For this lesson plan we are going to cover Mechanism of Injury, but we will also discuss the scene itself and things that we can gain while doing our scene evaluation that will help us with our treatment.

We know that EMS and Fire is a teamwork activity. We all must be able to know what we can handle and what we can’t handle. We also must be able to identify what we should handle as well as the things that we shouldn’t. When we should stay and play as we say, as well as when we should leave for the hospital. Consider the fastest route to get there as well as the fastest route away from the scene. Then we have to evaluate what to do, what not to do and when to wait for help.

A critical part of trauma assessment is the scene size up. We need to take all the information in from our dispatchers and anticipate what you may find at the scene. We also need to think about what type of equipment may be needed on scene as well as the other resources to handle the scene. As you approach the scene, form a plan of action for everyone to carry out. You always must be prepared to modify the plan as well if things change. Failure to perform a good scene size up can jeopardize lives of not only the responders, but the patients that you have been called to care for.

Remember that when we are doing our scene size up that we need to have our standard equipment on such as gloves and eye protection, because once we get to the vehicle is not the time to be searching for these items. Do your initial triage and figure out your total number of patients on the scene and ask yourself if you will need more equipment or resources to handle the situation. Now is when you want to start looking at the mechanism of injury. How did the accident happen and where might the patient be injured based on that assessment.

As you park the MICU or Fire Apparatus at the scene, think of the potential danger from other vehicles and position your vehicle to help protect the responders and make it easy to egress the scene. You do not want to box your MICU in at the scene to where you cannot get out. Remember to do what is called a Windshield Survey where you are looking out the windshield of your vehicle and identifying the items we discussed above, but also are there any threats to you, threats to or from the patient as well as to or from any of the bystanders. Below is a good example of the engine parked to protect the scene.
Energy will follow the laws of physics when it comes to mechanism of injury. Injuries will present themselves in predictable patterns based on where the damage in the vehicle may be, or how the patient may have been injured. Missed or overlooked injuries can be catastrophic if not found. About 5-15% of patients involved in a high energy event, despite normal vitals and no apparent injury on initial assessment will exhibit severe injuries on later examination.

High energy also carries a higher risk of severe injury. You should always consider injured until proven otherwise. A strong correlation exists between injury severity and automobile velocity changes, as measured by amount of vehicle damage. Severity of vehicle damage has also been suggested as a non-physiologic triage tool. There can be two types of mechanism of injuries as well with the patient. Generalized MOI where we need to do a good head to toe survey to determine patient injuries. And then a focused MOI such as the patient may have broken an ankle while running to first base. You would only examine the leg and then question if they hurt anywhere else.

We can also talk about injuries in the form of blunt vs penetrating. With blunt injuries, we have a rapid deceleration either forward or backwards. The patient may also have had a rapid vertical deceleration and also there is the blunt energy transfer from an instrument or object. Penetrating injuries are items that can penetrate the body. These can be projectiles, knives and even falls on to objects can puncture the body.

When we discuss the motor vehicle collision, we are talking about three separate collisions that are taking place.

- Machine collision
- Body collision
- Organ collision

To explain forces involved, consider Sir Isaac Newton's first law of motion: “A body in motion remains in motion in a straight line unless acted upon by an outside force.” Motion is created by force (energy exchange), and, therefore, force will stop motion. If this energy exchange occurs within body, damage of tissues is produced.
Consider the other collisions that can take place as well. Objects in the vehicle can actually become projectiles or missiles and cause injury. The vehicle after initial impact, may actually collide with another object or other vehicles.

Clues to look at to clue you into possible injuries include deformity of the vehicle itself. What forces were involved in the collision? Look for deformity in the interior structures of the vehicle. What if anything did the patient possibly impact? Deformity or injury patterns on the patient can clue us into what areas were actually hit. Look at the vehicle itself and determine what type of collision it was. Was it a:

- Frontal impact
- Lateral impact
- Rear impact
- Rollover
- Rotational

In head-on collision, the body is brought to a sudden halt, and energy transfer is capable of producing multiple injuries. Windshield injuries: of utmost concern is the potential for serious airway and cervical-spine injury. The Brain, soft tissue injuries to the face as well as C-Spine injuries are of concern. Steering wheel deformity is a cause for alarm and must heighten your index of suspicion. Look for the tattooing of the skin to give you heightened suspicion of steering wheel impact. Dash board injuries can also involve the face, brain, C-spine pelvis, hips and knees. You must also relay this information to receiving physician.
Potential injury patterns with front end collisions:

- Deformed steering wheel
  - Cervical-spine fracture
- Dashboard knee imprints
  - Flail chest
- Spider deformity of windscreen
  - Myocardial contusion
  - Pneumothorax
  - Aortic disruption
  - Spleen or liver laceration
  - Posterior hip dislocation
  - Knee dislocation

Lateral-Impact collisions are similar to frontal impact only with lateral energy patterns. These are hard to predict injury and can cause considerable organ damage. You may want to pay close attention to the impact side of the patients head, neck, upper arm, shoulder, thorax, abdomen, pelvis and legs.

Potential injury patterns with lateral impacts include:

- Contralateral neck sprain.
- Cervical-spine fracture.
- Lateral flail chest.
- Pneumothorax.
• Aortic disruption.
• Diaphragmatic rupture.
• Laceration of spleen, liver, kidney.
• Pelvic fracture.

Rear impact collisions can cause a posterior displacement of energy. Sudden forward increase in acceleration from rear-impact mechanisms produces the posterior displacement of occupants and possible hyperextension of cervical spine if headrest is not properly adjusted. If the seat actually breaks off and the patient ends up in the back seat, there is a greater risk of lumbar spine injury. The potential injury patterns are:
  • Cervical spine injuries
  • Lumbar spine injuries
Rollover collisions are the next mechanism we will discuss and there are multiple impacts that take place during the rollover. The vehicle can actually travel in multiple directions and cause multiple injuries during this event. The patient can experience an axial loading injury to the spine because of the downward force being put on the head as the vehicle is rolling over and the top of the vehicle is being crushed. If the patient is an ejection from the vehicle, the chance of death from the accident increases by as much as 25%.

Rotational collisions are where there is basically a head on and lateral impact combined. In this type of MVC, there is the forward motion that is then converted to a spinning motion. All of the same types of injuries we discussed on the frontal and lateral impact apply to these patients.

Now let us discuss the occupant restraint systems. Restrained occupants are more likely to survive a collision because they are protected from much of impact inside the vehicle and are unlikely to be ejected. Not many vehicles left on the roadways still have only a lap belt. With this type of restraint, you could have a “clasp knife effect” or folding of the body on impact. It could also cause damage to the abdomen as well as the lumbar spine.

The three point restraint as we see in most cars these days, can cause injury to the cervical spine as well as the clavicle. Airbags are also standard on all newer model cars and protect the patient from that “first impact”. They do not prevent “down and under” movement, so may still impact with legs and suffer leg, pelvis, or abdominal injuries. They can still cause damage to the face, abdomen, chest and lumbar spine. Always lift the bag and look at the underlying structure of the car to see if there was any damage.

Tractor or farm accidents account for approximately 50% of all farm fatalities. About 85% of these are side overturns and it is possible that the driver can be thrown clear of the turning tractor. In about 15% of all tractor accidents it is a rear overturn and the patient is likely to become entrapped or crushed. Additional mechanisms of injuries are chemical burns from gasoline, diesel fuel, hydraulic fluid, or even battery acid. Thermal burns from hot engine parts or ignited fuel are also common. Possibility for chemical exposure from insecticides and also liquid nitrogen systems are very cold and can produce frostbite.
Small vehicle crashes are those that involve motorcycles, all-terrain vehicles, personal watercraft as well as snowmobiles. Operators of these machines are not encased within them and wear no restraining devices. They could be considered high-speed pedestrians. Only forms of protection are evasive maneuvering, helmet usage, protective clothing (such as leather clothes, helmet, boots) and use of vehicle to absorb kinetic energy (such as bike slide).

Pedestrians and vehicles as we know do not mix. The mechanism of injury can depend on the initial impact as well as any additional impacts that take place such as when they hit the pavement. Pedestrian almost always suffers severe internal injuries as well as fractures. This is true even if vehicle is traveling at low speed. An adult usually has bilateral lower-leg or knee fractures plus whatever secondary injuries occur when body strikes hood of car and then ground. Children are shorter, so the bumper is more likely to hit them in the pelvis or torso. They usually land on their heads in secondary impact.

Falls from any height can have significant trauma as well. There is the first question of how far did the patient fall or from what height, what area of the body impacted what type of object, and finally what type of surface did the patient land on? Primary groups involved in vertical falls are adults and children under age of 5 years.

- Children
  - Most commonly involve boys and occur mostly in summer months in urban high-rise, multiple-occupant dwellings.
  - Head injuries are common.
• Adults:
  o Generally occupational or due to influence of alcohol or drugs.
  o “Lover's leap” fall
  o Attempt to land on feet, impacts initially on feet and then falls backwards, landing on buttocks and outstretched hands
  o Fractures of feet or legs
  o Hip and/or pelvic injuries
  o Axial loading to lumbar and cervical spine
  o Vertical deceleration forces to organs
  o Colles fracture of wrists

The greater the height…the greater the potential for serious injury. Think about transference of energy from impact—what path did it follow? The surface density and irregularity also influence severity.

Penetrating injuries are those of knives or gunshots. With a knife wound we have to look at the anatomical area that was penetrated. What is the length of the blade as well as the angle of the penetration. We always must remember to stabilize the object in place and minimize the external movement of the knife.

Firearms are another form of penetrating injuries and it helps EMS providers to know if it was a low velocity or high velocity gunshot as well as the caliber of the bullet and what type of ballistic it was.
  • Low-velocity
    o Less than 2,000 feet per second, include essentially all handguns and some rifles.
    o Injuries are much less destructive than those sustained from high-velocity weapons.
  • High-velocity
    o Wounds carry additional factor of hydrostatic pressure.

The entry wound may be smaller than the exit and may also have a darkened or burned area around it if it was fired from a close range. The exit wound may or may not be present on the patient. Usually as indicated, they will be larger in diameter, but do not have to be. Do not get focused on entry vs exit wounds. Remember that you treat patient and wound, not description of weapon.

Internal wound is where the actual projectile comes in contact with the tissues and damages it. When the bullet or projectile from this projectile is traveling through the tissues, there are shock waves through the tissues. There can be a cavity that is created by the projectile and this area is also considered damaged tissue. The cavity created can be 30-40 times the diameter of the initial projectile. This also is known as cavitation.
The last item in mechanism of injury we want to discuss is blast injuries. There are four basic categories for these injuries. Primary are the air-blast injuries that occur from the force of the explosion and are almost exclusive to air-containing organs. Secondary injuries are produced from the projectiles from the blast or the devices placed in the device to cause injury. These may be penetrating or blunt. Tertiary injuries are much same as when a person is ejected from an automobile. What did they strike or thrown against and what injury did that cause. Now that terrorists are using explosives to disperse chemical, biological, or radiological material, some classify injuries resulting from this as “quaternary injuries.” Remember that we do not approach a scene until scene size up has been completed.

References: ITLS Scene Size Up.
1) What are the 5 types of vehicle collisions?
   a. ______________________
   b. ______________________
   c. ______________________
   d. ______________________
   e. ______________________

2) Cavitation is described as?

3) In a tractor accident about ______ % of all accidents are rear overturn and the patient is likely to __________________ or ____________________.

4) When we discuss the motor vehicle collision, we are talking about what three separate collisions?
   a. ______________________
   b. ______________________
   c. ______________________

5) If the patient is an ejection from the vehicle, the chance of death from the accident increases by as much as 35%.
   a. True
   b. False

6) Failure to perform a good scene size up can?
7) There are 4 basic categories for blast injury patterns. They are?
   a. _________________________________
   b. _________________________________
   c. _________________________________
   d. _________________________________

8) In a rear impact collision, the sudden forward increase in acceleration can cause a posterior displacement of the occupants and produce _______________________.

9) In a frontal impact collision, spider deformity of the windscreen can make you suspicious of what type of injuries?
   a. ________________________
   b. ________________________
   c. ________________________
   d. ________________________
   e. ________________________
   f. ________________________

10) Explain the difference between an adult and a child in regards to pedestrian vs vehicle accidents.

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