy then perforating
  - Cavitation
    - secondary shock wave
  - Yaw-> tumbling
  - Caliber, construction of bullet (Mass, fragmentation
  - Clothing


1. Di Maio VJM: Gunshot Wounds: Practical Aspects of Firearms, Ballistics, and Forensic Techniques. 1993.
2. Bartlett, C et al. Ballistics and Gunshot wounds: effects on musculoskeletal tissues. JAAOS. 2000.

# Barrel speed

## High ( > 2,000 ft./s)

- Rifles, some hand guns
- *Shotgun fire within 10ft.
- More significant soft tissue injury and contamination

## Low ( <2,000 ft./s)

- Most handguns
- Shotguns at further distances
- Lower infection risk


1. Ramasamy, McMenemy, Stinner, Clasper. Gunshot and Wartime Injuries. Rockwood and Green's Fractures in Adults, 9e.2019.

# Evaluation

1. History
    1. Type of firearm/projectile ( low vs high energy)- not as important as injury itself
        1. Is wadding present ( shotgun)
2. Physical exam
    1. Assess soft tissue damage, contamination, exposed deep structures
    2. Thorough motor/sensory exam if possible
    3. Vascular exam –palpation, doppler, ABI if appropriate
    4. Compartment exam -> open wound does not indicate compartment decompression
3. Imaging
    1. Plain radiographs
    2. Intra-articular extension of diaphyseal fractures and significant comminution is common
        1. Consider CT- only changes management 10% of the time but useful surgical planning tool
        2. CT angiogram if exam suggests injury


1. Ramasamy, McMenemy, Stinner, Clasper. Gunshot and Wartime Injuries. Rockwood and Green's Fractures in Adults, 9e.2019.
2. Bartlett, C et al. Ballistics and Gunshot wounds: effects on musculoskeletal tissues. JAAOS. 2000.

# Early Management- High energy

- Dictated by soft tissue and osseous injury
  - Treated like an open fracture
  - Higher infection rate than closed injury
- Early antibiotics, debridement and stabilization
  - 1st generation cephalosporin continued for 1-3 days post injury[1,2]
  - No aminoglycoside or PCN required


1. Hospenthal DR, et al. Guidelines for the prevention of infections associated with combat related injuries 2011 update. Jtrauma.2011.
2.Murray, CK. Et al. Prevention of infection associated with combat related extremity injuries. J Trauma. 2011.

# Management- low energy

- 1. minimal/ no contamination, joint penetration, vascular injury, no unstable/ surgically indicated fracture, clinically stable patients can be managed conservatively
  - Bedside I&D
  - Discharge from ED
- recommend prophylaxis[1-3]
  - Consider prophylaxis with PO 1st Gen cephalosporin[2]
- Allow wound to drain ( do not close primarily)
  - Wound care
- Standard closed fracture care


1. Di Maio VJM: Gunshot Wounds: Practical Aspects of Firearms, Ballistics, and Forensic Techniques. 1993.
2. Bartlett, C et al. Ballistics and Gunshot wounds: effects on musculoskeletal tissues. JAAOS. 2000.
3. Sathiyakumar, V, et al. Gunshot induced fractures of the extremities: a review of antibiotic and debridement practices.Curr Res Msk Med.2015.

# Surgical indications

- Fracture would otherwise be surgically managed
- Intraarticular fragments
  - I&D of intraarticular wounds without retained fragments not recommend
    - Meniscal/chondral injuries still common
- Wound part of potential surgical site for other injuries
- Significant soft tissue wounds
- Routine debridement of  low energy bullet wounds not indicated
  - 2% infection rate


1. Bartlett, C et al. Ballistics and Gunshot wounds: effects on musculoskeletal tissues. JAAOS. 2000.
2. Ramasamy, McMenemy, Stinner, Clasper. Gunshot and Wartime Injuries. Rockwood and Green's Fractures in Adults, 9e.2019.

# Thank you!