# The Kinetics of Trauma

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# Basic Trauma Facts

- Leading Cause Of Death For Persons Under 39 Years Old
- Responsible For More Than 150,000 Deaths Each Year, Neighborhood of 50,000 On Highways
- Superficial Injuries Can Mask Life-threatening Conditions

# Basic Trauma Facts

- Rapid Recognition Of The Seriously Injured Patient And Expeditious Transport Are Keys To Successful Treatment In Trauma Cases
- Mechanism Of Injury And Index Of Suspicion Are Key Factors In Trauma Assessment

# Trauma Triage Protocols Identify Mechanisms Of Injury; Establish Physical Or Clinical Findings Reflecting Internal Injury

# Determining Mechanism Of Injury

- Identifying The Forces Involved
- Identifying The Directions From Which They Came
- Identifying Bodily Locations Affected By These Forces

# Mechanisms Of Injury In Auto Crashes

- Process Involving Exchange Of Forces
- Between The Auto And What It Struck
- Between The Patient And The Interior Of The Auto
- Between Various Tissues And Organs Within The Patient As They Collide
- Identified By Close Inspection Of The Auto And The Kinetic Forces

# Index Of Suspicion

- Analysis Of Mechanism Of Injury Leads To Anticipation Of Possible Injuries
- Be Prepared To Reexamine Mechanism Of Injury And Look For Subtle Signs Of Serious Injury

# INDEX OF SUSPICION

# The Golden Hour
# Where Did It Come From?

- Conceptualized During The Vietnam "Conflict"
- Based Upon Battlefield Conditions
- Arbitrary Time

# The Golden Hour
# Is It Realistic?

- Survival Chances Of Critical Trauma Patients Are Greatly Enhanced If They Are Delivered To Surgical Intervention Within One Hour Of Injury

# The Golden Hour Is It Realistic?

- The Golden Hour Leaves 10 Minutes For Field Assessment, Stabilization, Extrication, Packaging, And Initiating Of Transport
- Distinguishing Between Need For On-the-Scene Stabilization And Need For Rapid Transport Is Key

# All Trauma Care Is Emergent But Not All Emergency Care Is Trauma

# "Getting The Right Patient To The Right Place At The Right Time."

# Indicators For Decision To Transport Rapidly

- **Mechanism Of Injury**
  - **Fall Greater Than 20 Feet**
    - **Children: >10 feet or two or three times the height of the child**
  - **Death Of A Car Occupant**

# Indicators For Decision To Transport Rapidly

- Struck By Vehicle Traveling Over 20 MPH
- Ejected From Vehicle
- Severe Vehicle Deformity
- Rollover With Signs Of Impact
- Vehicle Telemetry Data Consistent With A High Risk Of Injury

# Indicators For Decision To Transport Rapidly

- Physical Findings
  - Pulse Rate > 120, < 50
  - Systolic BP < 90
  - Respiratory Rate > 29, < 10
  - Glasgow Coma Scale Score ≤13

# Indicators For Decision To Transport Rapidly

- **Physical Findings**
  - Penetrating Trauma (Except Extremities)
  - More Than Two Proximal Long Bone Fractures
  - Flail Chest
  - Burns Greater Than 15% Of BSA
  - Burns To Airway Or Face

# Kinetics Of Trauma

- The Law Of Inertia (Newton's First Law Of Motion)
  - A Body In Motion Will Remain In Motion Unless Acted Upon By An Outside Force
  - Car Braking For Stop Sign: Car (Body In Motion), Brakes (Outside Force)
  - Car Hitting A Brick Wall: Car (Body In Motion), Brick Wall (Outside Force)

# Kinetic Energy

- Force – Summarized By Newton's Second Law Of Motion
- Force = Mass & Acceleration (Or Deceleration)
- The Rate At Which Objects Change Speed Is Critical

# Types of Trauma

# Blunt (Closed) Trauma

- Caused By Body Striking Or Being Struck By Object
- Transmission Of Energy Rather Than Object Causes Damage – Deceleration And Compression Injuries
- Fails To Break Skin But Does Internal Damage

# Blunt (Closed) Trauma

- **Force Compresses Or Stretches Tissue Beneath The Skin, Causing Chain Reaction: Possibility Of Hollow Organs Rupturing, Spilling Their Contents; Solid Organs Bleeding Profusely; Organs Suspended By Ligaments Being Lacerated**

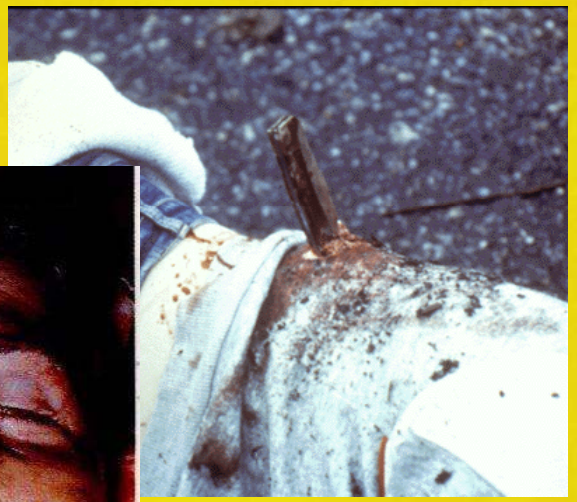
# Penetrating (Open) Trauma

- Caused By Energy Source Progressing Into The Body
- Object In Direct Contact With The Body Causes Injury
- Skin Is Broken

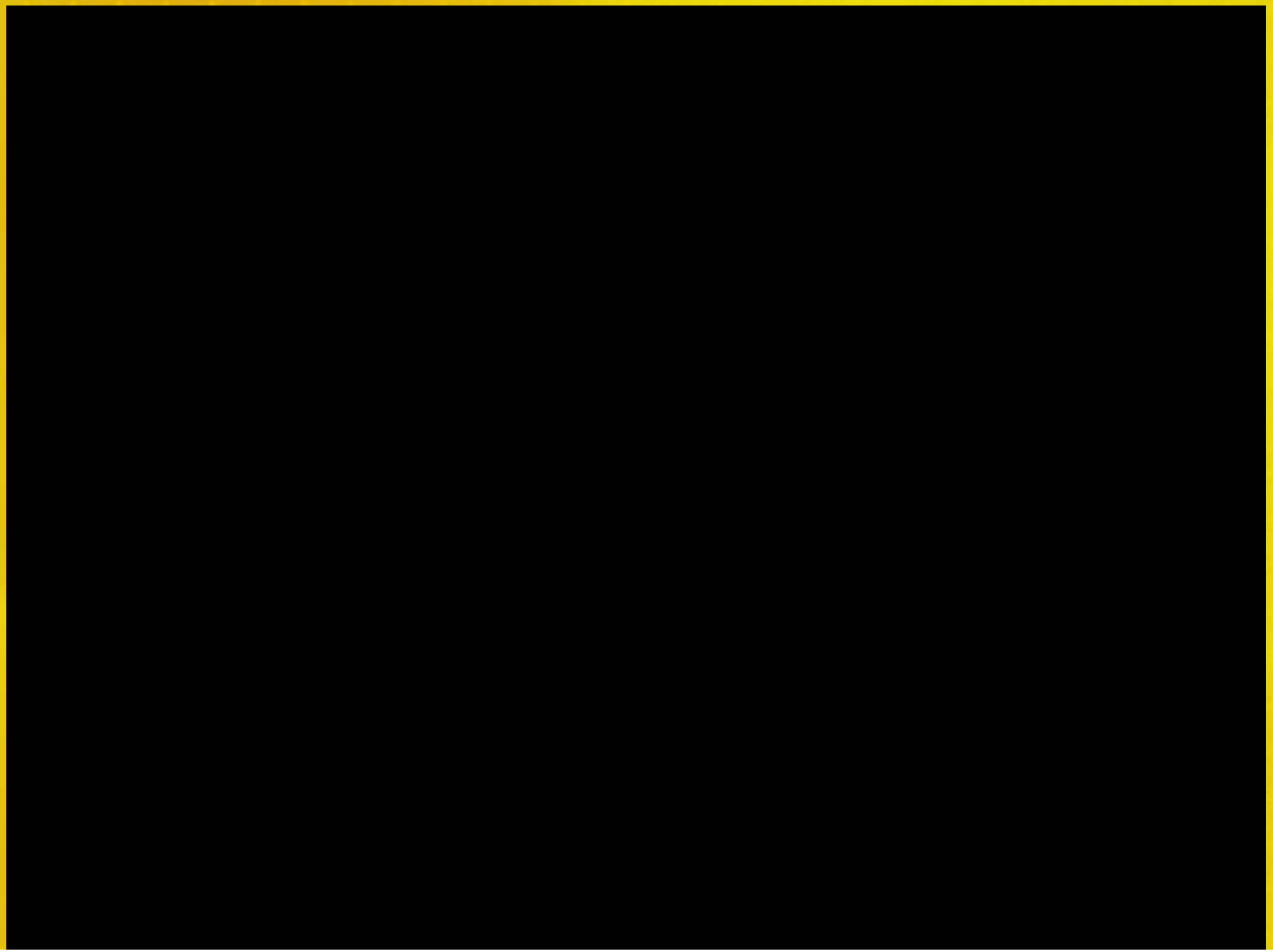
Unregistered HyperCam 2
LiveLeak

# Penetrating (Open) Trauma

- Energy From Object Can Be Transmitted To Surrounding Tissues Extending Trauma Beyond Open Wound
- Energy Transfer Is Dependent On The Size Of The Object And The Speed Of Travel



# Automobile Crashes



# Automobile Crashes

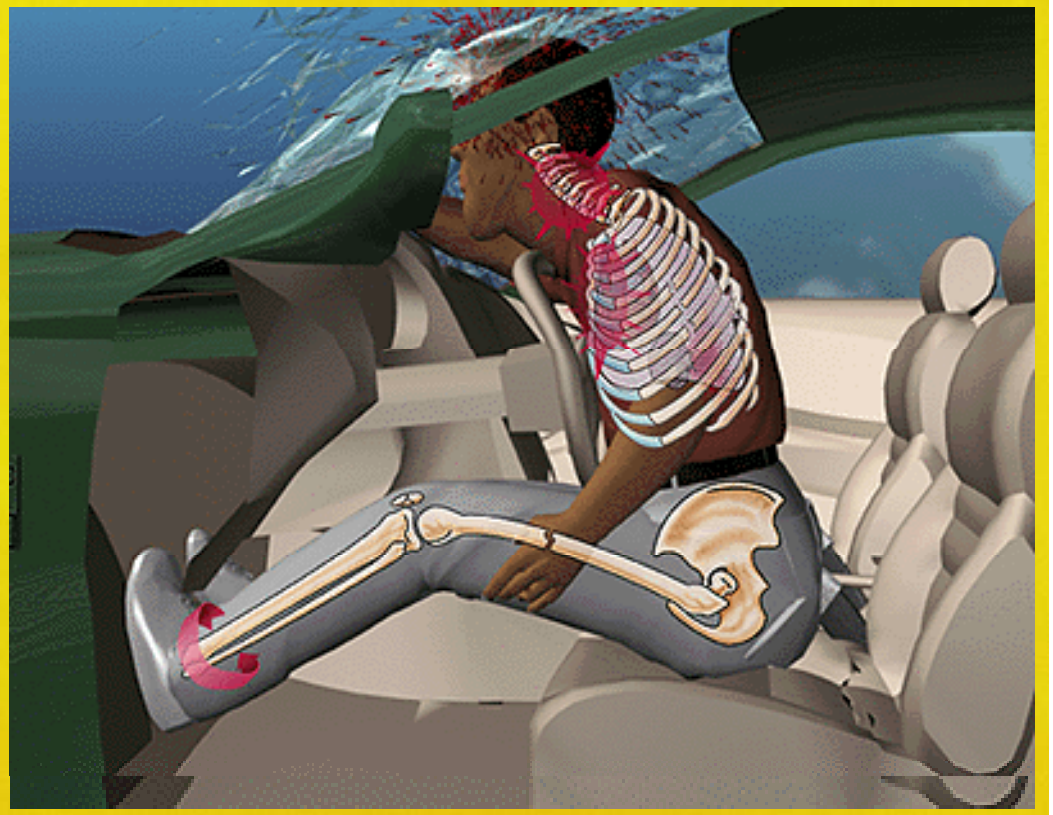
- Account For 50,000 Deaths In 100,000 Serious Accidents Per Year In U.S.
- ALS Provider's Tasks In Auto Accidents
  - Recognize Various Types Of Auto Accidents
  - Identify Possible Mechanisms Of Injury
  - Form A Reasonable Index Of Suspicion

# EVENTS OF IMPACT

- Vehicle
  - Collision Vehicle Strikes An Object

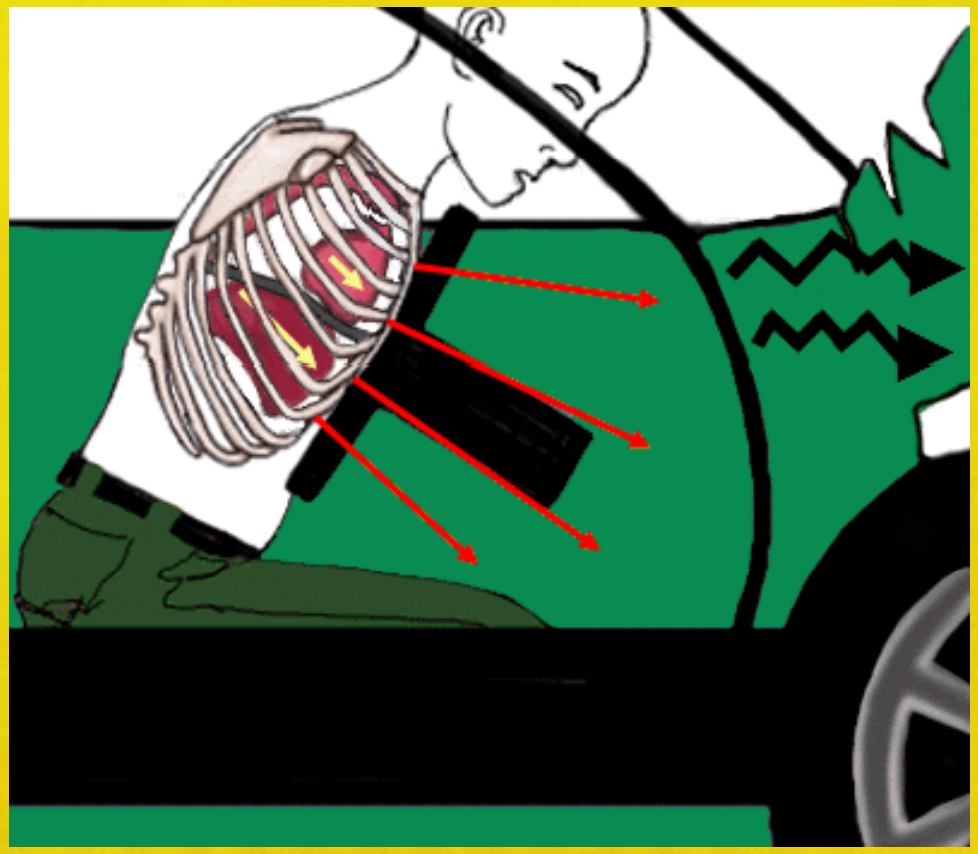
# Events Of Impact

- Body Collision
  - Body Strikes Inside Of Vehicle



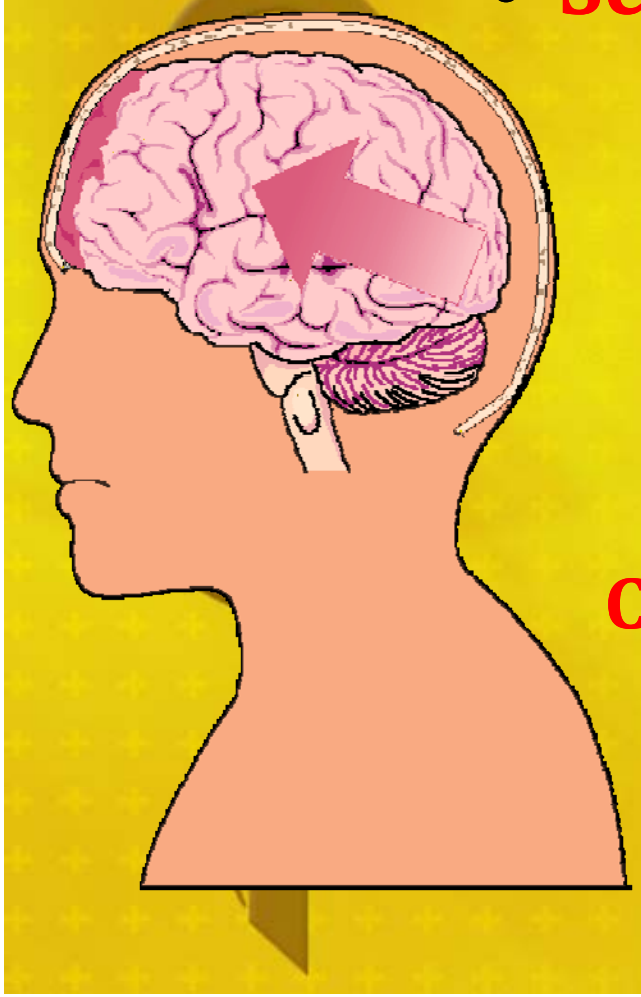
# Events Of Impact

- **Organ Collision**
  - **Organs Collide Within Body Cavity**



# Events Of Impact

- **Secondary Collisions**



**Coup/Countercoup Injury**

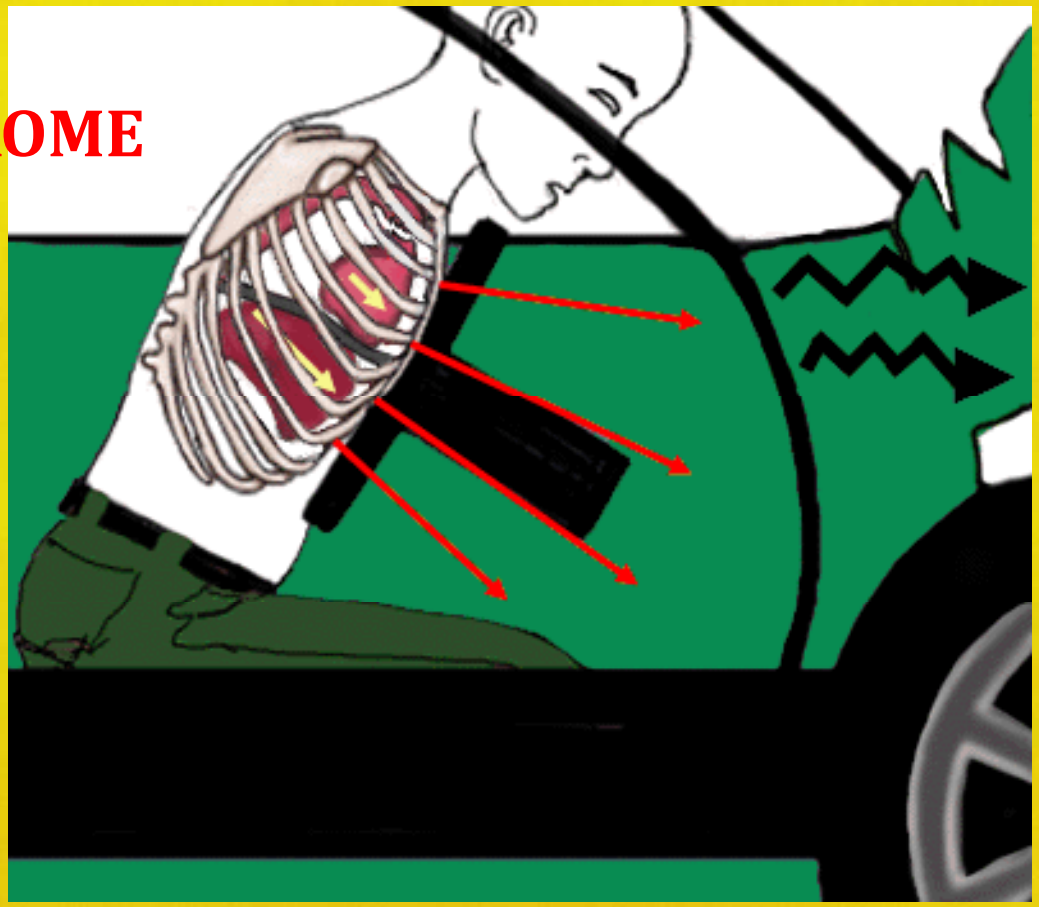
# Types Of Impacts

# Frontal Impact

- Frontal Impact
  - Down-and-under Pathway
    - Patient Slides Downward, Knee Contacts The Fire Wall
    - Fractures And Dislocations Of The Hip And Lower Extremities
    - Upper Body Crashes Into Steering Wheel
    - Flail Chest, Myocardial Contusion, Aortic Trauma

# Frontal Impact

- "Paper Bag" Syndrome



# Frontal Impact

- Up-and-over Pathway
  - Accounts For Over Half Of All Vehicular Deaths
    - Patient Tenses And Pivots Forward And Up
    - Femurs Impact The Steering Wheel
    - Blunt Abdominal Trauma, Thoracic Injuries
    - Head And Spinal Cord Injuries From The Windshield

Mechanism of Injury

Front Impact Accident

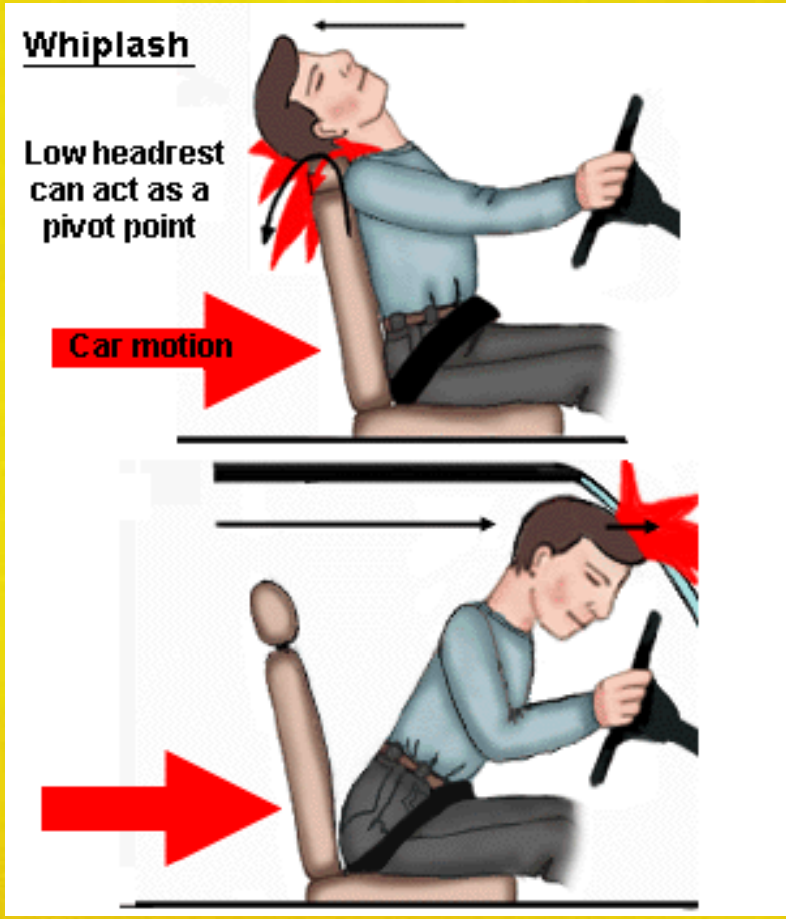
*Up and Over*

# Frontal Impact

- Ejection–accounts For 27% Of Vehicular Deaths
  - Injuries From Impact With The Windshield
  - Injuries From Impact With The Ground, Tree, Or Secondary Object

# Rear Impact

- Passenger Is Propelled Forward By The Vehicle Seat
- Head Remains Stationary
- Neck Extends And Snaps Forward Quickly
  - Soft Tissue And Skeletal Neck Injuries



# Lateral Impact

- Accounts For About 22% Of Vehicular Deaths, But Only 15% Of Impacts
- Very High Index Of Suspicion For Serious Internal Injury

# Lateral Impact

- Kinetics Same As For Frontal Impact But With Forces Applied From Different Direction And Less Protective Structural Steel For Occupants

Mechanism of Injury

Side-Impact Accident

# Lateral Impact

- **Increase In Upper Extremity Injury: Skull, Cervical Spine, Internal Head, Chest Injuries Common**

# Rotational Impact

- Oblique Angle Impact Causes The Vehicle To Turn
- Injuries Much Like Those In Frontal And Lateral Impacts
- Less Injury Than Might Be Expected

# ROLLOVER

- Caused By A Change In Elevation Or A High Center Of Gravity
- Many Impacts Within The Vehicle
- Often Partial Or Whole Ejection

Mechanism of Injury

Roll-Over Accident

# Common Contributing Factor In Auto Crashes

- Intoxication
  - Can Interfere With Patient Assessment
  - Can Mimic Head Injury
  - Can Lower Level Of Orientation
  - Can Anesthetize The Patient
  - Can Increase Possibility Of Overlooking Serious Injury
  - Should Increase Index Of Suspicion

# Crash Evaluation

- Analyze The Four Types Of Impact
- How Did Objects Collide
- From What Direction Did They Come
- At What Speed Were They Traveling
- Were They Similarly Sized
- Were There Any Secondary Collisions

# Analyze The Mechanism Of Injury

- What Caused The Accident
- Was Alcohol Involved
- Are There Skid Marks

# Examine The Auto Interior

- Is The Windshield Cracked
- Is The Steering Wheel Deformed
- Is The Dash Dented
- Is There Intrusion Into The Passenger Compartment

# MOTORCYCLE CRASHES

# Motorcycle Crashes

- Impact Differences From Auto Crashes
- Frontal Impact Propels Rider Upward And Forward
  - Lower Abdomen Or Pelvis Catches Handlebars
  - Bilateral Femur Fractures Possible

# Motorcycle Crashes

- Angular Impact Traps The Lower Extremities Between The Bike And The Object
  - Fractures And Crushing Injuries To The Foot, Ankle, Leg, Knee, Femur
  - Ejection Common And Usually Severe
  - Skull Fractures And Internal Head Injuries
  - Spinal Fractures And Paralysis
  - Extremity/Pelvic Fractures

# Motorcycle Crashes

- Rider Protection
- Experienced Riders Lay The Bike Down, Sliding Into The Other Object
- Reduces Chances For Ejection, Major Injury
- Increases Lacerations, Abrasions, And Minor Fractures
- Leather Clothing Protects Against Soft Tissue Injuries

# HELMETS REDUCE INCIDENCE OF HEAD INJURY !!

# PEDESTRIAN ACCIDENTS

# Adult Victim

- Turns Away From Car And Presents A Lateral Surface
  - Low Impact
    - Tibia/fibula
  - Upper Body Propelled Onto Hood Of Car
    - Femur, Pelvis, Lateral Chest, Upper Extremities
  - Head May Impact The Windshield
    - Shoulder, Head Injuries
  - Patient Hits The Ground
    - Numerous Injuries

# Child Victim

- Turns Into The Approaching Car And Presents Differently
  - Bumper Hits The Femur, Causing A Fracture
  - Hood Impacts The Chest And Upper Extremities, Possibly The Head
  - Patient Often Thrown In Front Of Vehicle And Run Over

# Mechanism of Injury

# Pedestrian Accident

# PEDESTRIAN INJURIES

# Recreational Vehicle Accidents

# SNOWMOBILES

- Crushing Injuries Secondary To Rollover
- Severe Head And Neck Injuries Upon Impact
- Severe Neck Injuries From Unseen Wire Fencing

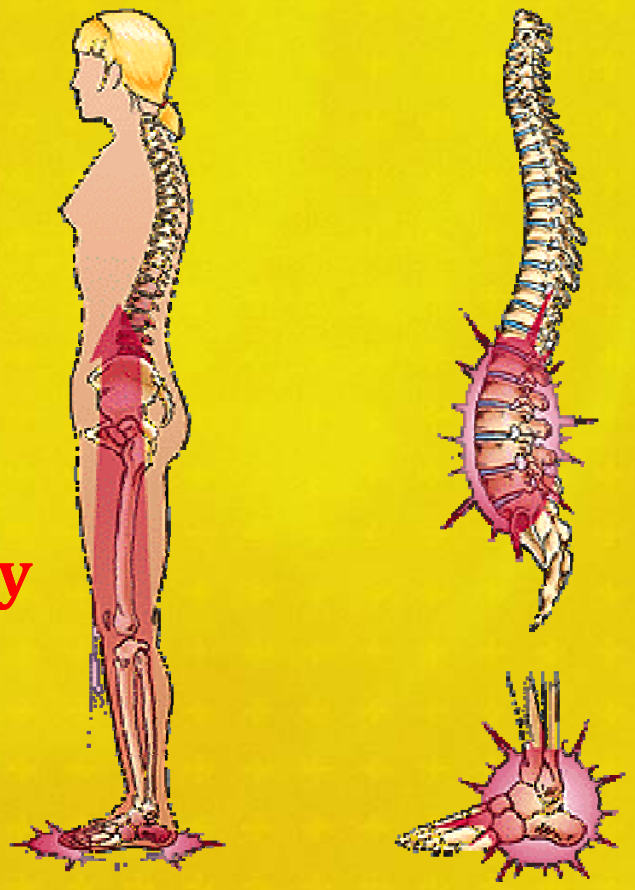
# OTHER BLUNT TRAUMA

# FALLS

- The Greater The Height, The Greater The Energy Upon Impact, The Greater The Trauma
- Stopping Distance Is More Important Than Height Of The Fall

# FALLS

- Area Of Contact Is Important
- Landing On The Feet Transmits The Energy Up The Legs And Spine
- Landing On An Outstretched Arm Causes Upper Extremity Fractures Or Dislocations



# Sports Injuries

- Most Caused By Extreme Exertion, Fatigue, Or The Direct Forces Of Trauma

# Sports Injuries

- Acceleration, Deceleration, Compressional, Rotational, Hyperextension, Hyperflexion Are Common Causes Of Injuries
  - Soft Tissue Damage
  - Connective Tissue Injury
  - Skeletal Trauma
  - Internal Damage
- Protective Gear Minimizes Injuries But Can Cause Some Injuries

# Sports Injuries

# Sports Injuries

# PENETRATING TRAUMA

# Categories Of Projectile Injury

# Low Velocity

- Knife, Ice Pick, Arrow, Etc.
  - Slow Object Speed As Projectile Enters Body
  - Trauma Usually Limited To The Pathway Alone Low

# Velocity

- Characteristics Of Attacker Can Affect Trauma
  - Males Strike Outward/Crosswise
  - Females Strike Overhand/Downward

# High Velocity, Medium Energy

- Shotgun Pellets Or Handgun Bullets
- High Velocity, High Energy
  - Rifle Bullets
  - Energy Transmitted Beyond The Bullet Pathway
  - Cavitation Wave Pushed In Concentric Pattern

# Pathologies Of Penetrating Trauma

- Head
- Facial Area
  - Often Affected In Suicide Attempts
  - Severe Hemorrhage And Threat To Airway

# Pathologies Of Penetrating Trauma

- Neck
  - External Hemorrhage From Major Vessels
  - Airway Problems
  - Cervical Spine Compromise

# Pathologies Of Penetrating Trauma

- **Thorax**
  - **Lungs (Pulmonary Contusions, Pneumothorax)**
  - **Heart (Tamponade, Exsanguination)**
  - **Ribs (Fractures Causing Projectile To Fragment And Deflect)**

# Pathologies Of Penetrating Trauma

- **Abdomen**
  - **Abdominal Contents Spilling Into Peritoneum**
  - **Massive Bleeding From Liver Or Spleen Rupture**

# IMPALEMENTS

# Pathologies Of Penetrating Trauma

- **Extremities**
  - **Often Wounded In Attempts To Protect Upper Body**
  - **Significant Bleeding From Major Vessels**

# DISTRACTIONS

Thank You