SOCIETY OF TRAUMA NURSES

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Mechanism of Injury

Understanding the Kinematics of Trauma

SOCIETY OF TRAUMA NURSES

Objectives

At the conclusion of this presentation the participant will be able to:

- State how the fundamental principles of physics apply to various types of injuries
- Given a specific mechanism of injury, predict injury patterns

Trauma

Chris Riley — Times-Herald

Kinematics

- The study of basic physics concepts that dictate how energy affects the human body
- Allows prediction of injuries based on motion involved

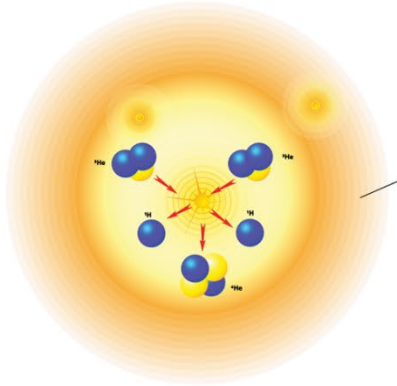
Mechanism of Injury

Mechanism of injury (MOI) is the way in which traumatic injuries occur

Different MOIs produce injuries that may be isolated or occur in many body systems

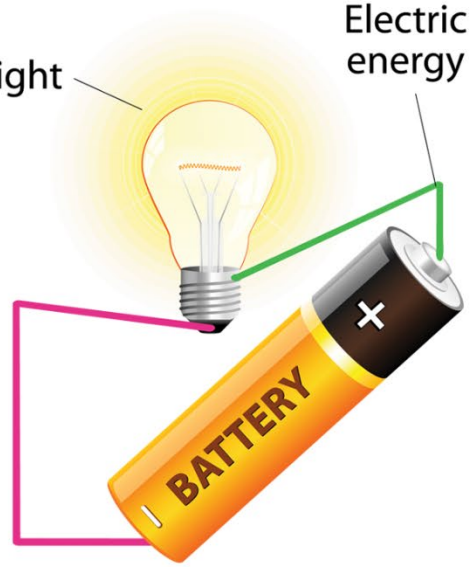
Forms of Energy

Nuclear energy
(nuclear fusion in stars)

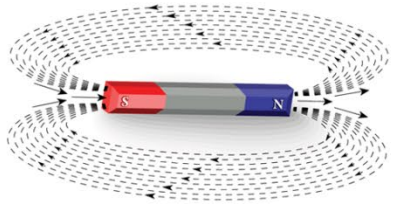


Light

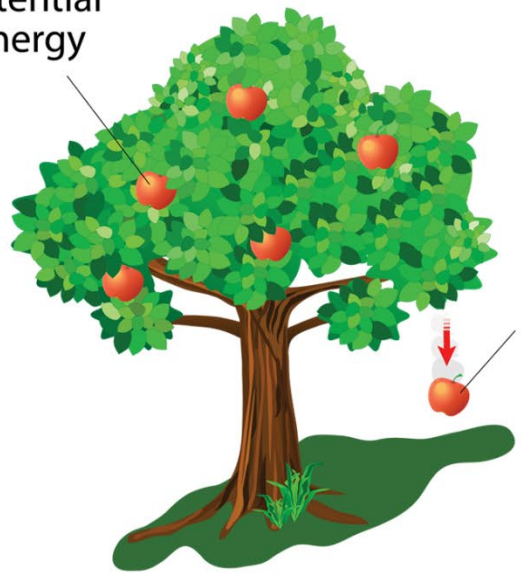
Electric
energy



Magnetic
energy



Potential
energy

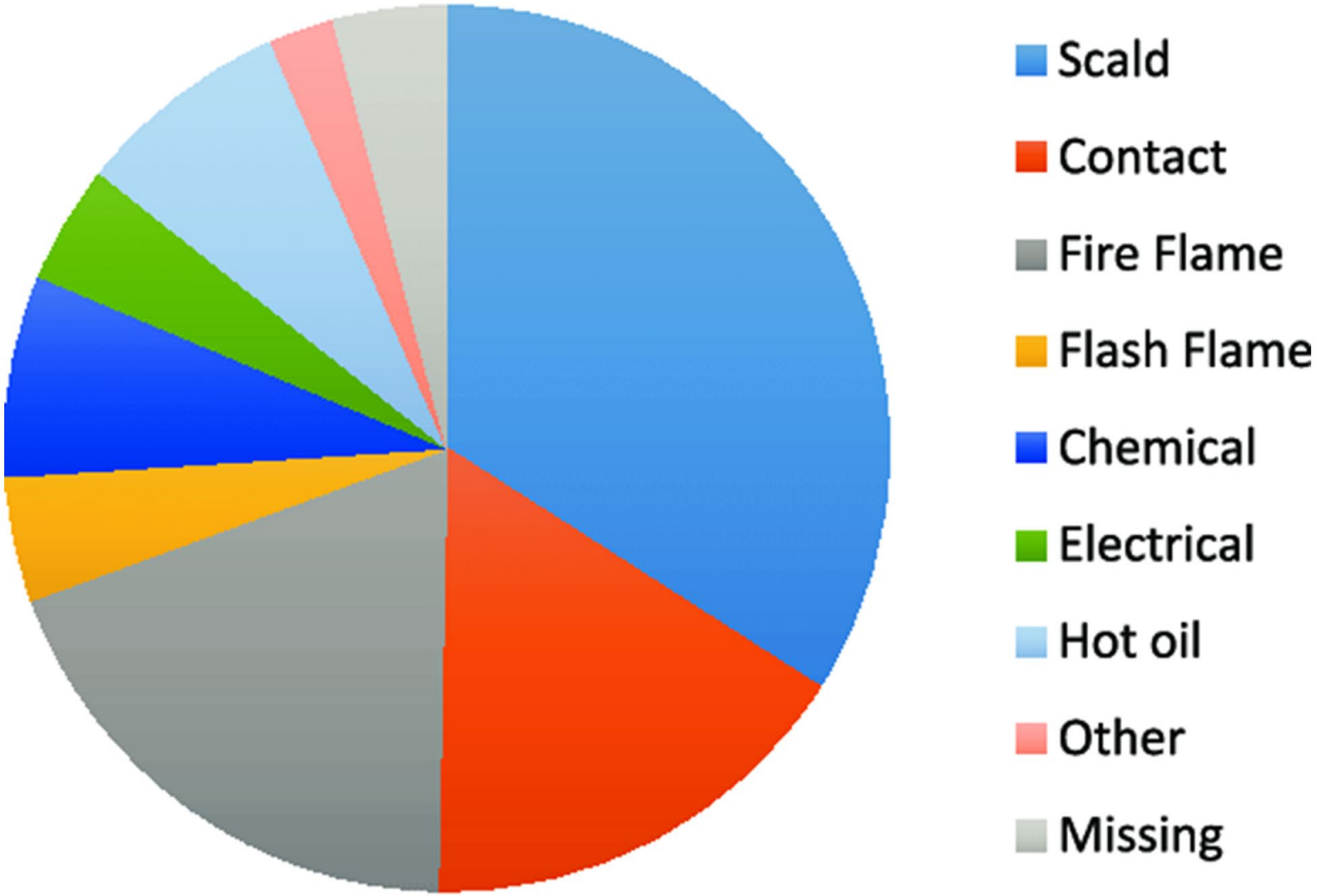


Kinetic
energy

Chemical
energy

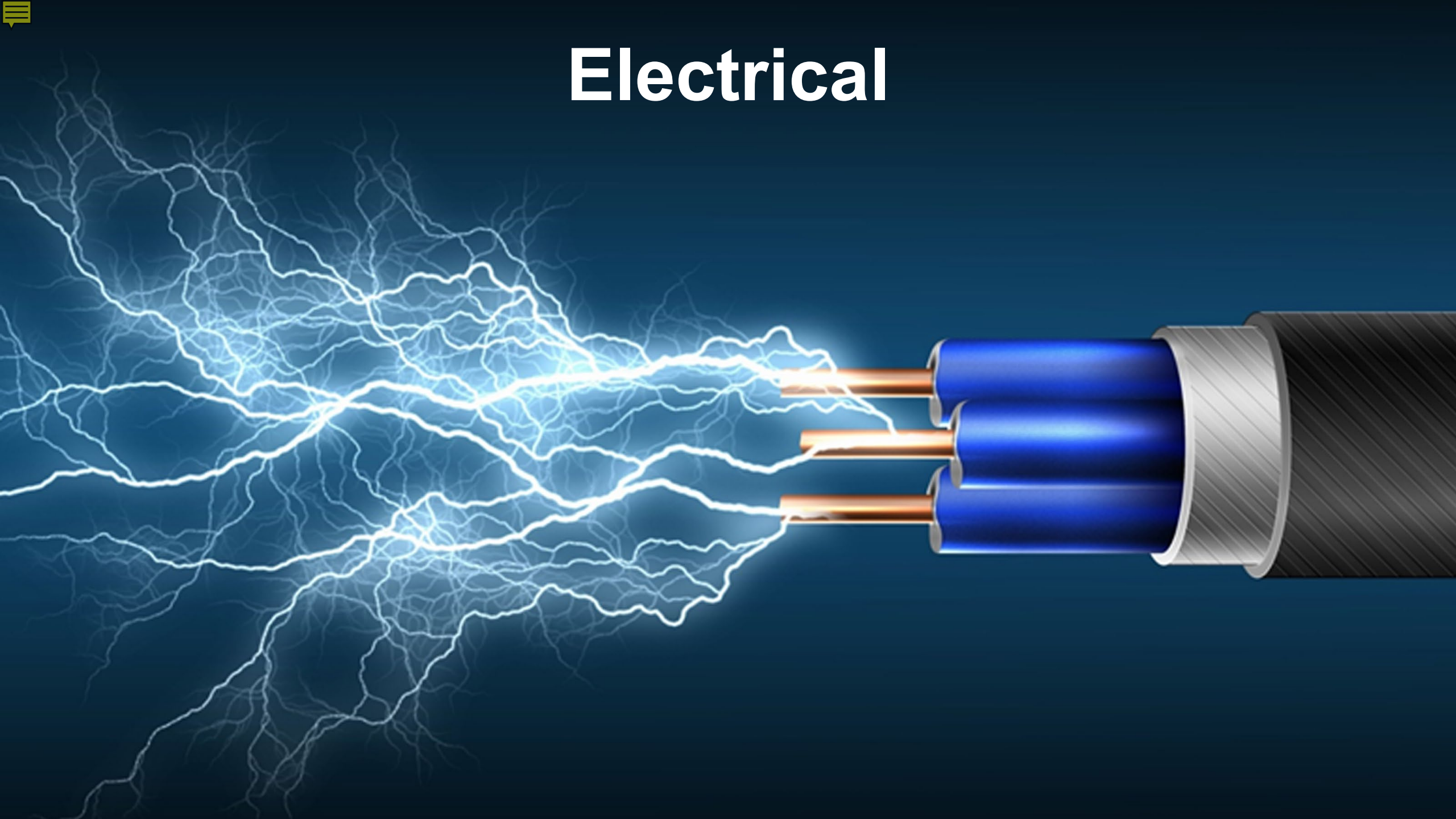
Thermal
energy

Burn Injury Mechanism



Thermal

Electrical



Chemical

Items in the Home that Cause Chemical Burns

- Ammonia
- Bleach
- Mold and mildew cleaner
- Drano and other drain cleaners
- Furniture polish
- Laundry detergent
- Toilet bowl cleansers

Photo / Instagram

Other Chemical Items Around the Home

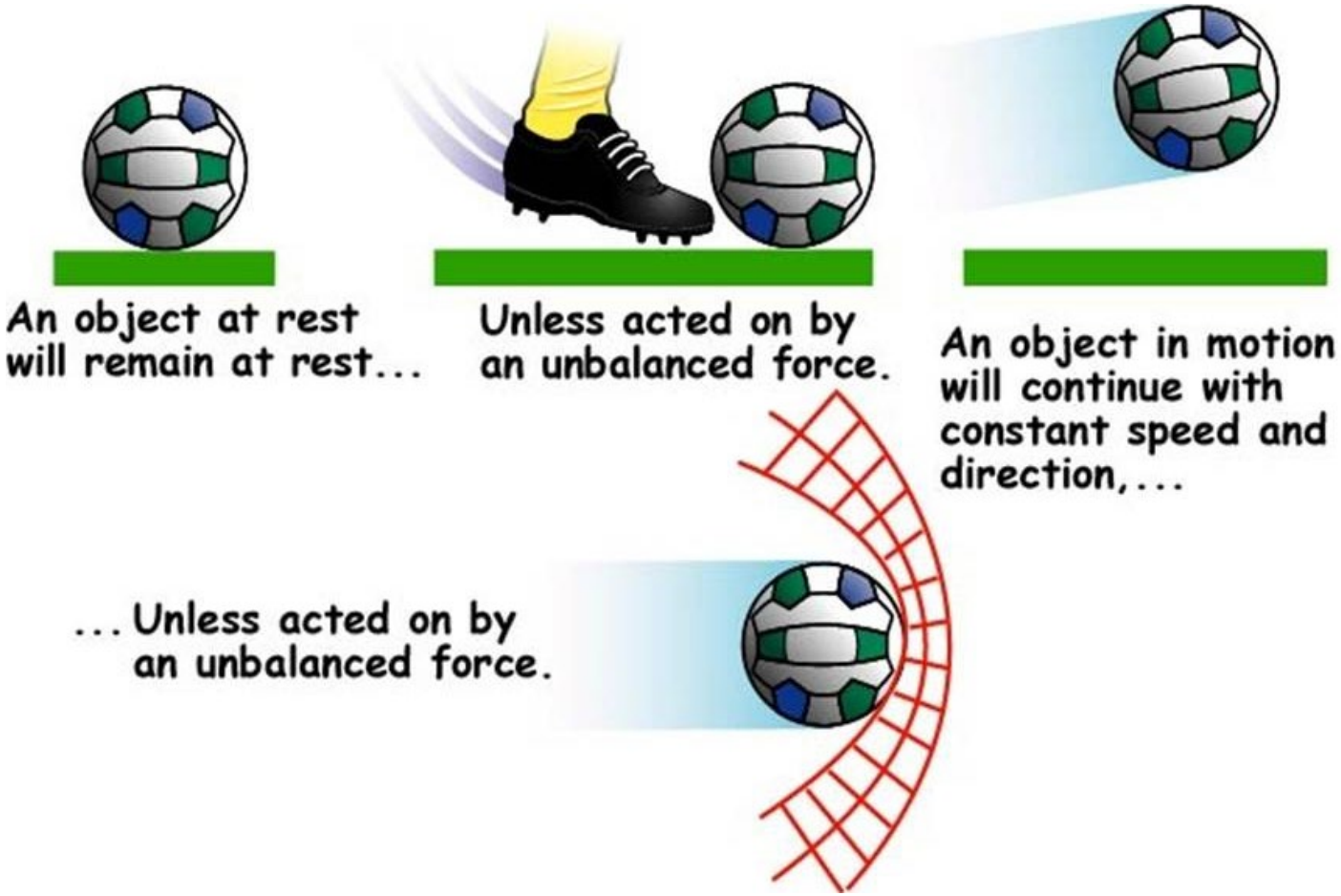
- Fertilizers
- Hydrofluoric acid
- Concrete mix
- Fireworks
- Pool cleaners
- Paint thinners

https://www.slideserve.com/demetra/working-around-concrete-safety-101

Kinetic Energy

Newton's First Law of Motion

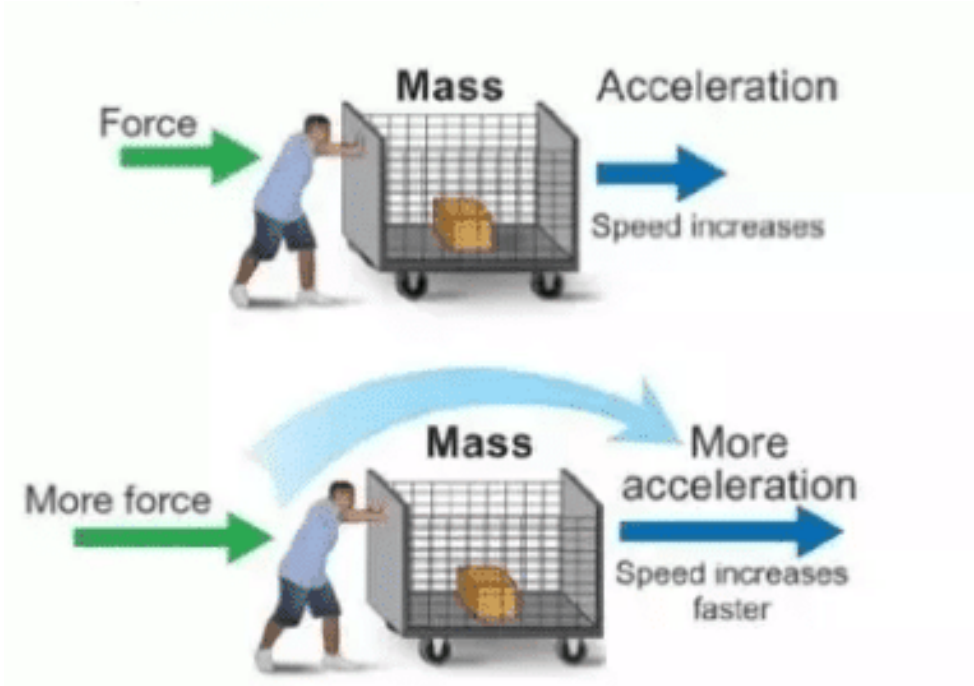
- Objects tend to stay at rest or in motion unless acted upon by some force
- Velocity is constant



http://ffden-2.phys.uaf.edu/webproj/211_fall_2016/Juan_Acevedo/Juan_Acevedo/Newtons%20Laws%20Of%20Motion.html

Newton's Second Law

Defines the relationship between acceleration, force, and mass

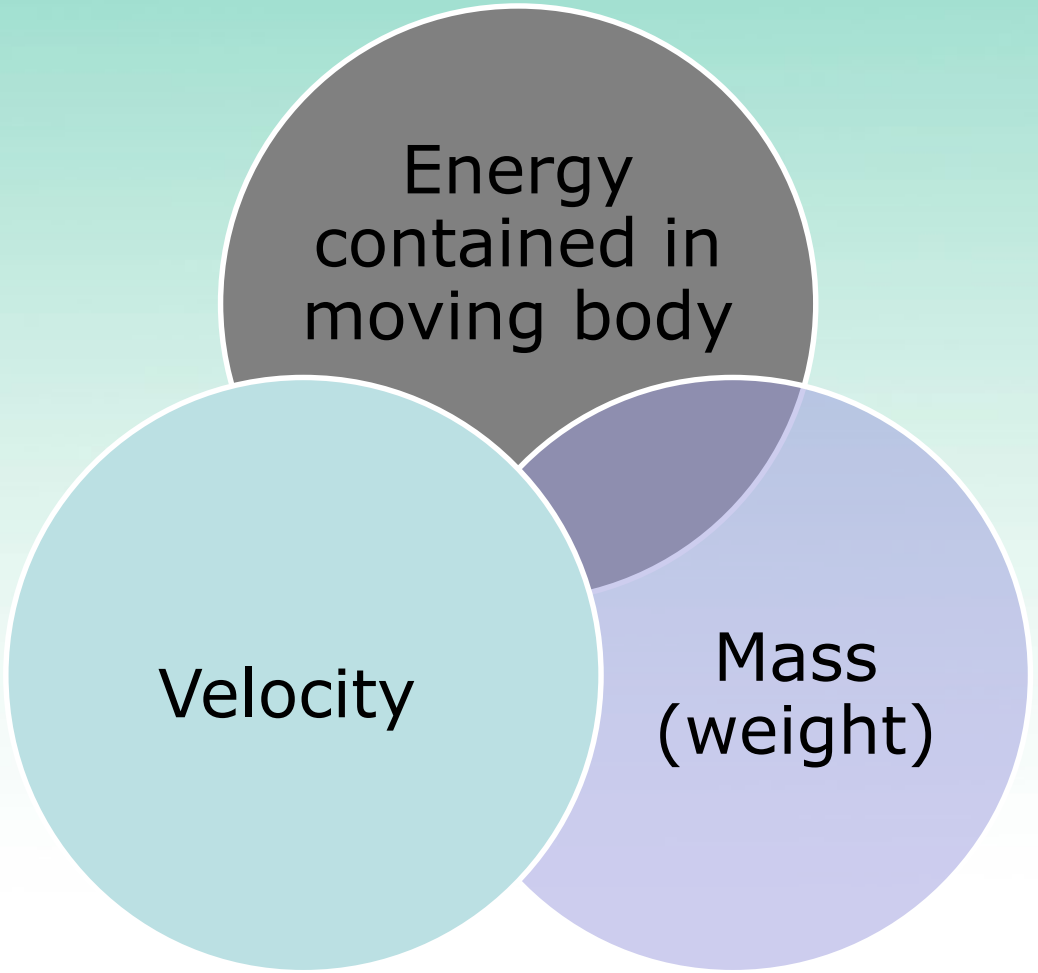


https://slidetodoc.com/newtons-second-law-but-first-review-newtons-first

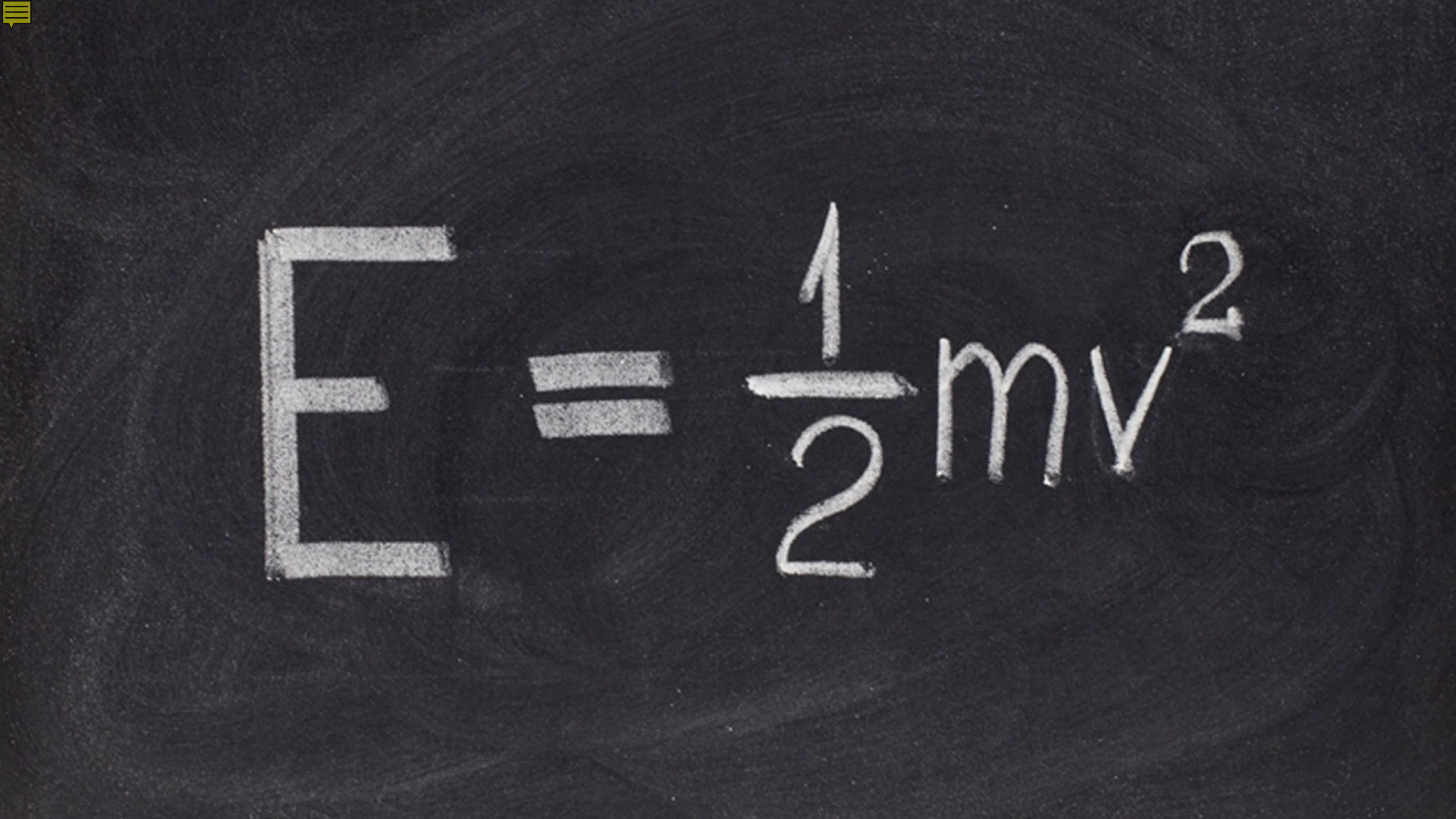
Newton's Third Law

- For every action (force), there is an equal and opposite reaction
- Energy cannot be created or destroyed
- Energy can only change from one form to another

Kinetic Energy



- Head on collision
- The kinetic energy of **two moving bodies** that collide are combined.


$E = \frac{1}{2}mv^2$

Speed 30 → 42 mph

EXAMPLE:

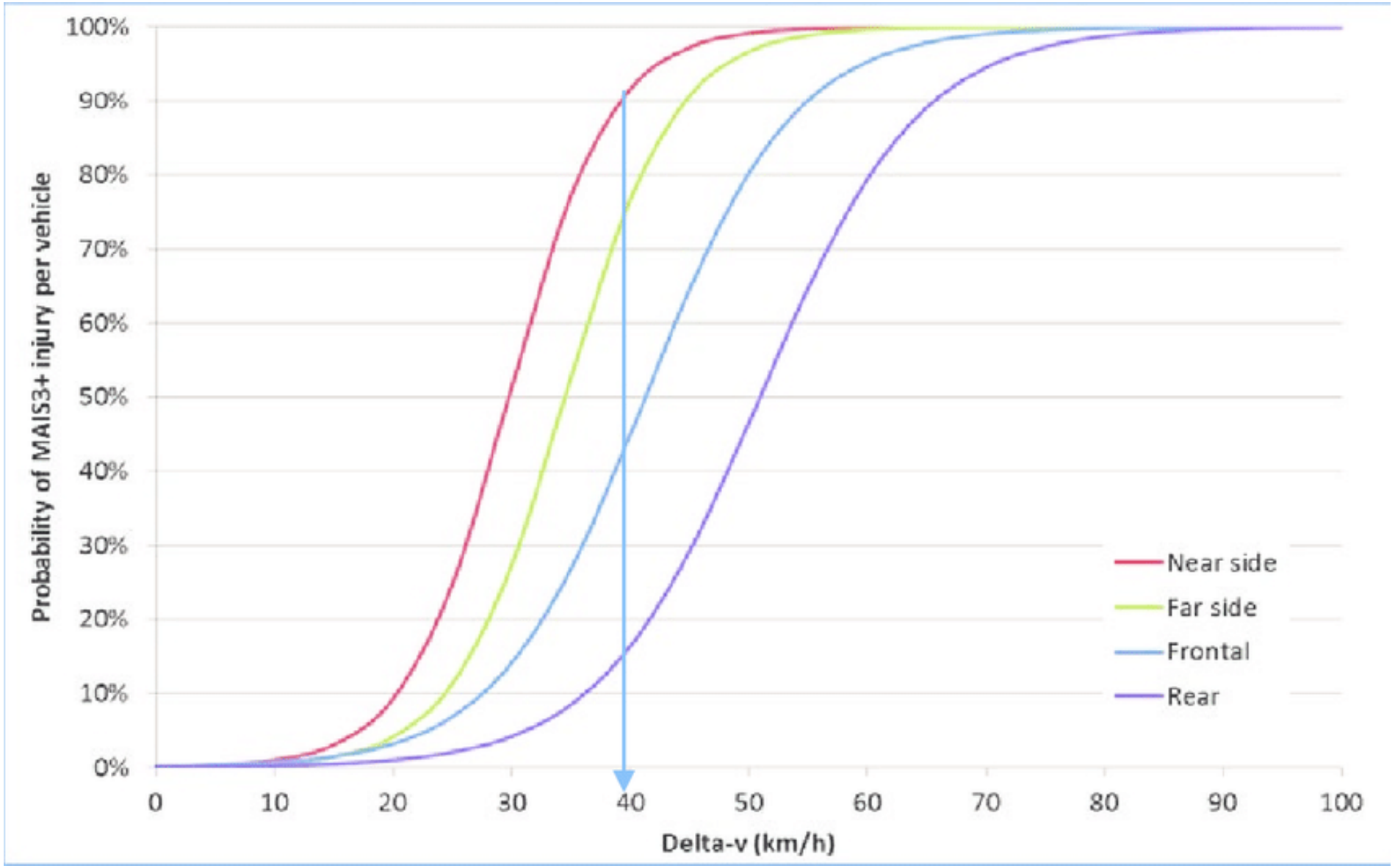
- 180 lb person moving at 30 mph
- 80 kg person at 13.41 meters per second
- **KE = ½ m v^2**
- KE = 80 (13.41 x 13.41) / 2
- KE = 7.193 kJ

EXAMPLE:

- 180 lb person moving at 42 mph
- 80 kg person at 18.774 meters per second
- **KE = ½ m v^2**
- KE = 80 (18.774x18.774) / 2
- KE = 14.098kJ

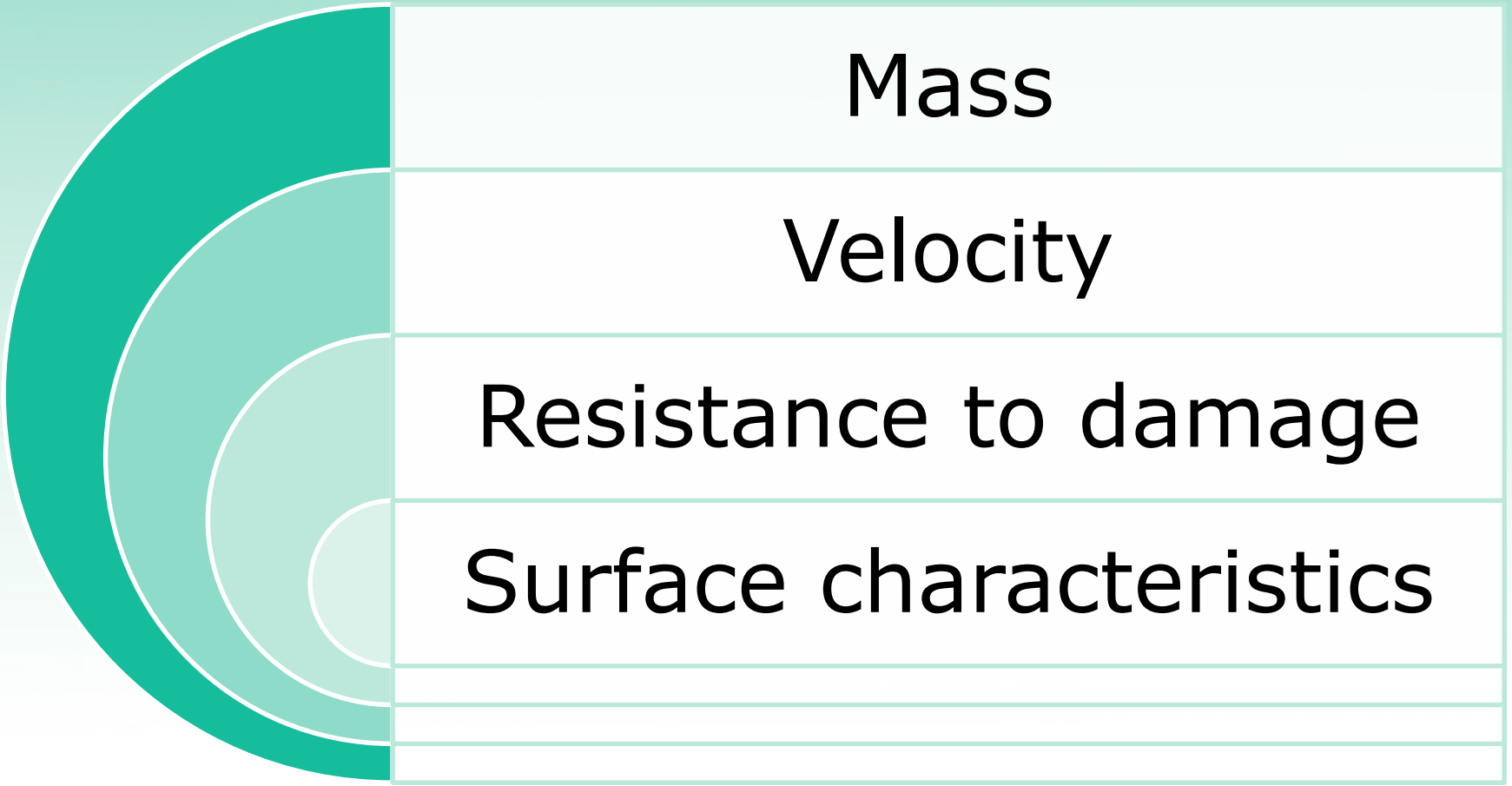
Increase speed from 30 to 42 mph, DOUBLES KE

ΔV



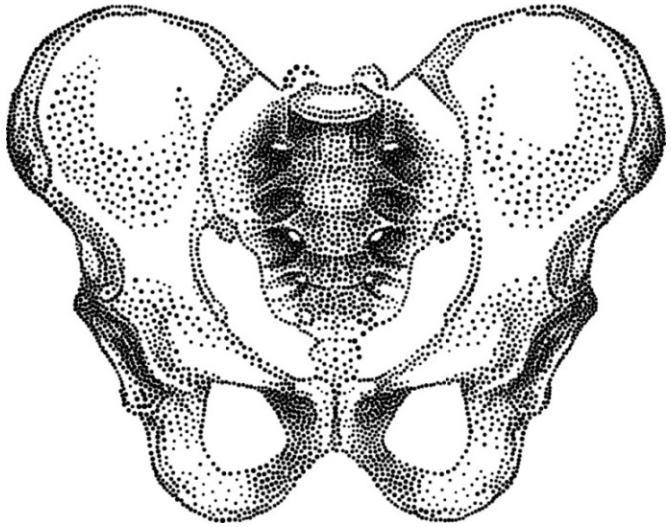
Bahouth et al., 2014

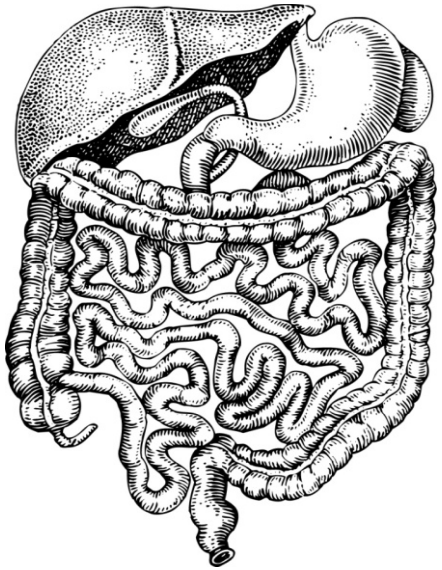
Factors to Consider



Resistance to Damage

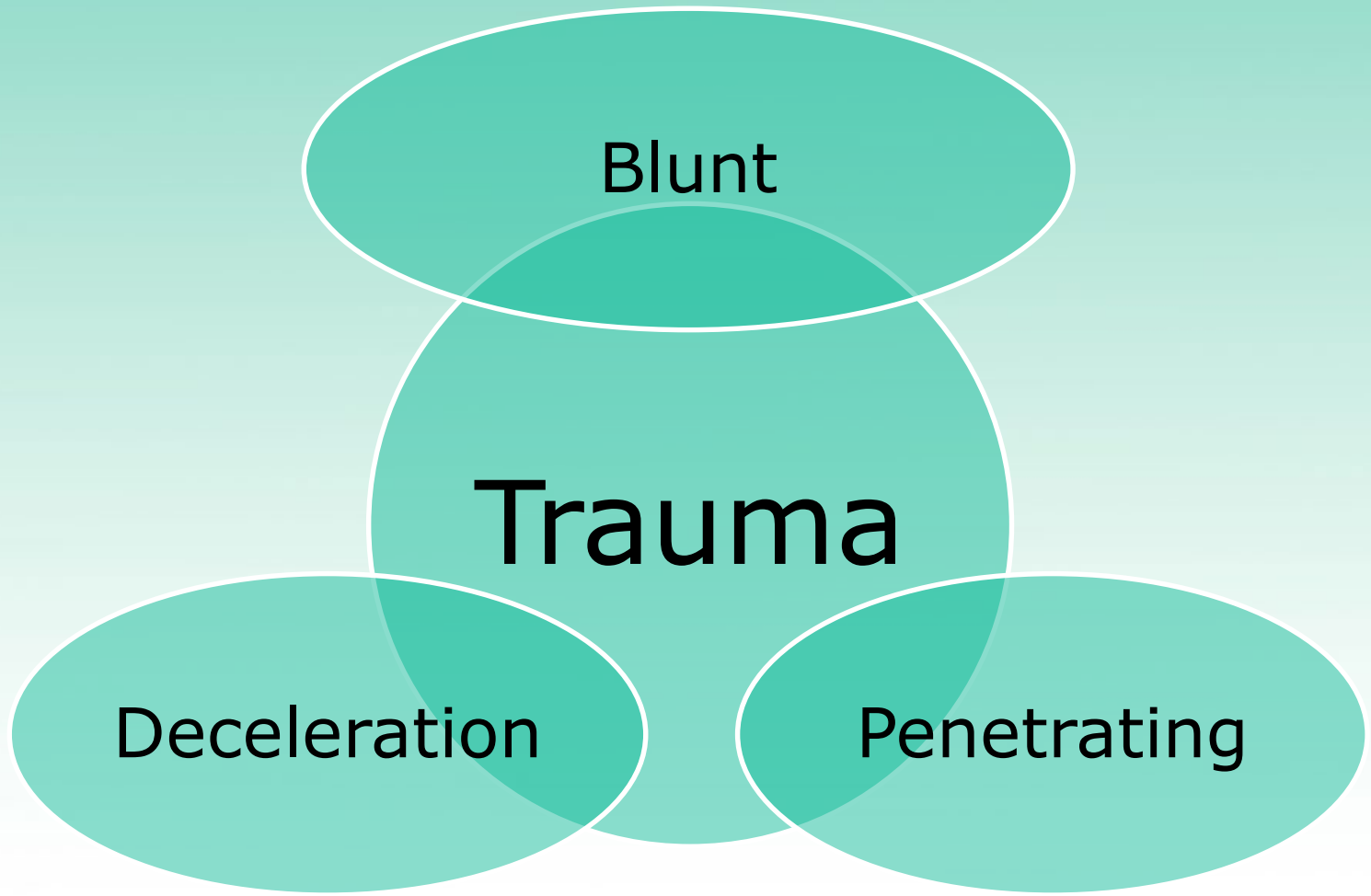
Tissue characteristics
Preexisting health conditions



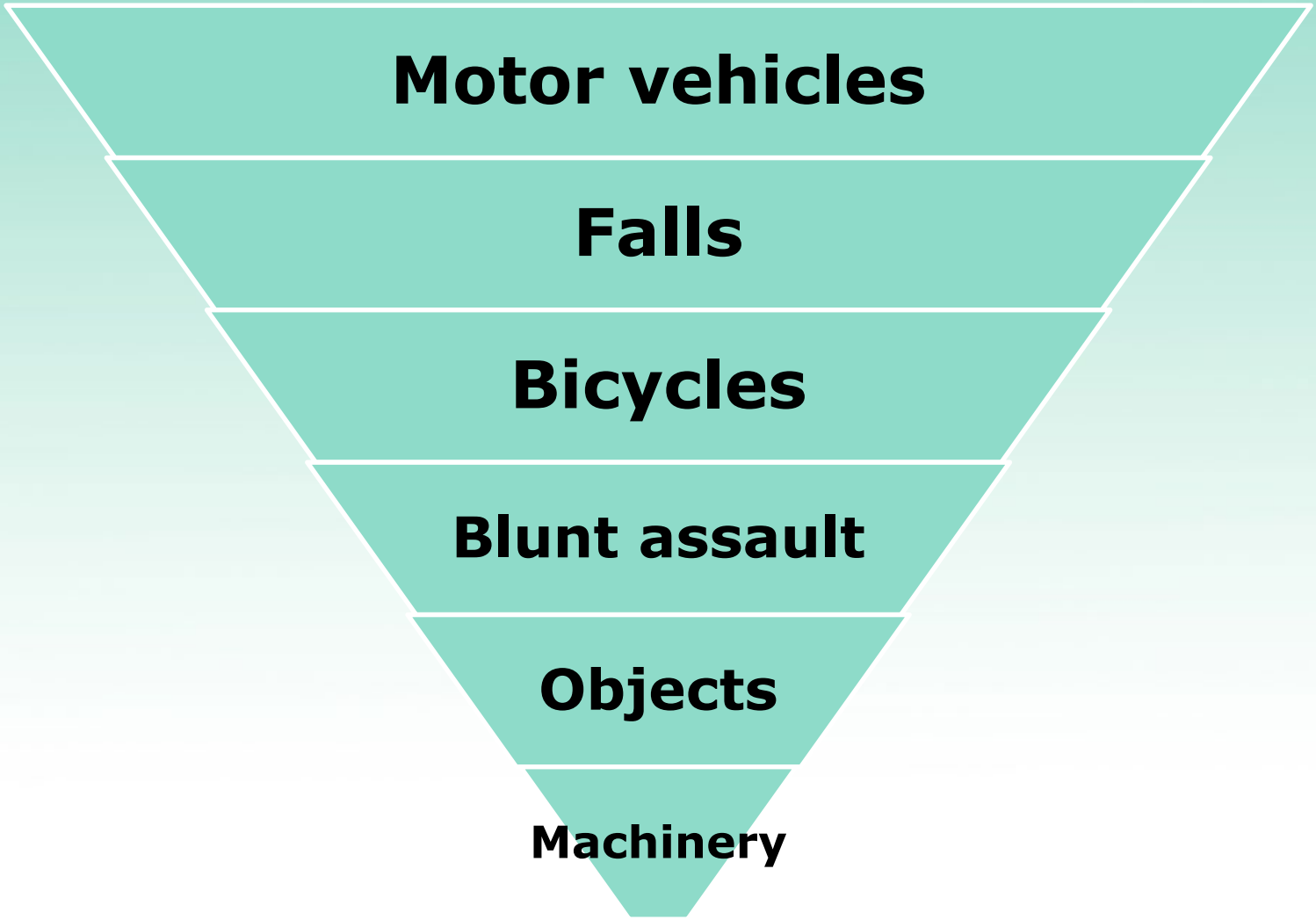


Kinematics in Prevention

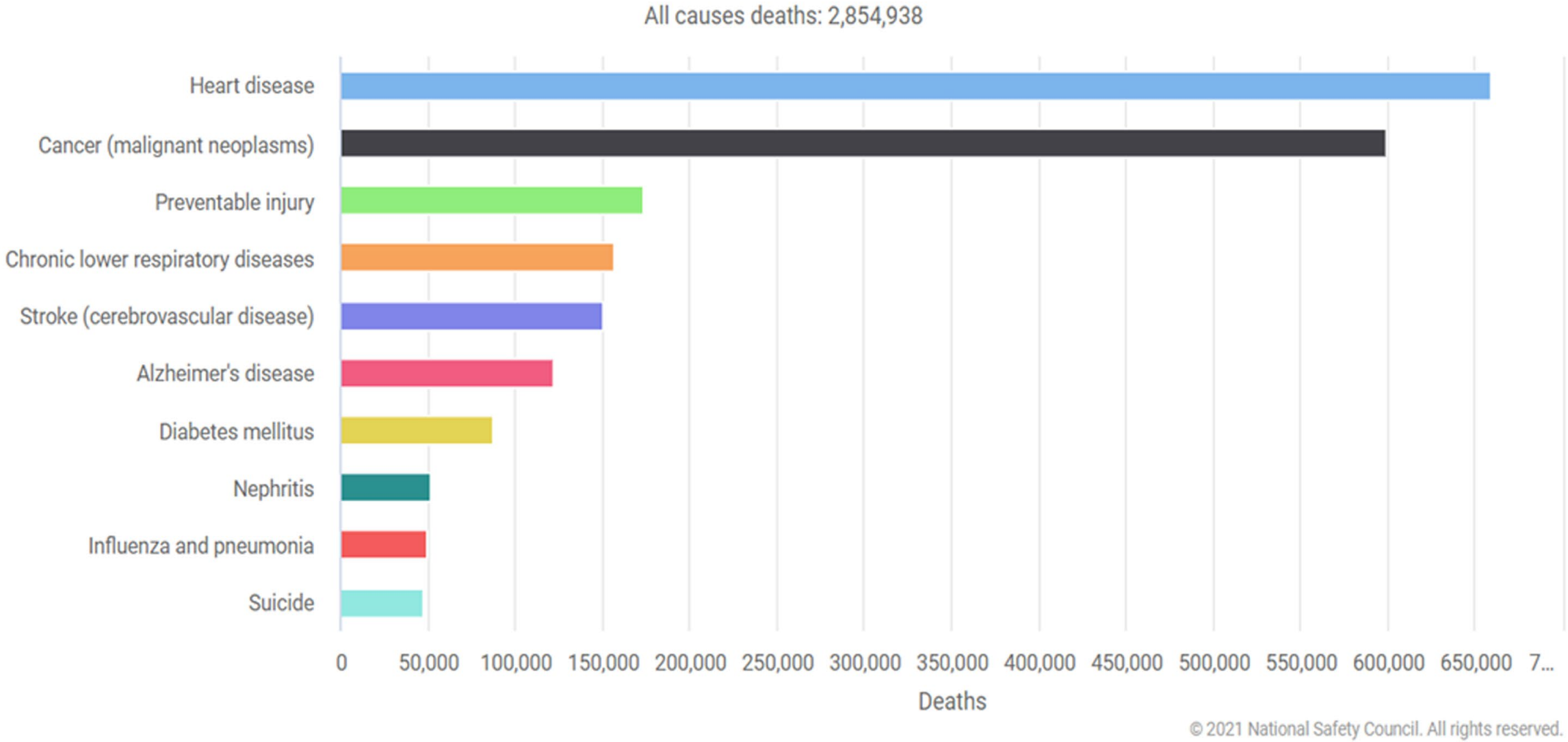
- Alter host and environment
- Development of devices to reduce injury
- Automotive safety research
- Special population considerations


Blunt
Trauma
Deceleration
Penetrating

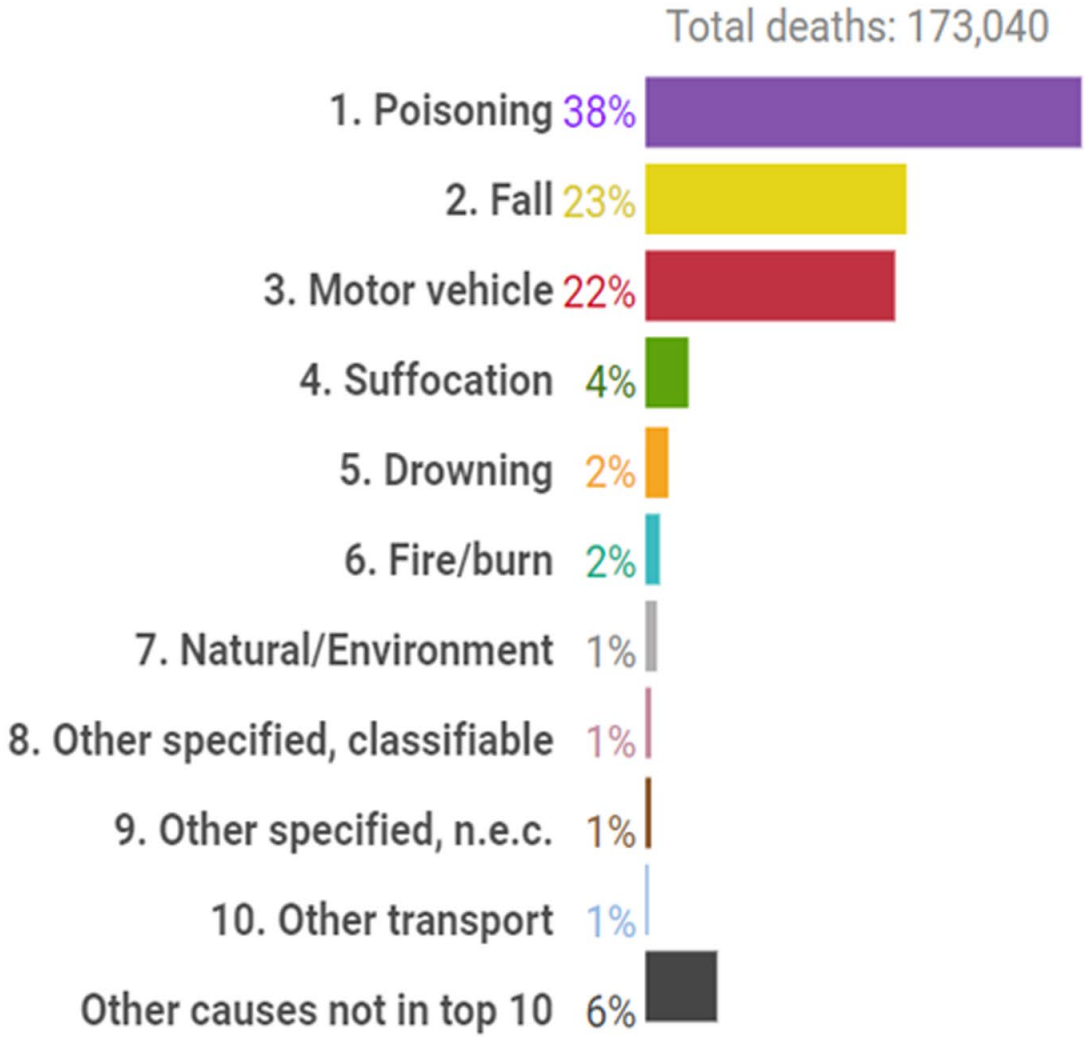
Blunt Trauma

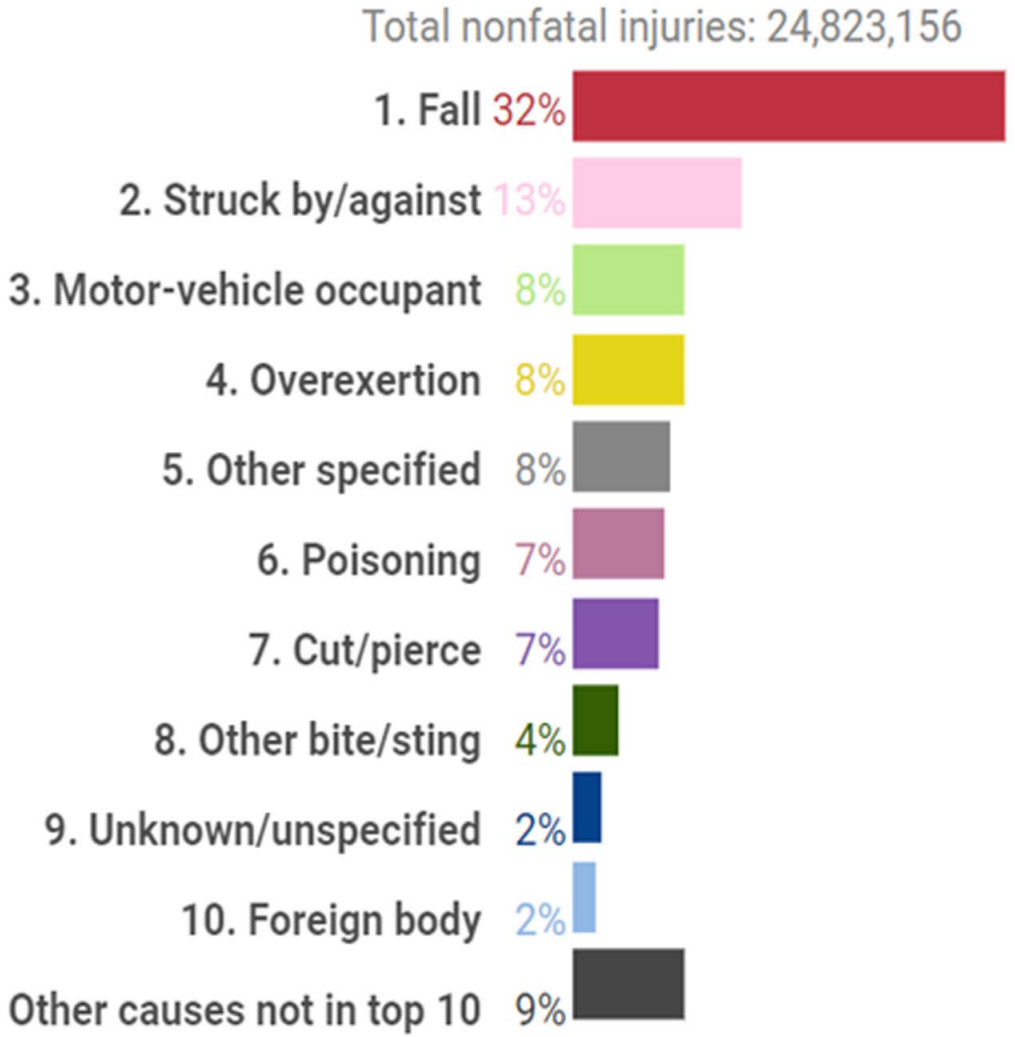


All Leading Causes of Death, US, 2019

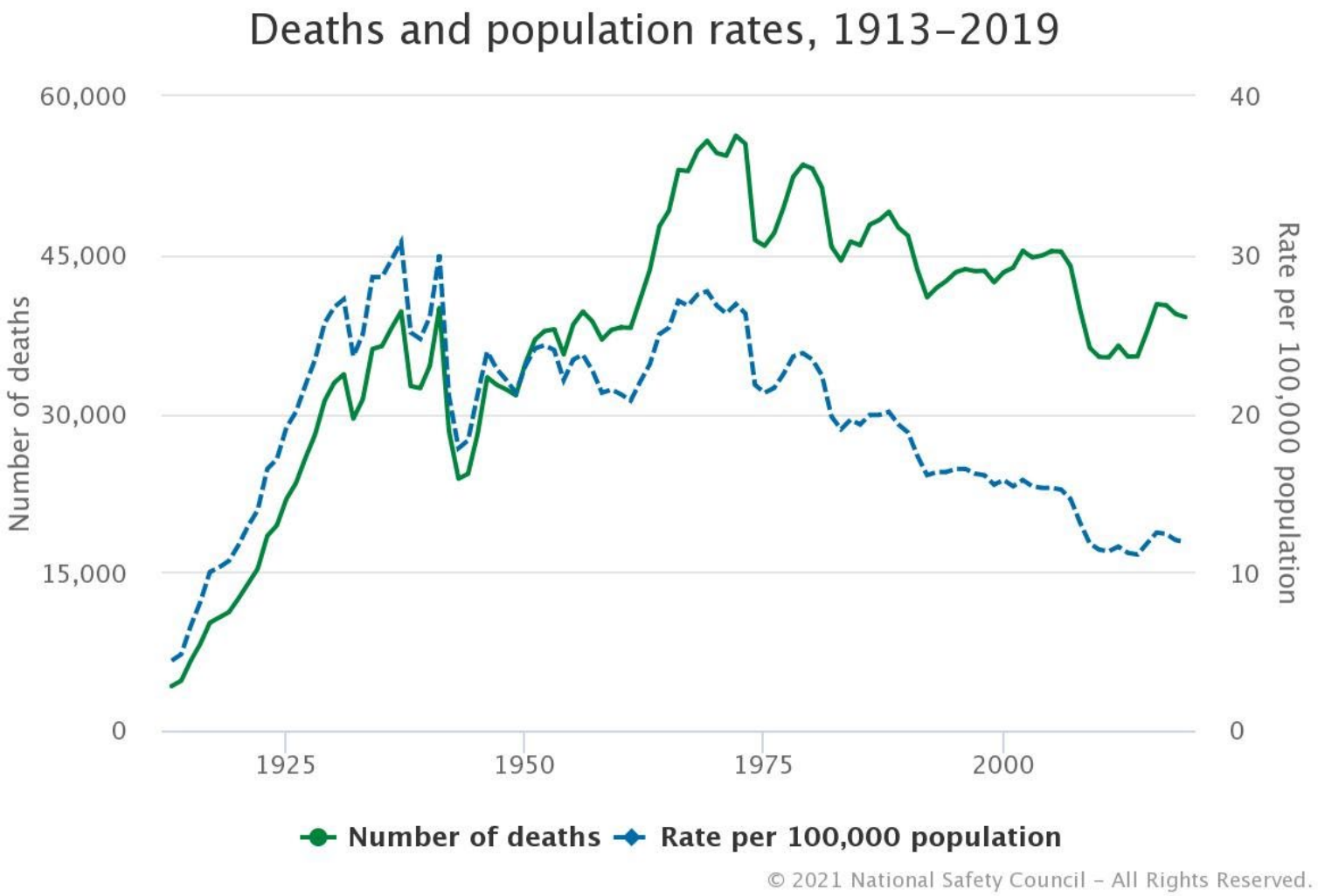


Top 10 Preventable Injuries, US, 2019



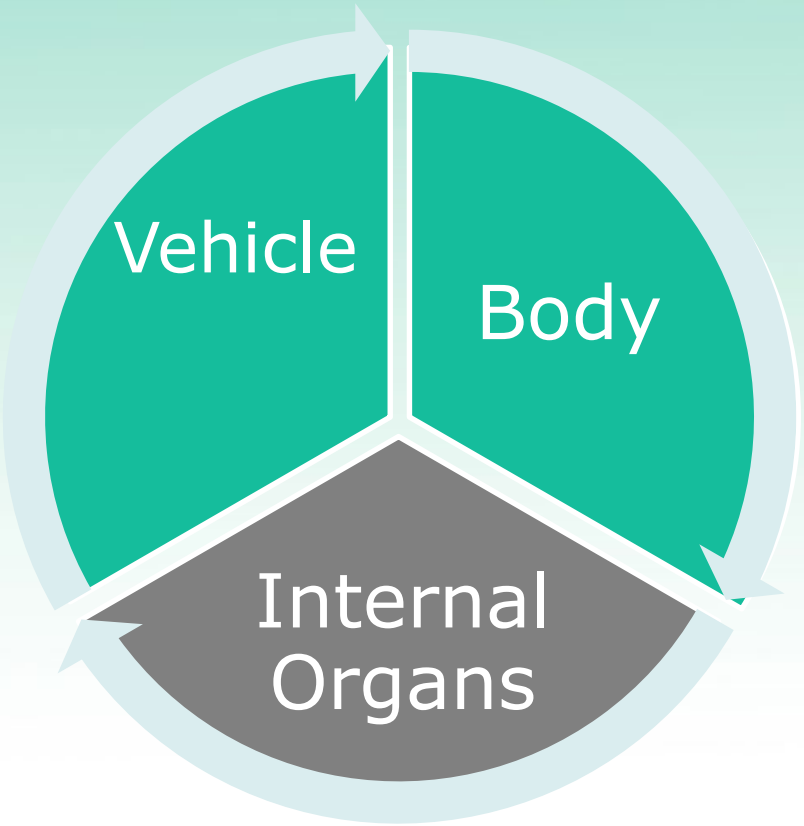


Motor Vehicle Fatality Trends



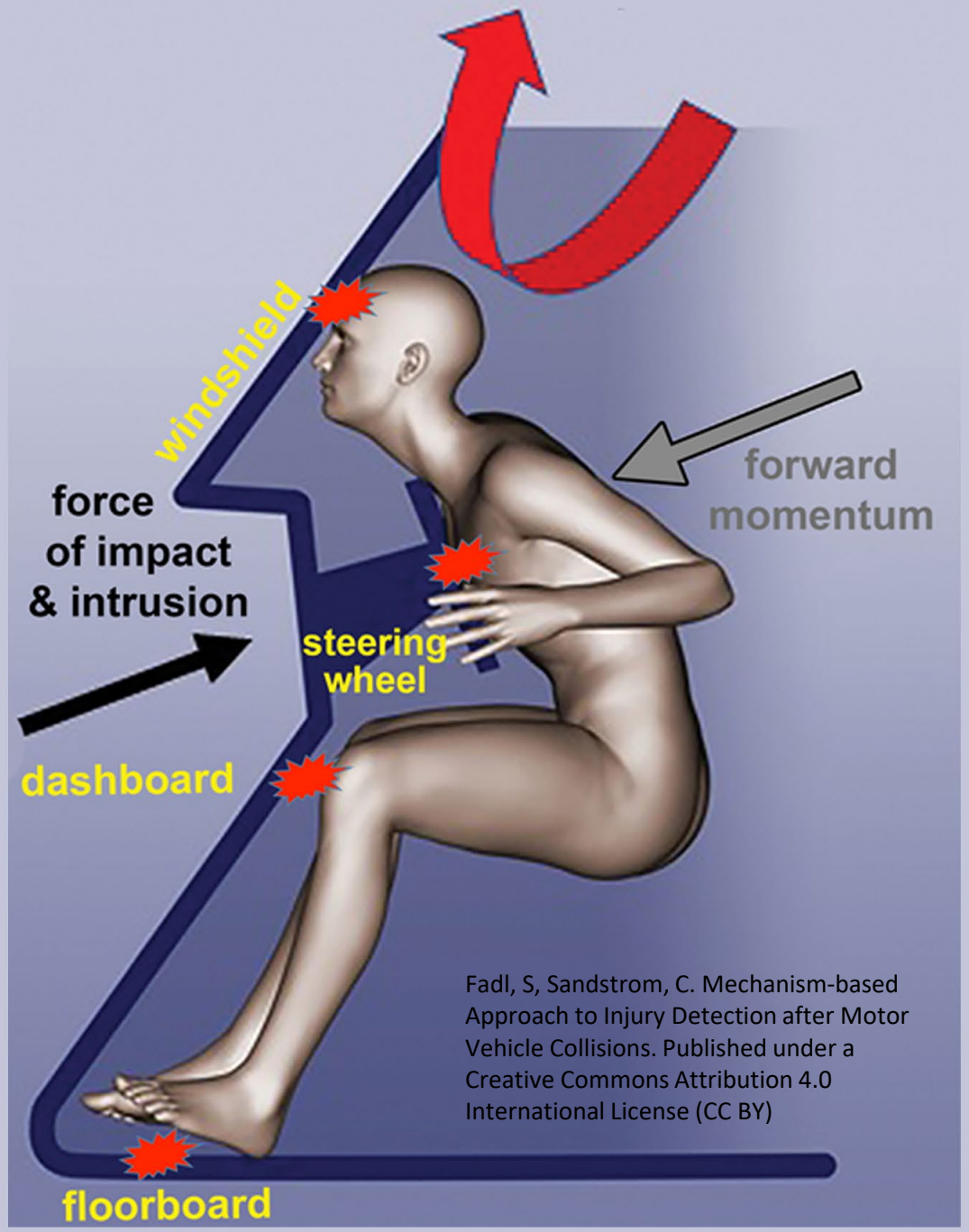
Motor Vehicle Collision

Three Collisions



Types of MVC

- Frontal
- Rear-end
- Lateral
- Rotational
- Rollovers

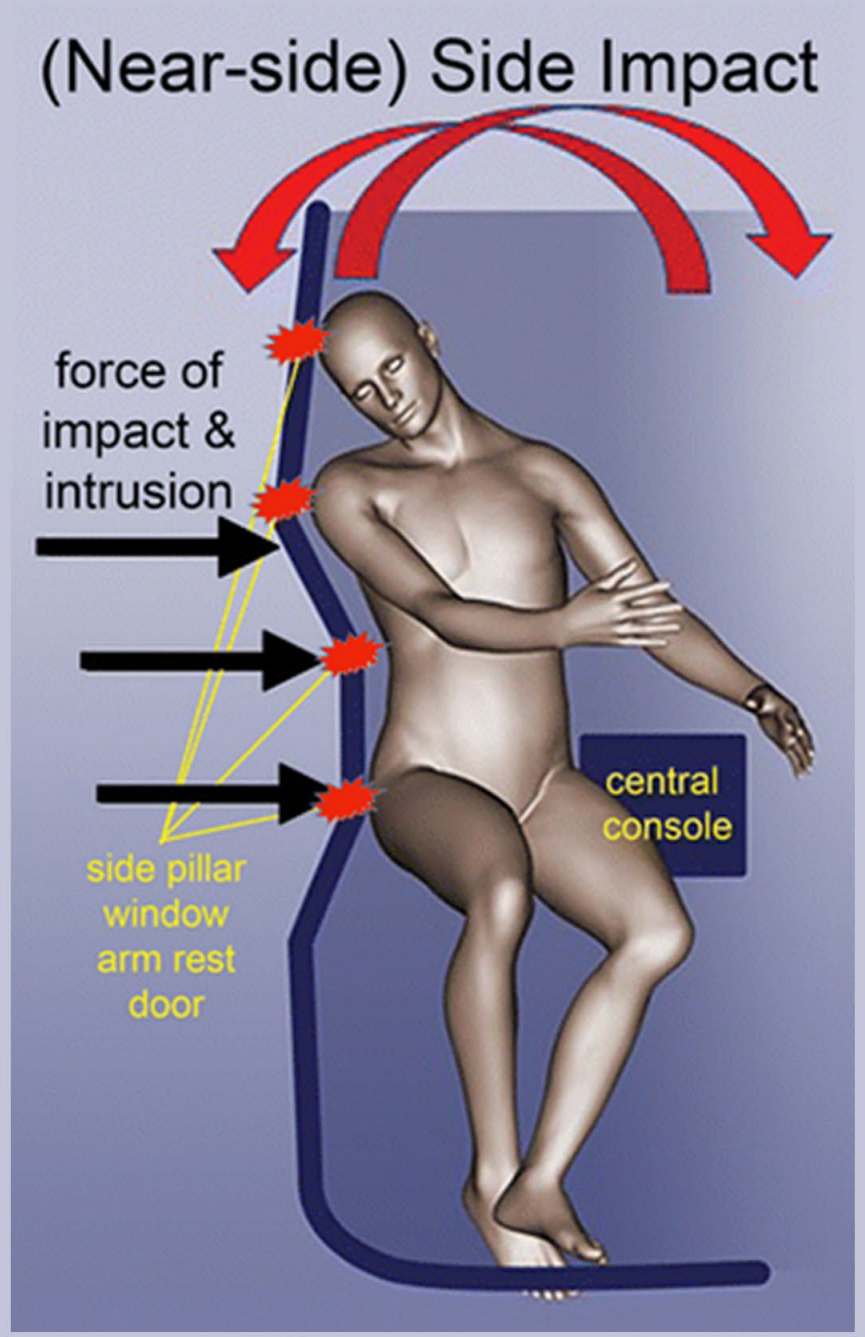


Frontal Impact

- Cervicothoracic vascular injury
- Cervicolaryngeal tracheal injury
- Spinal flexion-distraction injury
- C7 T1 TP fractures
- Sternal and rib fractures
- Bowel and mesenteric injuries
- Pelvic ring fractures/injuries
- Lower extremity injuries
  - Hip
  - Knee
  - Ankle
  - Midfoot

Red Flags

http://emergencywebnotes.blogspot.com/2012/01/life-saving-information-on-hollow.html



Lateral Impact

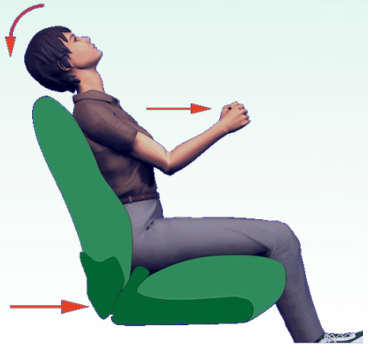
- Head
- Neck strains and sprains
- Spine
  - C2 body/odontoid fractures
  - C3-C4 thru C7-T1
- Rib fx, pulmonary contusions/ lacerations
- Diaphragmatic injuries may accompany pelvic and solid organ injuries

Fadl, S, Sandstrom, C. Mechanism-based Approach to Injury Detection after Motor Vehicle Collisions.

Rear End Collision

1

2



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4

https://slideplayer.com/slide/4151019/


2874
PARAMEDIC UNIT
EMS
EMERGENCY MEDICAL SERV
EMERGENCY 911


Rotational Impact

Acceleration and Deceleration

- Acceleration
  - Rate at which body in motion increases its speed
- Deceleration
  - Rate at which a body in motion decreases its speed


R.DEF
MAX A/C
NORM A/C

Child Restraints

Pedestrian vs MVC

Direct Strike

- Lower arm
- Pelvis
- Abdominal organs
- Hip
- Femur
- Knee

Thrown

- Head
- Face
- Neck
- Skin (road rash)


BRIDGESTONE

Feet-First Falls

- Compression fractures
- Calcaneus fractures
- Fractures of the wrist
- Injury to internal organs
- Injuries to head, back, and pelvis

Head-First Falls

- Brain injury
- Hyperextension of the head/neck
- Compression of the cervical spine
- Chest, lower spine and pelvic injuries are also common

Falls - Critical Factors

- Height
- Surface
- Objects struck during fall
- Body part of first impact

Important Heights

20 feet: Adult

2- 3 x height of the child (10 feet)

35 feet: 50% mortality


Blunt Assault
With weapon, fists, or kicking & stomping

Penetrating Trauma

Impalements

Ballistics

$$KE = \frac{1}{2} m v^2$$


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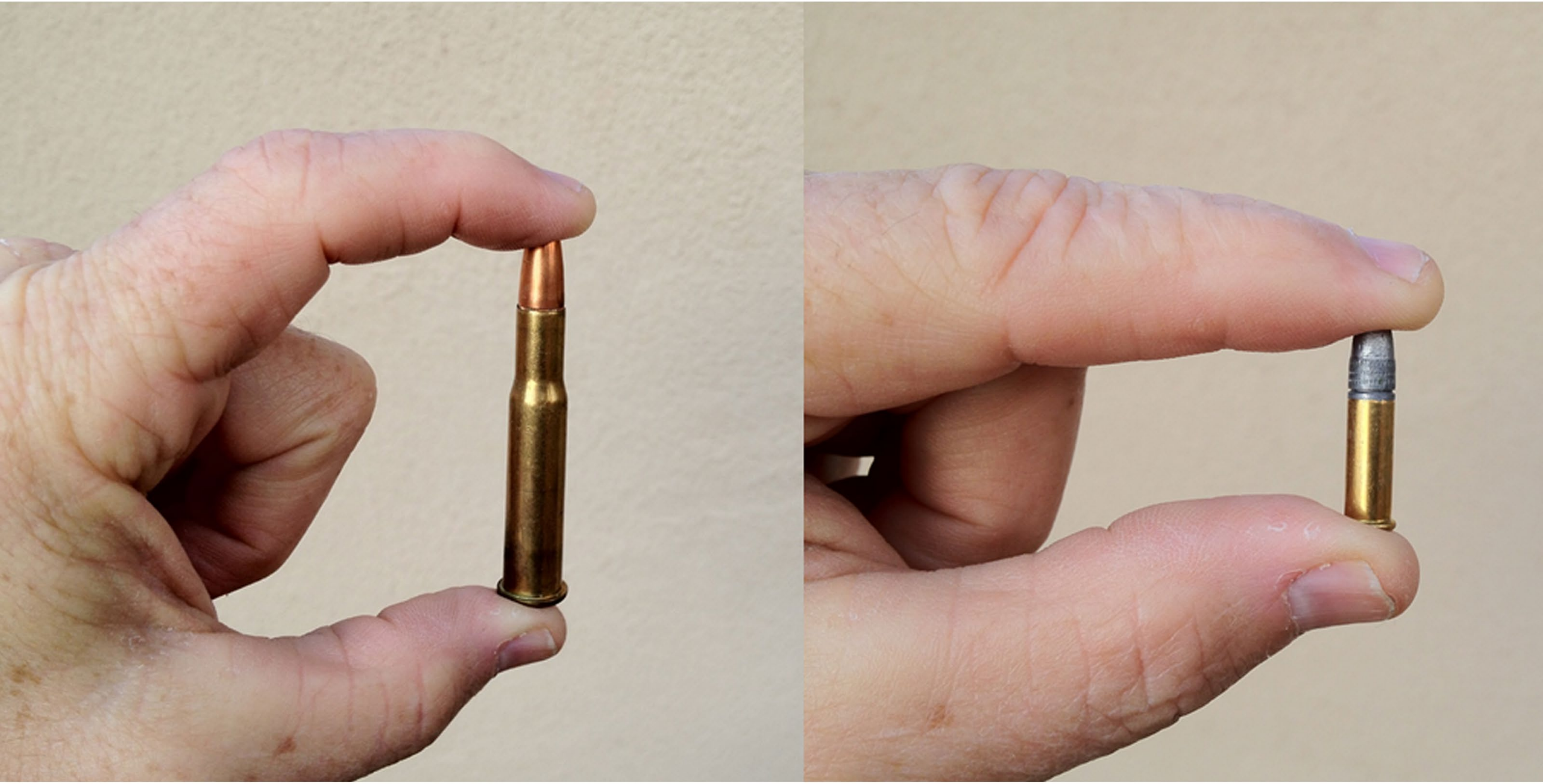
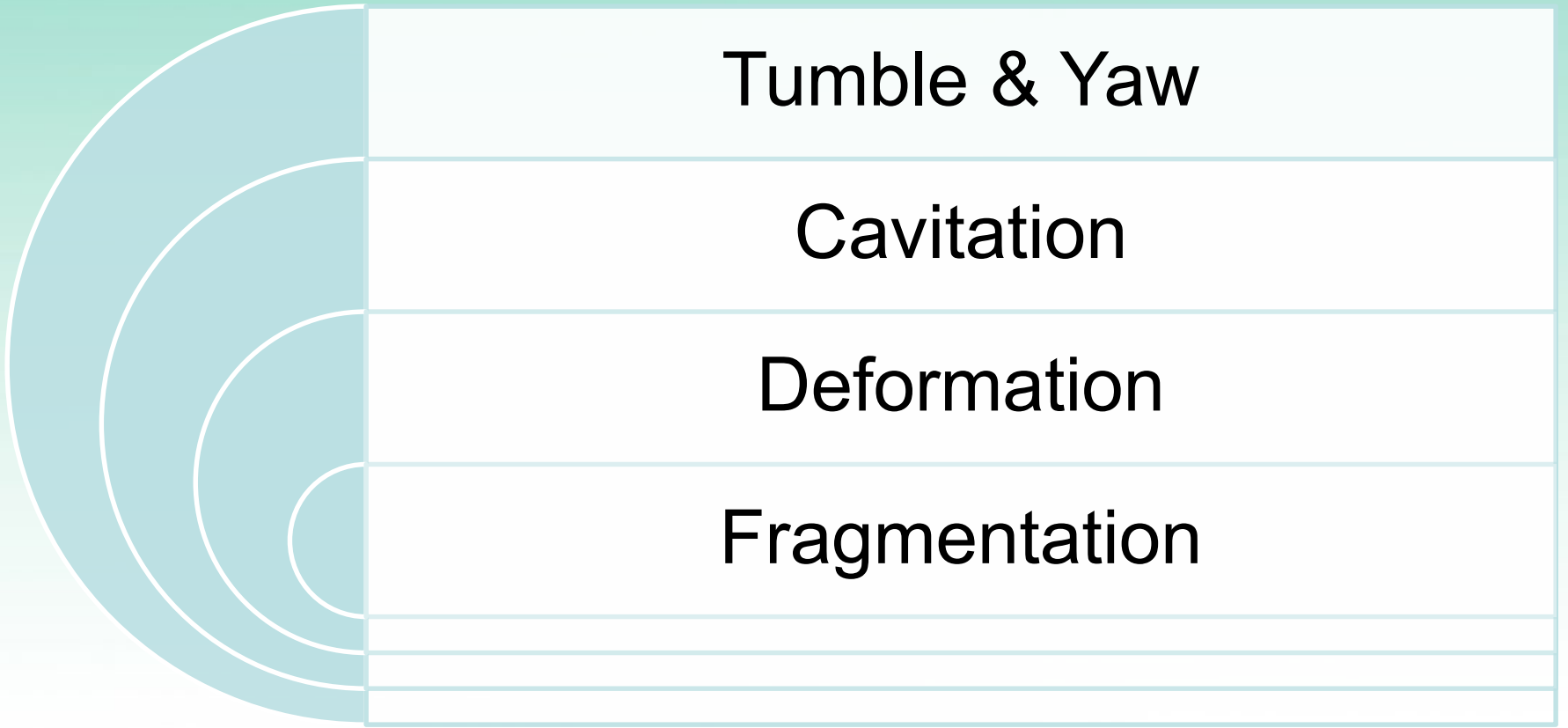
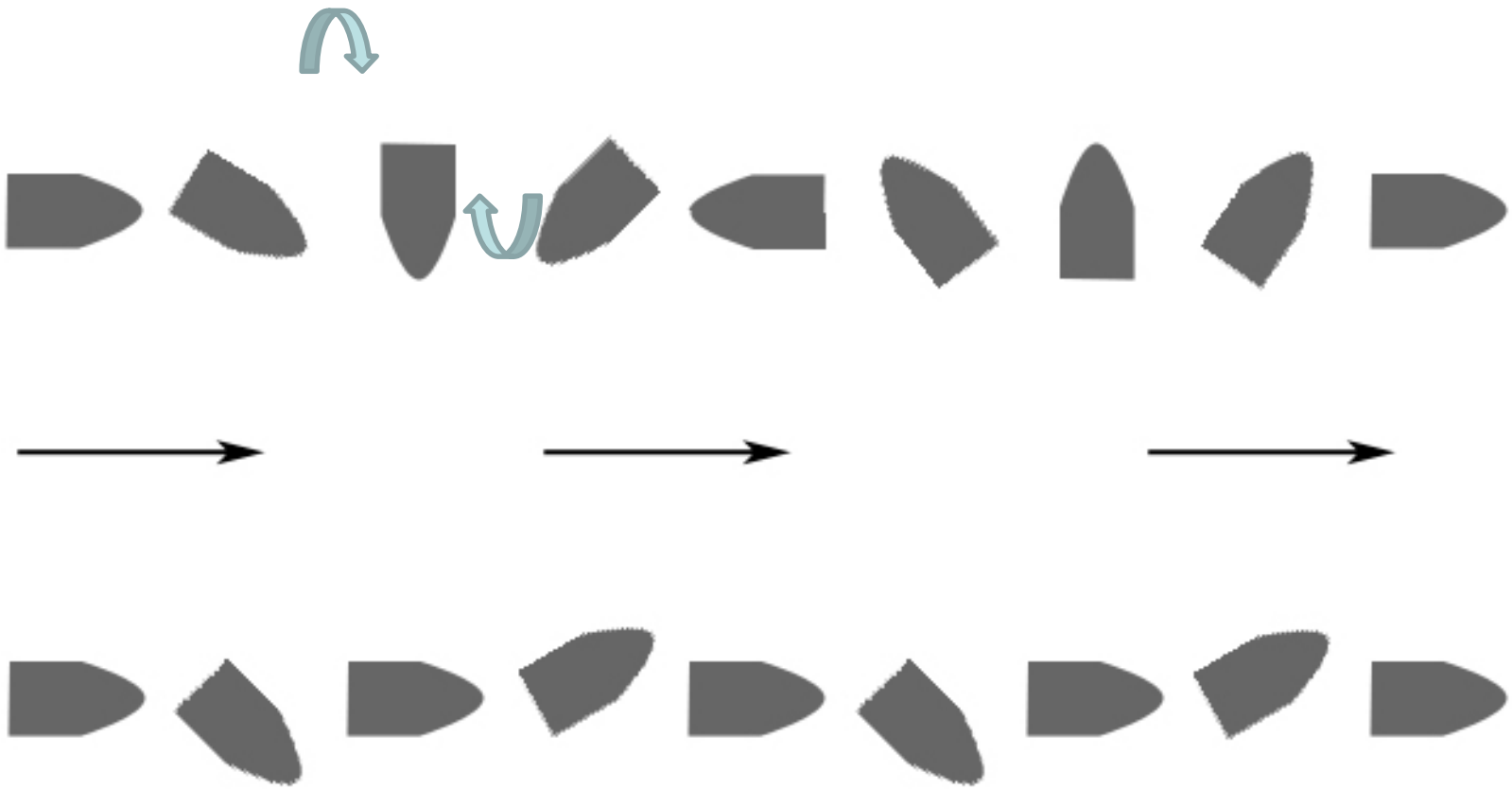
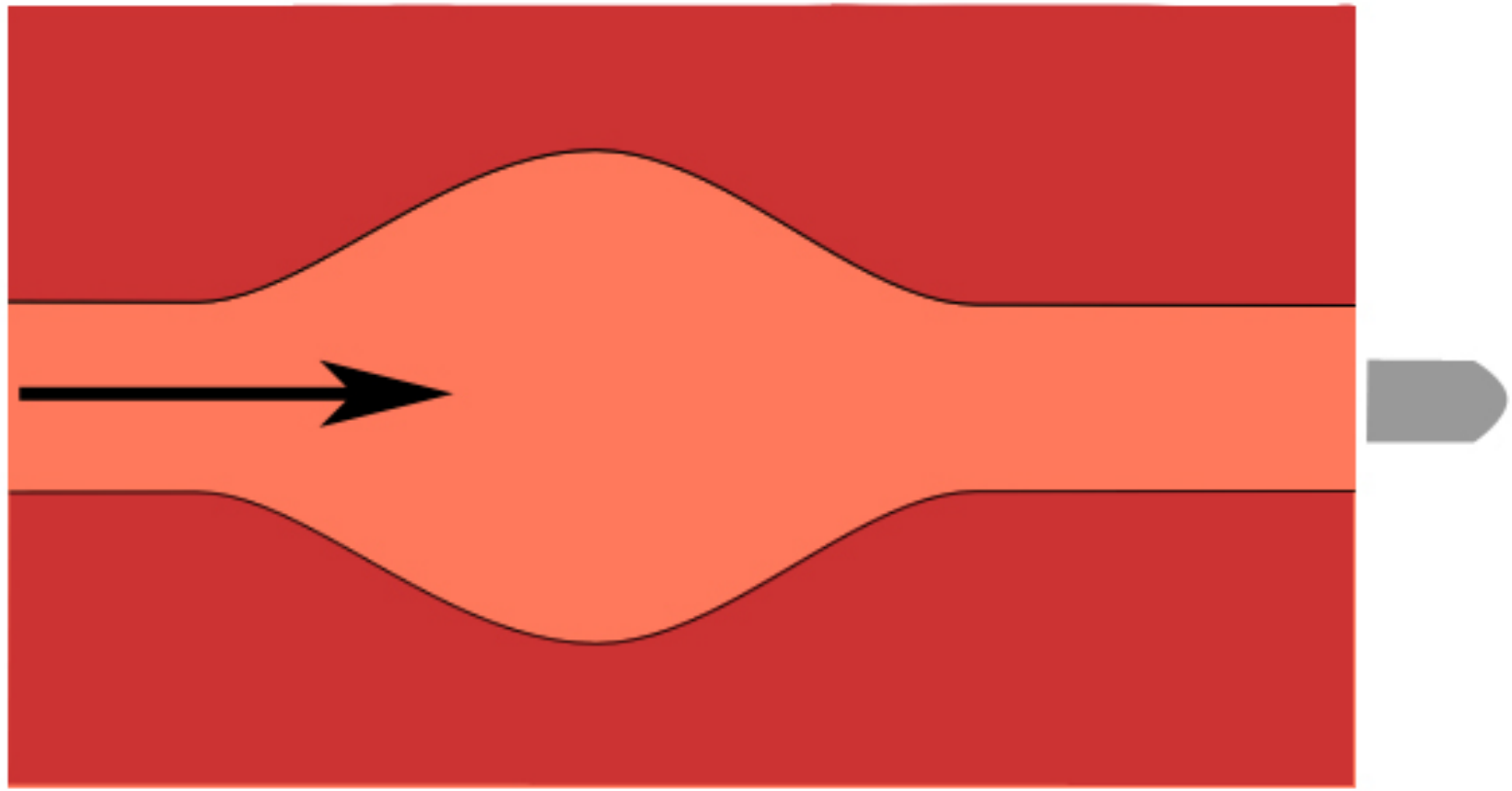


Other Ballistic Characteristics…







An x-ray illustrating fragmentation


2/1


- High-powered shotgun blast
- Close range

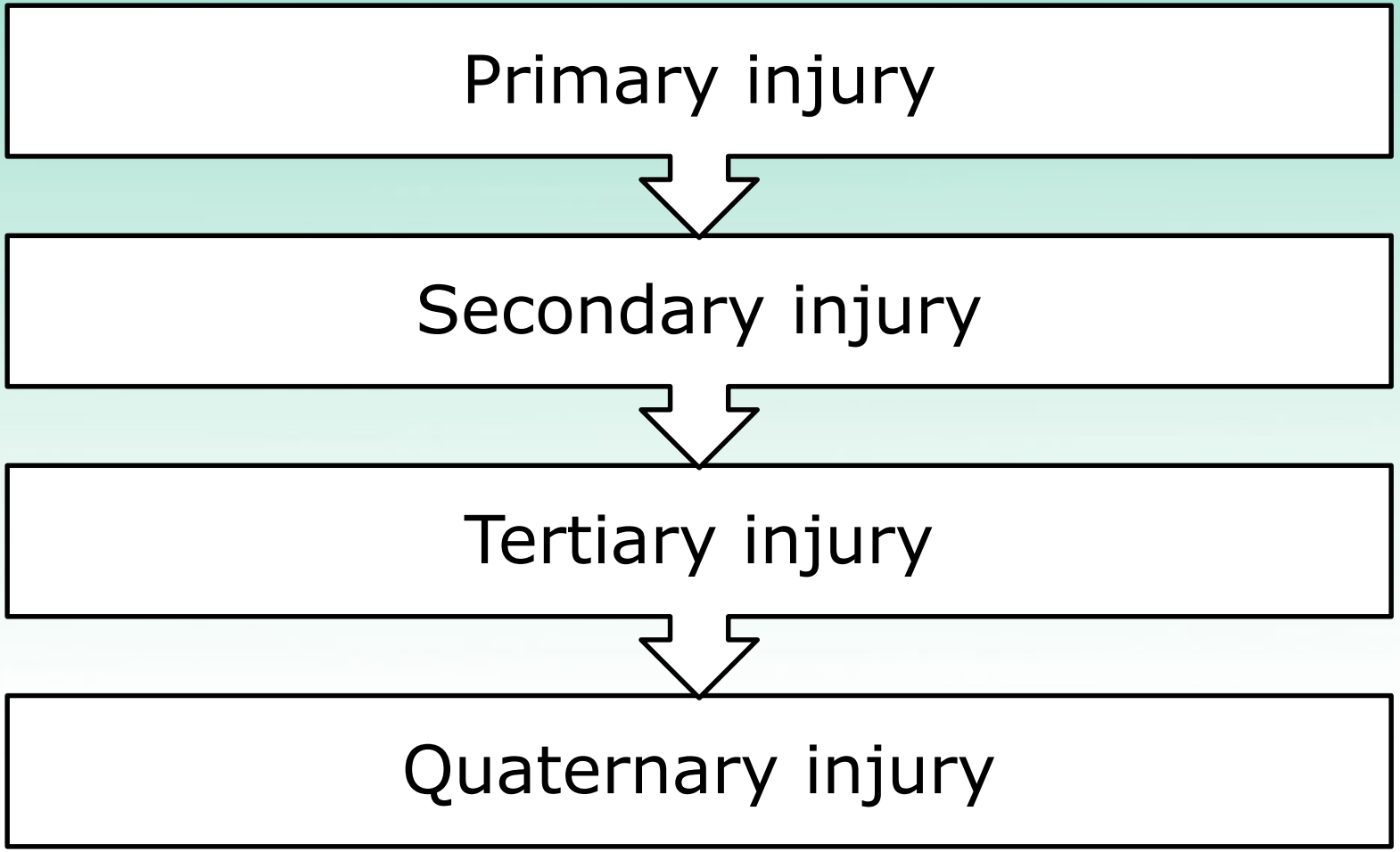
$$KE = \frac{1}{2} m v^2$$

Entrance vs. Exit Wounds

- Exit wounds are not always larger
- Avoid labeling wounds entrance or exit
- Include anatomic location, shape, size and any additional finding such as powder burns
- Preserve evidence
  - Cut around not through bullet holes in clothing
  - Handle any bullet carefully
  - Preserve chain of custody

Blast

Injury Phases of an Explosion



Summary and Conclusions

Injury patterns and severity are *predictable*, based on knowledge about **mechanism of injury,** especially **mass** and **velocity.**