Trauma Systems and Mechanism of Injury: 1

UNIT TERMINAL OBJECTIVE

4-1 At the completion of this unit, the EMT-Critical Care Technician student will be able to apply the principles of kinematics to enhance the patient assessment and predict the likelihood of injuries based on the patient's mechanism of injury.

COGNITIVE OBJECTIVES

At the completion of this unit, the EMT-Critical Care Technician student will be able to:

- 4-1.1 List and describe the components of a comprehensive trauma system. (C-1)
- 4-1.2 Describe the role of and differences between levels of trauma centers. (C-3)
- 4-1.3 Describe the criteria for transport to a trauma center. (C-1)
- 4-1.4 Describe the criteria and procedure for air medical transport. (C-1)
- 4-1.5 Define energy and force (kinetics) as they relate to trauma. (C-1)
- 4-1.6 Define laws of motion and energy and understand the role that increased speed has on injuries. (C-1)
- 4-1.7 Describe each type of impact and its effect on unrestrained victims (e.g., frontal impacts, lateral impacts, rear impacts, rotational impacts, rollover). (C-1)
- 4-1.8 Describe the pathophysiology of the head, spine, thorax, and abdomen that results from the above forces. (C-1)
- 4-1.9 Describe the organ collisions that occur in blunt trauma and vehicular collisions. (C-2)
- 4-1.10 Describe the effects that restraint systems (including seat belts, airbags, and child safety seats) have on the injury patterns found in motor vehicle crashes. (C-2)
- 4-1.11 List specific injuries and their causes as related to interior and exterior vehicle damage. (C-1)
- 4-1.12 Describe the kinematics of penetrating injuries. (C-1)
- 4-1.13 List the motion and energy considerations of mechanisms other than motor vehicle crashes. (C-1)
- 4-1.14 Define the role of kinematics as an additional tool for patient assessment. (C-1)
- 4-1.15 List seven types of accidents that can cause spinal injury. (C-1)
- 4-1.16 Describe the sign that an injury has been sustained between the 5th and 7th cervical vertebrae and the importance of the phrenic nerve in C3 to C5 injuries. (C-1)

AFFECTIVE OBJECTIVES

None identified for this unit.

PSYCHOMOTOR OBJECTIVES

None identified for this unit.

DECLARATIVE

l	Introduction	۱
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- A. Epidemiology
 - 1. A leading cause of death for people 1- 44 years of age
 - 2. 140,000 unexpected deaths per year
 - 3. Automobile related deaths are greater than 40,000
 - 4. Penetrating trauma may exceed blunt in near future
 - 5. Pre-incident, incident, post-incident phase
- B. History
 - 1. Complete and accurate history of incident will identify possibility for 95% of the injuries present
 - 2. Incident site
 - a. Indications of severity of injury
 - 3. Major factors of tissue injury
 - 4. Amount of energy exchanged
 - 5. Anatomical structures potentially involved

II. Trauma systems

- A. Components
 - 1. Injury prevention
 - 2. Prehospital care
 - a. Treatment
 - b. Transportation
 - c. Trauma triage guidelines
 - 3. Emergency Department care
 - 4. Interfacility transportation as necessary
 - 5. Definitive care
 - 6. Trauma critical care
 - 7. Rehabilitation
 - 8. Data collection/ trauma registry
- B. Trauma centers
 - 1. Levels
 - 2. Qualifications
 - a. Essential
 - b. Desired
 - 3. Role
- C. Transport considerations
 - 1. Level of receiving facility
 - 2. Mode of transport
 - a. Ground (Refer to Regional Protocols)
 - (1) If appropriate facility can be reached within reasonable time
 - (2) To a more accessible landing zone for air medical transport
 - b. Air medical (Refer to Regional Protocols)
 - (1) Indications
 - (2) Contraindications

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(3) Procedure

III. Energy

- A. Physical laws
 - Newton's first law of motion
 - a. A body at rest or a body in motion will remain in that state until acted upon by an outside force
 - b. In a vehicle traveling at 50 mph, the occupant is also traveling at 50 mph
 - c. When the car stops, the occupant continues to travel at 50 mph until some force acts on the occupant
 - 2. Conservation of energy
 - a. Energy cannot be created nor destroyed
 - b. It can be changed in form
 - c. Energy can be absorbed producing deformation of substance
 - 3. Kinetic energy (KE)
 - a. KE = Mass of the object multiplied by the velocity (speed) of the object squared divided by 2 (Mass X Velocity²)/2
 - b. Velocity (V) influences KE more than mass
 - c. Greater speed means more energy generated
 - 4. Force
 - a. Force = mass x acceleration
 - b. Force = mass x deceleration
 - c. Mass x acceleration = force = mass x deceleration
 - d. To accelerate a bullet from the muzzle of a weapon requires the force from the explosion of the gunpowder; once the bullet is set in motion by this explosion, an equal amount of tissue destruction must occur inside the body to stop it as was used to start it
 - 5. Energy law summary
 - a. Motion is created by force (energy exchange)
 - b. Force (energy exchange) must stop this motion
 - c. If such energy exchange occurs inside the body tissue damage is produced
- B. Energy exchange
 - Cavitation
 - a. Energy exchange produces particle motion
 - b. Temporary cavity
 - (1) Short lived
 - (2) Produced by stretching
 - (3) Dependent on the elasticity of the object involved
 - (4) Produces particle compression at the limits of the cavity
 - c. Permanent cavity
 - (1) Visible when the energy exchange has been completed
 - (2) Produced by compression and destruction
 - 2. Interaction between two bodies
 - a. At least one must be in motion
 - b. Both can be in motion
 - 3. Dependent on number of particles involved in the interface of the interaction

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W4444444444444444444444444444444444444	14444444444444444	14444444444444444444444444444444444444
	a.	Density of the interacting bodies (1) Air density (few particles) (a) Lung (b) Intestinal tract (2) Water density (more particles) (a) Vascular system (b) Liver (c) Spleen
		(d) Muscle (3) Solid density (thick particles) (a) Bone (b) Asphalt (c) Steel
	b.	Area on interaction (1) Shape of object (2) Position of object (3) Fragmentation of object
C. T		a based on ingress
	a. b. c.	Tissue not penetrated Cavitation away from site of impact Cavitation in direction of impact
2	. Penetra a. b.	
IV. Blunt trau A. V 1 2 3 4 5	fehicle collision Frontal Lateral Rear Rotatio	nal
	Occupant collis	

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			(3)	Torso ro	otates	
				(a)	Steeri	ng column
				(b)	Dash	
				(c)	Winds	shield
		b.	Up and	d over		
			(1)	Head in	npact	
				(a)	Winds	shield
				(b)	Roof	
				(c)	Mirror	
			(2)	Chest in	mpact	
				(a)		ng column
				(b)	Dash	
			(3)	Abdomi	inal imp	pact
				(a)	Steeri	ng column
				(b)	Dash	
	2.	Latera	l impacts			
		a.			into an	d impacts body
			(1)	Chest		
			(2)	Pelvis		
			(3)	Body m		aterally
				(a)	Neck	Datata
					i)	Rotates
					ii) :::\	Lateral flexion
	3.	Doorie	mnosto		iii)	Combination
	ა.		npacts	e seat pu	chac h	ody
		a.	(1)			in contact with seat move
			(2)	-	•	t in contact with seat move
		b.	` '			ehicle hits another object
		ъ.	(1)			tal impact
	4.	Rotatio	onal imp		10 110111	tai iiipaot
	••	a.	•		stops: t	he rest remains in motion
		b.				and lateral impacts
	5.	Roll ov				
	_	a.	Difficul	t to predi	ct the b	oody impacts
C.	Organ	collision				, , , , , , , , , , , , , , , , , , , ,
	1.			ijury from	blunt t	trauma
		a.	Compr			
		b.	Chang	e in veloc	city	
			(1)	Acceler		
			` '	(a)	Shear	
				(b)	Avulsi	on
			(2)	Deceler	ation	
				(a)	Shear	
				(b)	Avulsi	
	2.	Organ	collision	s with dif	ferent	vehicular collisions

Adapted from the United States Department of Transportation

	a.	Frontal (1)	impacts Head			
		(1)	(a)	Compre i) ii)	Skull fra	actures al contusion
			(b)	Deceler i) ii)	ration Opposit Hemorr	te end separation hage
		(2)	Neck	iii)	Brain st	em stretch
		(2)	(a)	Compre i)	ession Vertebr a) b)	Compression fracture Hyperextension injury - Posterior element compression - Anterior body separation Hyperflexion injury - Anterior body compression
	(0)		(b)	Shear		- Posterior element separation
			i) Not significant			
		(3) Thorax (a)	Chest wi)	vall Compre a)	ession Fracture rib(s) - producing single rib fractures, flail chest, and/ or pneumothorax	
				ii)	Shear a)	Fracture thoracic spine
			(b)	Heart	•	·
				i)	Compre a) b)	ession Contusion Rupture
				ii)	Shear a)	Not significant
			(c)	Aorta	•	_
				i)	Compre a)	ession Not significant
				ii)	Shear a)	Junction arch and descending portions
					b) c)	Aortic origin at the aortic valve At the diaphragm
			(d)	Lung	<i>U)</i>	At the diaphragin
			\-/	i)	Compre a)	Pneumothorax
				ii)	b) Shear	Rib fracture and penetration

a)

(4)	Abdom	en	,	- Total Grand Control of the Control
()	(a)		inal cavi	ity
	()	i)	Diaphra	•
		,	a)	Compression tears
			b)	Shear - not significant
		ii)	,	inal wall
		,	a)	Compression tears
			b)	Shear - not significant
	(b)	Liver	-,	
	()	i)	Compre	ession
		-,	a)	Burst type injuries
		ii)	Shear	Dailot typo mjamoo
		,	a)	Tears from Ligamentum Teres
			b)	Avulsion of liver from inferior vena cava at the
			D)	hepatic veins
	(c)	Spleen		nepatic veins
	(0)	i)	Compre	ession
		1)	a)	Burst
		ii)	Shear	Durst
		11)		Avulsion of nodiclo
	(4)	Control	a) ntestine	Avulsion of pedicle
	(d)			
		i)	Compr	
		::\	a) Shear	Rupture
		ii)		Availation of managements via special from power or
			a)	Avulsion of mesenteric vessels from aorta or
			b \	vena cava
			b)	Tears along mesenteric vessels
	(-)	0-11-1-	c)	Avulsion of vessels from intestine
	(e)	Gall bla		
		i)	Compr	
			a)	Rupture
		ii)	Shear	
			a)	Avulsion from liver
			b)	Avulsion of cystic duct
b. Lateral				
(1)	Head	_	_	
	(a)	Compre		
		i)		to frontal except lateral and compression is on
			the side	e of the impact to the vehicle
	(b)	Shear		
		i)	Shear	of brain and vessels opposite side of the impact
(2)	Cervica			
	(a)	Compre		
		i)		Il unless head hits the top of the passenger
			compa	rtment or the support for the windows
C)))))))))))))))))))))))))	,,,,,,,,	,,,,,,,,	,,,,,,,,	
<i></i>	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	,,,,,,,,,	111111111111111111111111111111111111111

Not significant

(b)	Shear
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- i) Two fold mechanism
- ii) Rotation
 - a) Center of gravity of the head is anterior to the pivot point of the head and the spine at the odontoid process; as lateral impact occurs the torso and then the C-spine are pushed under the head; the head rotates in relative position to the body, toward the impact
 - b) The center of gravity of the head is also cephalad to the point of support at the cervical spine; as the lateral forces push the torso away from the point of impact the motion of the head produces lateral flexion of the head
 - c) The combination of these two forces is lateral flexion of the neck opening the facets opposite the side of impact and rotation of the vertebral bodies in relation to each other; the result is jumped facets and if the force is great enough significant torsion of the spinal cord

(3) Thorax

- (a) Compression
 - i) Impact of the door into the thorax
 - Lateral ribs Fractures and flail chest
 - b) Lung Pneumothorax
 - c) Spleen or liver Lacerations and hemorrhage
- (b) Shear
 - i) Lateral motion of the thoracic spine as the torso is pushed away from the impact
 - ii) Thoracic aorta moves with the spine
 - iii) Arch and heart do not move until traction on the arch
 - iv) Shear forces tear the aorta at the junction of the movable arch and the descending aorta that is attached to the thoracic spine
- (4) Abdomen
 - (a) Compression
 - i) Liver or spleen depending of the side of the impact
 - ii) Kidneys depending of the side of the impact
 - iii) Diaphragm similar to frontal impact
 - (b) Shear
 - i) Abdominal aorta moves with the lumbar spine
 - a) Shear of the renal vessels
 - b) Shear of the splenic vessels
- (5) Pelvis
 - (a) Compression
 - i) Impact on the femur

	(6)	(b) Extrem	Shear	a) b) c) d)	Femoral head driven through the acetabulum Fracture of the ileum Sacro-iliac joint fracture Fracture of the other bones of the pelvis			
	(6)	(a)	Compre i) ii)	ession Clavicle compressed between the humerus and the sternum Lateral compression of the humerus				
C.	Rear im	•	Shear					
	(1)	Physics (a)		Moves Occupa Parts o until pu a) b) The for- different	w) imparted to the rear all attached parts of the vehicle ants in direct contact with vehicle move also if the occupants not in direct contact do not move led along Newton's first law of motion Unrestricted body parts will be separated or at least stretched by this differential velocity are of the energy exchange depends on the tial energy of the two vehicles and the exchange gy between the two			
	(2)	Head (a)	Compre i) ii)	ession Into stru Energy	uctures behind the seat of compression depends on the force of the of energy between the vehicle and the impact			
		(b)	Shear i)		tion of the brain and skull in front			
	(3) Neck (a) C	Compre i)	ession Unrestr	ained occupant into the top of the passenger tment or into the rear seat				
		(b)	Shear i) ii)	head for Neck hy restrain	estraint not in the correct position to move the rward with the motion of the vehicle perextended over the malpositioned head t; usually only ligamentous and tendon stretch fractures			
	(4)	Torso (a)		t of the t	orso is in contact with the seat and springs of ninimal differential energy is exchanged onto the			

- (b) Unless there is rebound when the vehicle hits another vehicle there is little injury to the torso
- (5) Extremities
 - (a) The extremities move with the torso and receive very little differential exchange
- d. Rotational impacts
 - (1) In the pure rotational impact, one part of the vehicle hits an immovable object, while the rest continues in motion (Newton's first law of motion)
 - (2) As the one part stops and the rest of the vehicle continues to move the vehicle moves around the fixed point
 - (3) The motion to the occupant is a combination of two motions
 - (a) Frontal and lateral
 - (b) Rear and lateral
 - (4) The injuries are combinations of the two motions with emphasis on the initial impact motion
- e. Roll overs
 - (1) Pattern of injuries is very difficult as the unrestrained occupant can hit all parts of the vehicle
- f. Ejections
 - (1) If the force is such and the occupant is unrestrained, then ejection is possible
 - (2) The major injuries occur inside the vehicle and on the way out rather than afterward on impact with the ground or some other object
 - (3) Since the major part of the injuries occur on the way out, the EMT-Critical Care Technician can better predict the injuries by focusing on the first part of the collision rather than the latter portion
- D. Restraints
 - Restraints are systems for absorbing the energy of the impact before the occupant hits something hard and limiting the distance the body has to travel, thus helping to decrease velocity (speed)
 - 2. Belt restraint
 - a. Contrary to popular belief the belt restraint works in lateral impacts as well as in frontal impacts (they are not quite as effective in lateral impacts because the hard parts of the passenger compartment are closer on the sides than in the front, therefore the belt systems do not have as much distance to be effective)
 - b. The benefit of the belt restraint can be seen on any Sunday at the automobile race track
 - c. Lap belts
 - (1) Attached to the floor behind the occupant at a 45° angle to the floor
 - (2) Benefits
 - (a) Hold the lower torso closely to the seat and away from the dash or steering column
 - (b) Prevent
 - i) Forward motion of the lower torso in frontal collisions
 - ii) Moves the torso with the vehicle and away from the impact in lateral impact collisions

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- iii) Multiple impacts in rollover collisions
- iv) Ejection
- v) Forward motion of the pelvis by supporting the anterior part of the pelvis
- (c) No impingement on the soft intra-abdominal contents
- (3) Limitations
 - (a) Upper torso is not supported
 - (b) If positioned above the anterior iliac spine, the belt stops the forward motion of the body against the lumbar spine with the intra-abdominal organs crushed between the belt and the spine
 - (c) High position can fracture or dislocate the lumbar spine
 - (d) Increased intra-abdominal pressure can rupture the diaphragm
- d. Shoulder restraints
 - (1) Benefits
 - (a) Prevent
 - Forward motion of the upper torso in frontal impact collisions
 - ii) Hyperflexion of the upper torso around the lap belts preventing spinal injuries
 - (b) Moves the upper torso with the vehicle in lateral impact collisions
 - (2) Limitations
 - (a) If worn without the lap belt, neck injuries can occur
 - (b) Lessened benefit if the seat is very close to the dash or steering column
- e. Air bags
 - (1) Benefits
 - (a) Supplemental protection
 - (b) Frontal impact protection only with frontal bags
 - (2) Limitations
 - (a) Minimally effective alone
 - (b) Can produce significant injuries if too close to the occupant
 - i) Bag expansion
 - ii) Protective cover into the face or chest
 - (c) Projects standing children into the seat producing cervical spine fractures
 - (d) Facial and forearm abrasions
 - (e) Deployed air bag may hide structural damage to the vehicle that may aid in assessment
- f. Child safety seats
 - (1) Age and types
 - (2) Proper use
 - (3) Injury patterns
 - (4) Proper use with airbags
- E. Motorcycle collisions
 - 1. Frontal impact

	a. b.	Bike st Occupa (1)	ant continuents (a) (b) (c) (d)	s parts of Face Chest Abdom Upper I I over th Into vel Onto gi	of the bike nen legs (femur) ne bike shicle
		(3)	Injuries (a) (b)	Cervica Torso i)	Compression injuries a) Solid organ crush b) Hollow organ rupture (e.g., lungs) Deceleration (shear injuries) a) Aorta b) Pedicled organs
2	Angula	r impost	(c)	Compo	ound tibia/ fibula fractures
2.	•	r impact			abiala.
	a. b. c.	(1) (2)	Open fr motion o	apped because a spine Similar Compressi) Decele i)	petween bike and vehicle and/ or dislocation into vehicle r to lateral impact in vehicle ression Lateral chest Lateral abdomen eration Aorta
3.	Protect a. b.	tion Head (1) Skin (1) (2)	Helmet (a) (b) Leather	300% ii Spine i) ii)	Pedicled organs increase in brain injury without helmet Small protection No increase e during slides on asphalt
		(-)	, ף		<u> </u>

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		c.		s and fee	
_	Dada	. 4	(1)		boots
F.		strian ve			
	1.			depends	s on
		a.	Heigh		
	0	b.		area tac	ing impact
	2.		phases		trion inches
		a.			strian impact
			(1)	Legs	Fact stay in place on conholt
				(a)	Feet stay in place on asphalt
				(b)	Legs pushed by bumper
			(2)	(c)	Torso moves after the legs
			(2)	Torso	Pelvis
				(a)	
				(b)	Crushed by front of vehicle
				(c)	Lateral or posterior angulation i) Lumbar fractures
					i) Lumbar fractures ii) Thoracic fractures
		b.	Dodos	strian rot	ates onto hood
		D.			t onto torso
			(1)		
				(a) (b)	Compression injuries Acceleration (shear) injures
			(2)		cal spine
			(2)	(a)	Severe flexion or lateral flexion
				(b)	Torsion
				(c)	Fractures and dislocations
		C.	Dodos	` '	Is off onto the ground (asphalt)
		U.	(1)		e vehicle
			(1)	(a)	Impact into the ground as fall from height
			(2)		nt of vehicle
			(2)	(a)	Run over by the vehicle
				(b)	Dragged by the vehicle
G.	Falls			(6)	Dragged by the vernele
О.	1.	Factor	'S		
	••	a.	_	t of fall	
		b.		ce of the	impact
		C.			during the fall
		d.			rst impact
	2.	Feet fi		, , , , , , , , , , , , , , , , , , , ,	
		a.		t onto ca	alcaneus
		b.			tion of the torso
			(1)		s, knees, femur
			(2)		bulum, pelvis
			(3)	Spine	, Ferrie

 $S_{1}, S_{1}, S_{2}, S_{3}, S_{4}, S_{5}, S_{5},$

Break the "S"

Arch

(a) (b)

			(4)	Torso	i) ii)	Convexity stretched and opened Concavity compressed
			(4)	(a)	Decele i) ii) iii) iv)	ration (shear) Liver Kidney Spleen Aorta
	3.	Head fi a. b.	(1) (2) (3) Deceler (1) (2)	ession Skull fra Brain (a) (b) Spine ration (s Aorta Kidney Other	Contus Lacerat	
	4.	Paralle	(3) I to grou			
		a.	Compre (1)	ession	s of the	impact
/ .	Penetrating	g injuries				
	A. En	ergy exchan				
	1.	Numbe a.	r of parti Density (1) (2)	icles involved for the second control of the	e Lung	
		b.		(a) interact	ation of	bullet
	2.	Cavitat a.		_		
			2			

(1)	Visible when examined
(2)	Crushed tissue

- (2) Crushed t
- b. Temporary
 - (1) Compression wave of tissue particles
 - (2) Away from the pathway of the bullet
 - (3) Lasts only a few microseconds
 - (4) Tissue damage produced by stretch
- 3. Available energy
 - a. $KE = M/2 \times V^2$
 - (1) Velocity more important than the mass
 - b. Mass x acceleration = force = mass x deceleration
 - The energy used to place the mass in motion must be completely exchanged into the body tissues to stop the mass
 - c. Energy potential
 - (1) Continuum of energy increase
 - (2) Can be broken down into artificial but workable groups
 - (3) Energy
 - (a) Low energy objects
 - i) Hand driven
 - a) Knife
 - b) Ice pick
 - c) Ax
 - d) Other
 - ii) Minimal cavitation
 - iii) Damage only by cutting edge
 - (b) Medium energy
 - i) Muzzle velocity greater than 1500 feet/ second
 - ii) Hand guns, low power rifle
 - iii) Small projectile
 - iv) Cavitation 6-10 times bullet frontal area
 - (c) High energy
 - i) Muzzle velocity less than 1500 feet/ second
 - ii) Military high velocity small caliber weapons
 - a) Examples (M16, AK 47/74)
 - b) Other
 - iii) Cavitation 20-30 times frontal area of missile
 - (d) Implications of soft body armor
- B. Anatomy
 - 1. Organs injured
 - 2. Pathway of missile
 - a. Entrance wound
 - (1) Hole is crushed inward
 - (2) Round or oval shaped
 - (3)
- (a) Dark

Rim

(b) 1-2 mm width

- (c) Produced by grease and other substance on the bullet
- (4) Abrasion
 - Produced by spinning of the bullet (a)
 - Largest with greatest contact of skin (b)
 - Larger when impact is at an angle
- (5) Burn
 - Flame from barrel (a)
 - (b) End of weapon 4-6 inches from the skin
- b. Exit wound
 - (1) Pushed outward
 - (2) Stellate or slit

VI. Blast

- Α. Introduction
 - 1. The blast effect is broken down into three phases depending on the type of force that occurs during that phase
 - 2. Each phase has a different energy pattern
- B. **Phases**
 - 1. Primary
 - Pressure wave of the blast a.
 - Major effect on gas-containing organs (1)
 - (a) Organ systems
 - Lungs i) ii)
 - Intestinal tract
 - (b) Pathology
 - Rupture of the organ
 - (c) Air emboli
 - b. Heat wave
 - Burns on unprotected part of body (1)
 - (2) Skin burns
 - (3) Eye burns
 - 2. Secondary
 - Struck by flying particles a.
 - Glass (1)
 - (2)Bricks
 - (3)Wood
 - (4) Metal
 - Pathology b.
 - (1) Compression
 - (2)Lacerations
 - 3. **Tertiary**
 - Patient becomes flying object a.
 - Impact into other objects (1)
 - (2) Similar to falls

VII. Causes of spinal trauma.

Motor vehicle accidents. Α.

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Adapted from the United States Department of Transportation

- 1. Most common cause of para/quadriplegia.
- 2. <u>Deceleration causes flexion and extension injuries, particularly of the cervical spine.</u>
- 3. Assume a spine injury until disproven by x-ray.
- 4. Cost of x-ray series is cheap compared to the cost of the injury. Experts say that a paraplegic costs over one million dollars in the first year alone. This does not include the pain and suffering to the patient and his or her family.

B. Falls from heights.

- 1. does not have to be from an extreme height. Three times your body's height equals a probable spinal injury. Compound fractured ankles from a fall from a height equals a possible spinal injury.
- 2. Injury determined by height and manner of impact.
- 3. Maintain suspicion of thoracic aortic injury.
- 4. Death rate increases markedly with age.

EMT-Intermediate: National Standard Curriculum Division 4-1 Page 17

- C. Athletic competition.
 - 1. Cervical injuries are the number one cause of football fatalities primarily due to spear tackling and using the head to spear one's opponent.
 - 2. Other sports can obviously cause spinal injuries also, ie: surfing, wrestling, rock climbing, gymnastics, parachuting, hang gliding, trampoline, etc...
- D. Diving accidents.
 - 1. Often cause a high cervical flexion injury from breaking water or striking a solid shallow bottom.
 - 2. May result in drowning. Stabilize the neck during water rescue. Chicago study showed 50% of water related spinal transections said they could swim to the surface. We are very buoyant in water. Board them in the pool, don't just pull patients out of the water if you can't swim!
- E. Penetrating trauma.
 - 1. <u>Direct transection by gun or knife.</u>
 - 2. Damage due to cavitation of the projectile.
- F. Electrical shock.
 - 1. <u>Direct injury.</u>
 - 2. Associated violent muscle spasms.
- G. Sudden twist.
 - 1. Particularly in patients with previous intervertebral disc disease.
 - 2. Suspect whenever there is a sudden onset of severe back pain with no associated trauma, but also consider a dissecting aortic anurisim.

VIII. Special assessment considerations.

- A. The phrenic nerve at C-3, C-4 and C-5 innervates the diaphragm thus controlling respirations. Transection above or in this area causes respiratory arrest.
- B. <u>Injuries between C-5 and T-1 cause diaphragmatic breathing due to intercostal muscles being paralyzed.</u>
- C. Hypothermia has a higher incidence because of the loss of thermoregulatory mechanisms. the messages just do not make it up and down the cord. The sympathetic nervous system utilizes the peripheral nerves of the thoracic spine.
- D. Specific injuries that can occur are a bruise, compression, laceration or transection.
 Actually, we probably will not know if it's a complete transection with a grim prognosis or a compression that can be treated, thus we immobilize them all.