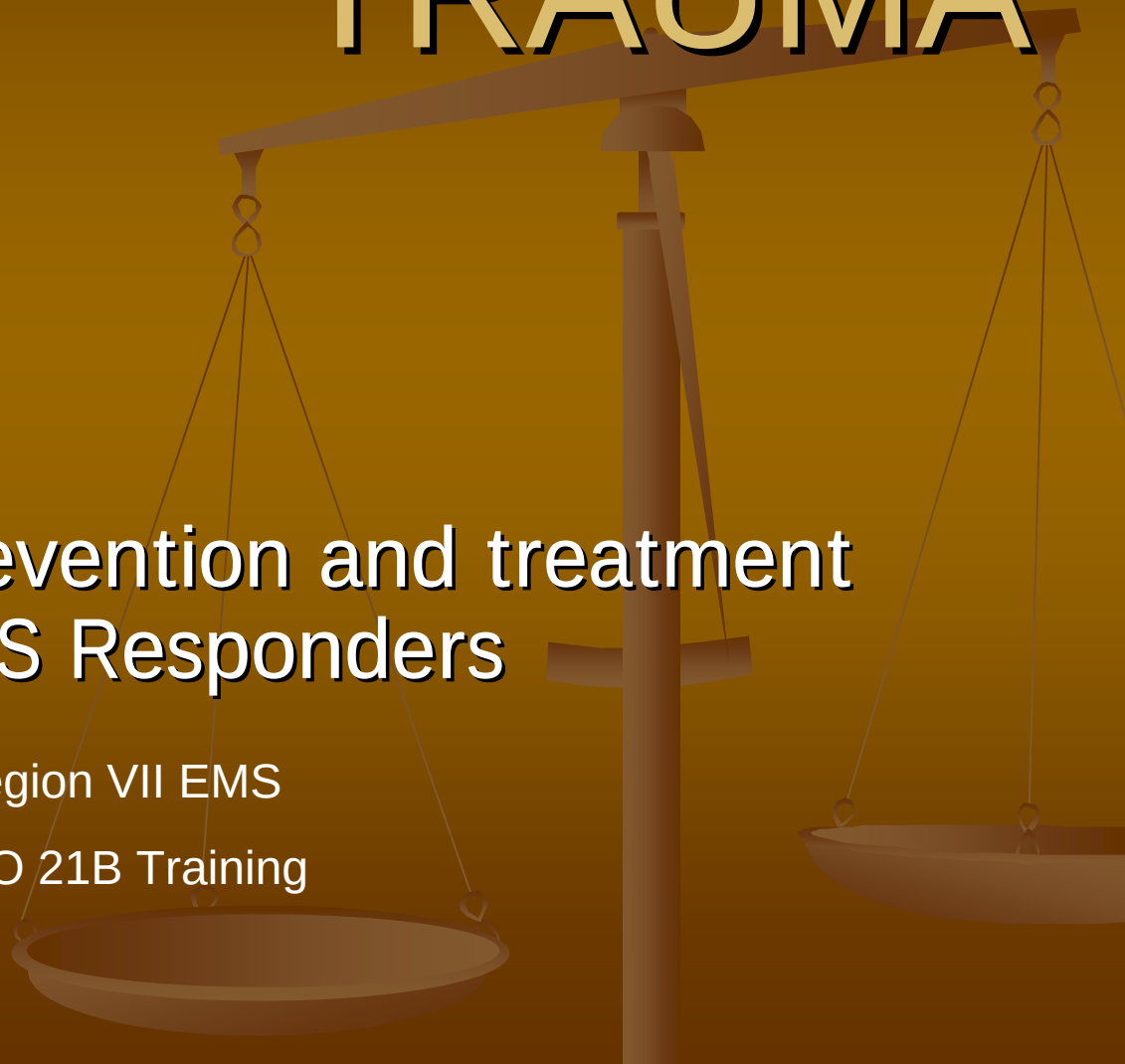
SUSPENSION TRAUMA

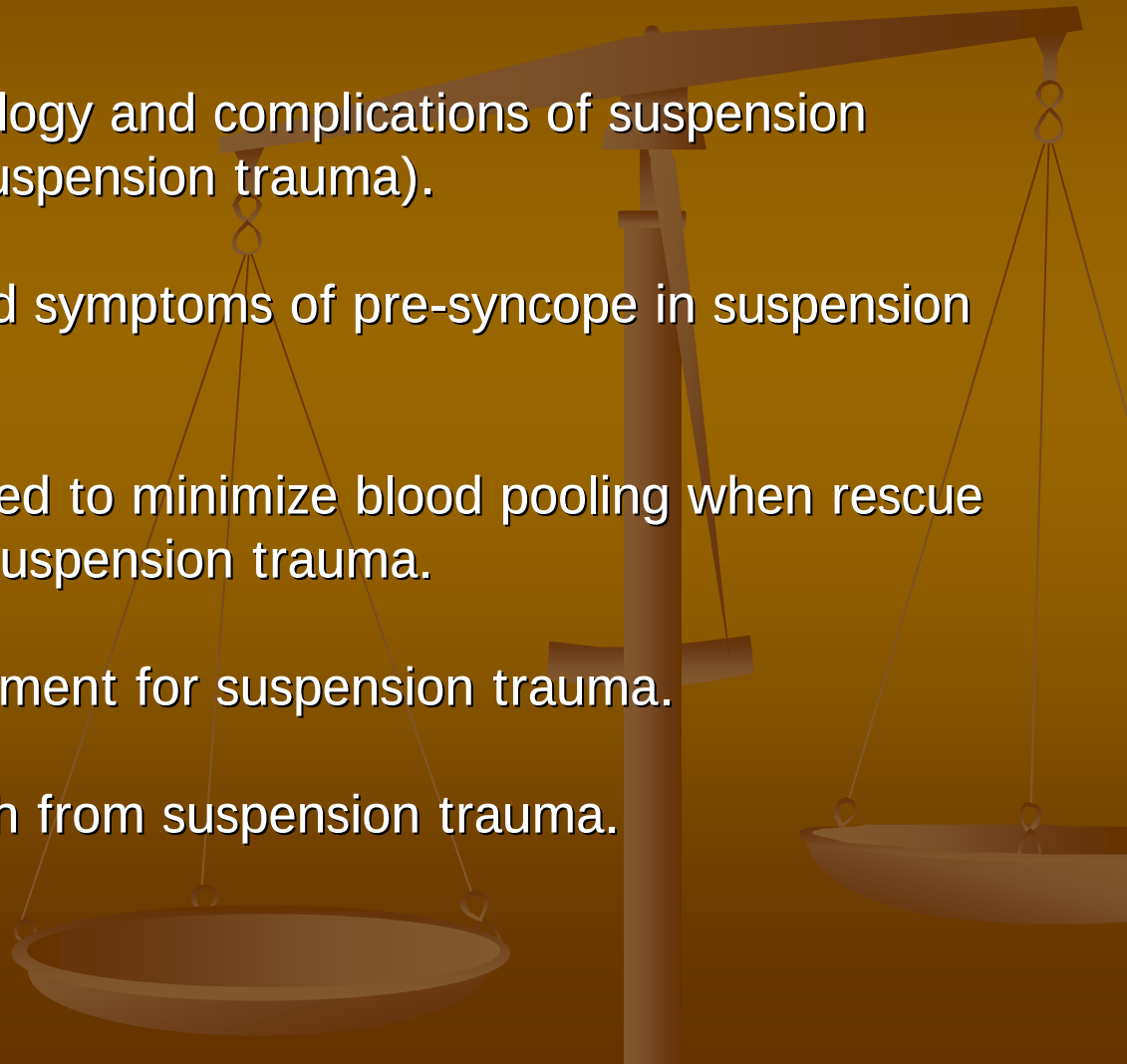


Recognition, prevention and treatment for EMS Responders

Region VII EMS

SMO 21B Training

Learning Objectives



Describe the pathophysiology and complications of suspension trauma syndrome (i.e., suspension trauma).

List the warning signs and symptoms of pre-syncope in suspension trauma victims.

Describe interventions used to minimize blood pooling when rescue is delayed for victims of suspension trauma.

Discuss pre-hospital treatment for suspension trauma.

List those at risk for death from suspension trauma.

Glossary Terms

- **Fall Arrest Systems:** A series of equipment components designed to stop the fall of individuals elevated in the air. It is an OSHA requirement when workers are exposed to vertical drops of 6 feet or more.
- **Orthostatic Hypotension:** In suspension trauma, this refers to the pooling of blood in leg veins that occurs when individuals caught in harnesses, confined spaces, ropes, etc., are forced to hang vertically with legs relaxed.
- **Reflow Syndrome:** The return of pooled, hypoxic blood and its metabolic byproducts from the extremities to the heart.
- **Rescue Death:** When related to suspension trauma, this type of death occurs in patients who appear physiologically stable during the rescue and extrication but suddenly die after being freed.
- **Suspension Trauma:** Injuries sustained from being immobilized in a vertical position when the legs are relaxed. Injuries include hypoxia; syncope; hypoxemia; acidosis; ventricular fibrillation; myocardial infarction; damage to the liver, kidneys and brain; and possibly death.
- **Suspension Syndrome:** The condition in which a suspended person becomes unconscious due to orthostasis without traumatic injury.
- **Suspension Trauma Syndrome:** Previous terminology for suspension syndrome.
- **Syncope:** A sudden loss of consciousness due to a rapid drop in blood pressure.

Suspension trauma

- *(Syn. "orthostatic shock while suspended")*, also known as **harness hang syndrome (HHS)**, or **orthostatic incompetence** is an effect which occurs when the human body is held upright without any movement for a period of time. If the person is strapped into a harness or tied to an upright object they will eventually suffer syncopal episodes. If one faints but remains vertical, one risks death due to one's brain not receiving the oxygen it requires. People at risk of suspension trauma include people using industrial harnesses (fall arrest systems, confined space systems), people using harnesses for sporting purposes (caving, climbing, parachuting, etc), stunt performers, circus performers, and so on. Suspension shock can also occur in medical environments, for similar reasons.

Introduction

- Suspension Trauma
  - The medical effects of immobilization in a vertical position
  - Medical term is ‘Orthostatic Incompetence’
- The effects are nothing new
  - Crucifixion is death from suspension trauma
- It presents an immediate threat of death to anyone immobilized in a vertical position
  - Hanging still in an industrial, theatrical or sport harness
  - Stretcher patients, performers, stuntmen, confined space workers
- The onset and progress are rapid and unpredictable
- All those ‘working at height’ must be trained in how to recognize, manage and prevent suspension trauma

Immobile is important!

- Suspension trauma can only affect someone who is immobile – specifically not using their leg muscles to any great extent
- It does not normally affect people who wear a harness who are:
  - Actively moving about (climbing, caving, etc)
  - Suspended for only a minute or two (parachutists)

- The danger is when someone is unable to move FOR AS LITTLE AS 4 MINUTES!

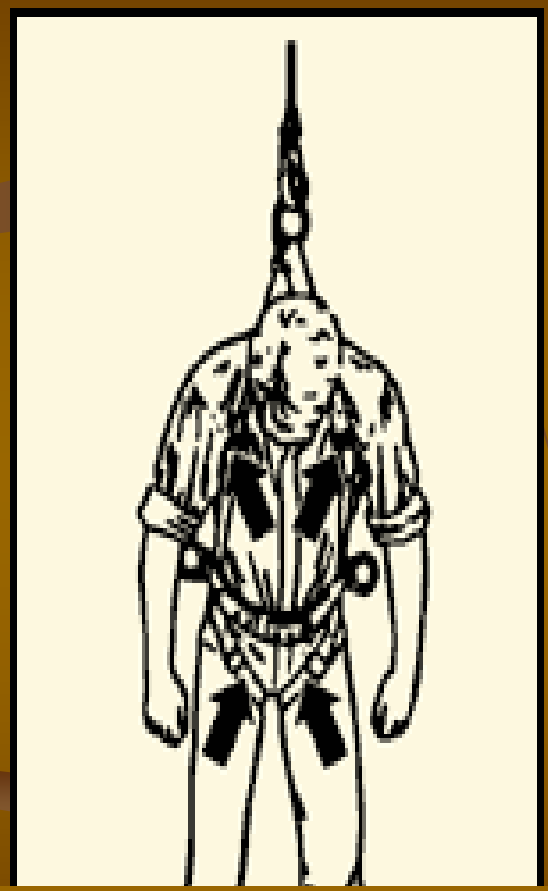
Who may be at risk?

- The ‘classic group’ are people who wear harnesses
  - Sport climbers, cavers, parachutists, etc
  - Industrial workers, high angle work, windmill work
  - Confined space workers lowered using a harness and winch
  - Theatrical and circus performers, stuntmen and artists

- There are other ways to be ‘immobilized’
  - Personal pursuits involving bondage or confinement
  - Becoming stuck in a confined space

So what happens?

- General feelings of unease
  - Dizzy, sweaty and other signs of shock
  - Increased pulse and breathing rates
- Then a sudden drop in pulse & BP
- Instant loss of consciousness
- If not rescued, **death is certain**
  - From suffocation due to a closed airway, or from lack of blood flow and oxygen to the brain.



Excess pressure here can cut blood flow to the legs

A little biology…

- Humans are not designed to stand upright
  - Our circulatory system was built for life on all fours
  - Volume of blood vessels is much greater than that of the blood

- So, when we stand upright we have a problem
  - Gravity pulls your blood into your legs
  - Your heart is a positive-pressure pump – it cannot suck!
  - The only way to get the blood back out of the legs is to pump it using another method.

Muscular pumps

- The veins in your legs are entwined within the skeletal muscles, and when you move your legs, these muscles squeeze the veins, pushing the blood out of the way
- We have one-way valves in these veins, so each squeeze can pump the blood a short distance towards the heart
- Providing you are walking around, this process makes a ‘heart in each leg’ – and it’s very effective!
  - Try it – take your socks off and stand still – look at your feet and you’ll see the veins all standing out and the skin red.
  - Now walk around in a little circle and look again – the veins are empty and flat, and the skin goes pale. Pumping in action!

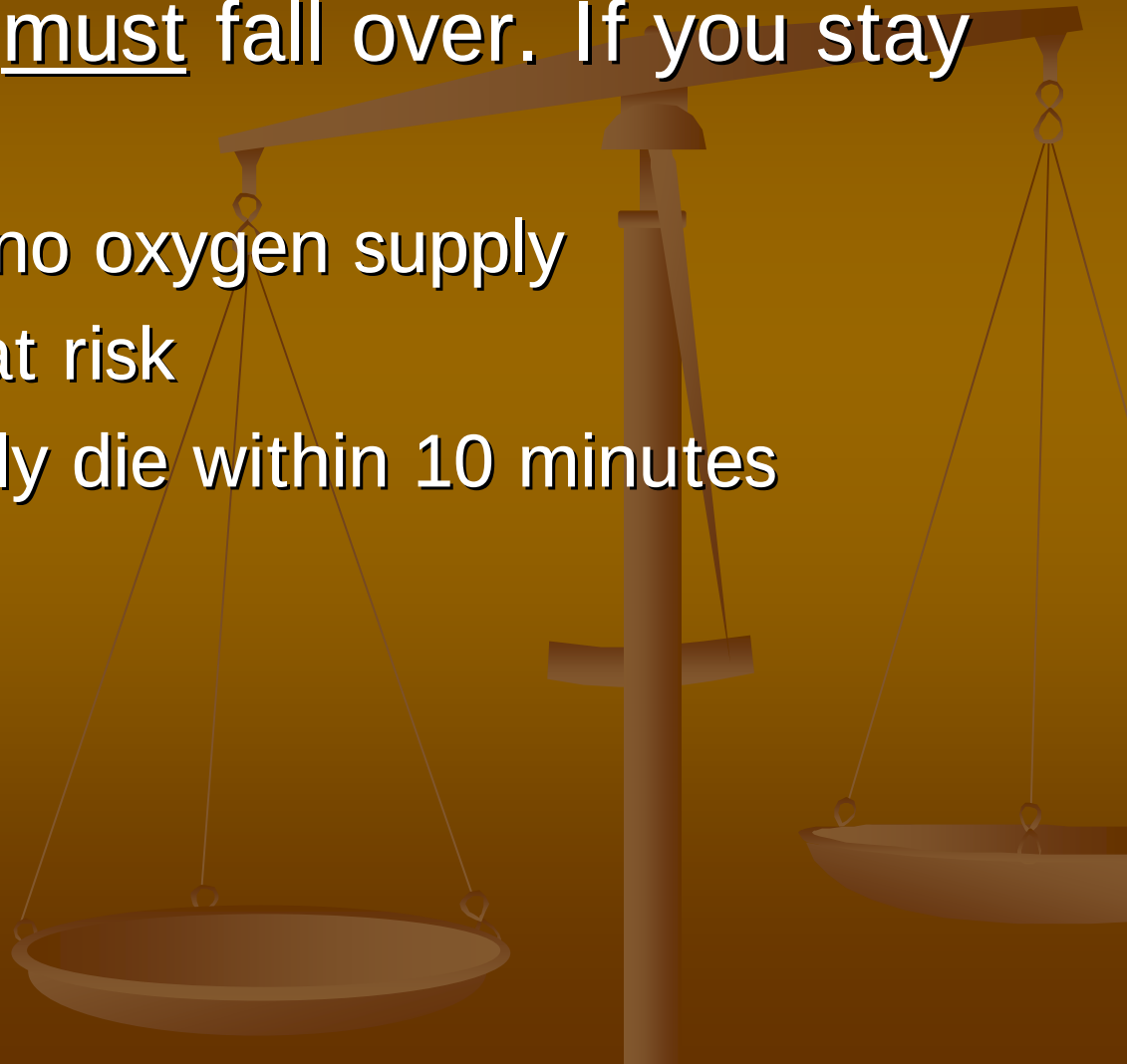
But what if we're not pumping?

- If the muscles are not pumping the blood upwards, it pools in your legs
  - You can 'lose' several pints and go into shock
- Your brain tries 'shock' for a while, but of course it doesn't help – blood is still stuck in your legs.
- After a few minutes, it goes for the last-ditch method

If I faint, I fall over. I get the blood back.

Syncopal Response

- It assumes you must fall over. If you stay upright:
  - Your brain has no oxygen supply
  - Your airway is at risk
  - You will probably die within 10 minutes

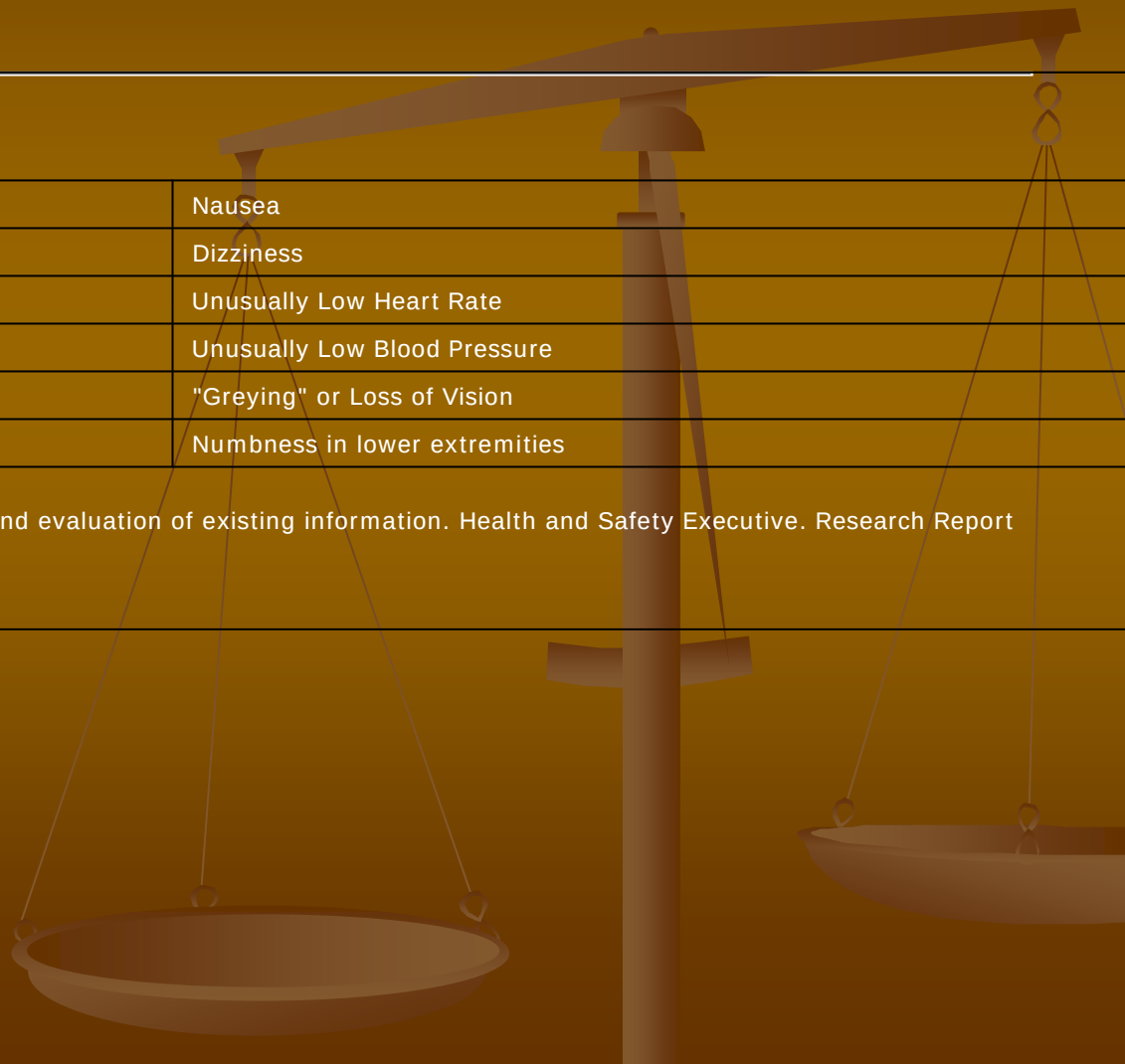


Signs & symptoms that may be observed in an individual who is approaching orthostatic intolerance:

Faintness	Nausea
Breathlessness	Dizziness
Sweating	Unusually Low Heart Rate
Paleness	Unusually Low Blood Pressure
Hot Flashes	"Greying" or Loss of Vision
Increased Heart Rate	Numbness in lower extremities

References: Seddon, Paul. Harness Suspension: review and evaluation of existing information. Health and Safety Executive. Research Report 451/2002. 104 pp.

Sheehan, Alan. Suspension Trauma. Training handout.



Factors that can affect the degree of risk of suspension trauma:

Inability to move legs	Hypothermia
Pain	Shock
Injuries during fall	Cardiovascular disease
Fatigue	Respiratory disease
Dehydration	Blood loss

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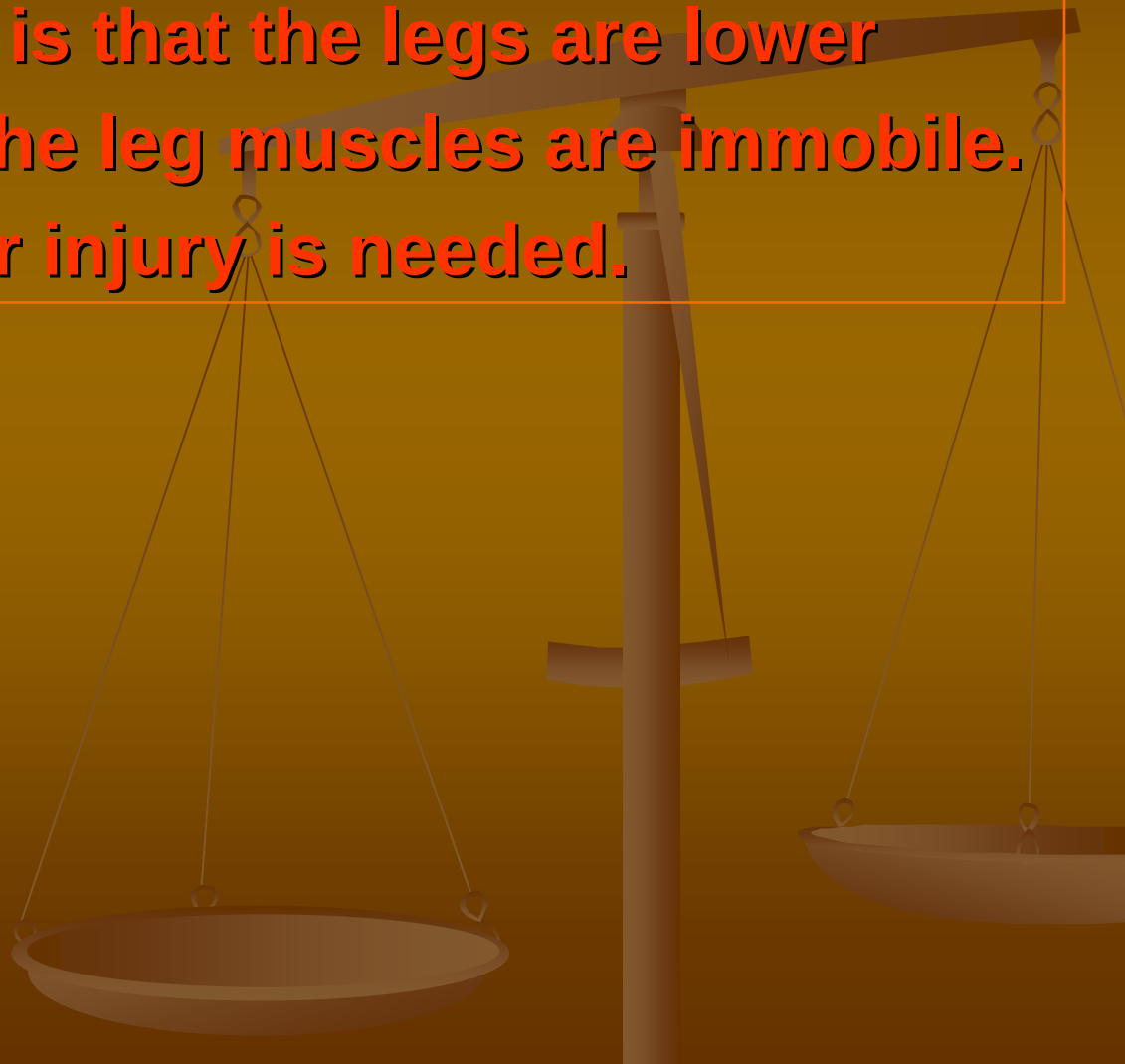
What actually matters?

- Constrictive leg loops contribute but are NOT needed
  - Even stretcher patients are at risk
- All designs of harnesses show almost identical results
- Patient age, weight, height, sex and fitness seem to make little difference to the time it takes before you faint
- Stress, panic, injury, smoking/drinking, extant cardiac conditions and illness increase the risks

There may be no visible trauma

All that matters is that the legs are lower than the heart and the leg muscles are immobile. No other injury is needed.



OK, so we rescue them!

- No so fast! There's something important to deal with:
- The blood that is trapped in the legs may not be in very good condition, and may even kill the person if we let it all pour back into their brain!
- This is called the 'reflow syndrome' and is medically very complicated – you will not be able to control it once it starts, and the patient will die. Luckily you can prevent it from happening if you handle them with care!

Reflow Syndrome

- Pooled blood in the legs is ‘stale’ after 10-20 mins
  - Drained of oxygen, saturated with CO2
  - Loaded with toxic wastes (from the fat burning process)
- Re-elevating the legs returns this to the rest of the body in a massive flood
  - Heart can be stopped
  - Internal organs (especially the kidneys) can be damaged
- You have to stop this flood of stale blood – but still keep enough flowing to the brain to keep the person alive!

Emergency action

- Anyone released from immobile suspension should be kept in a sitting position for at least 30 minutes
  - It is called the W Position
- Ked boards should be used if spinal precautions are needed

Hitting the ground

- Lowering systems must be controlled to prevent the patient's body from being laid flat as it reaches the ground
  - Keep them sitting up for 30 minutes
- Normal first-response and paramedic rules are WRONG
  - This is not 'fainting' !
  - Do Not lay your patient flat on a cot or hospital bed

Code 21b Suspension Trauma

Suspension trauma is a term used to describe the condition where a person is trapped in an upright position while using a safety harness for fall protection.

Check for:

Pain – Paresthesia –Paralysis -Pallor - Pulselessness Not needed but good indicators

INITIAL MEDICAL CARE

AIRWAY AS NEEDED

Do NOT allow the patient to lie flat or stand up

Provide oxygen at 100% for all patients

Manually stabilize the C-Spine via all possible means (KED), but do not lie the patient flat

FULLY CONSCIOUS and MOBILE:

Place Pt. in a safe position which is, sitting upright with the legs bent at the waist ('W-position') for 30 mins.

Cardiac monitor as soon as possible

IV Normal Saline 1000ml bolus

Albuterol (Ventolin) 2.5mg via Nebulization

Code 21b Suspension Trauma

If hyperkalemia suspected

and abnormal ECG rhythm - peaked T-wave or widened QRS → **No** → **Transport**

YES ↓

•Sodium Bicarbonate 50 meq IV followed by 20ml Normal Saline flush

•Calcium Chloride 1.0gm slow IV followed by 20ml Normal Saline flush

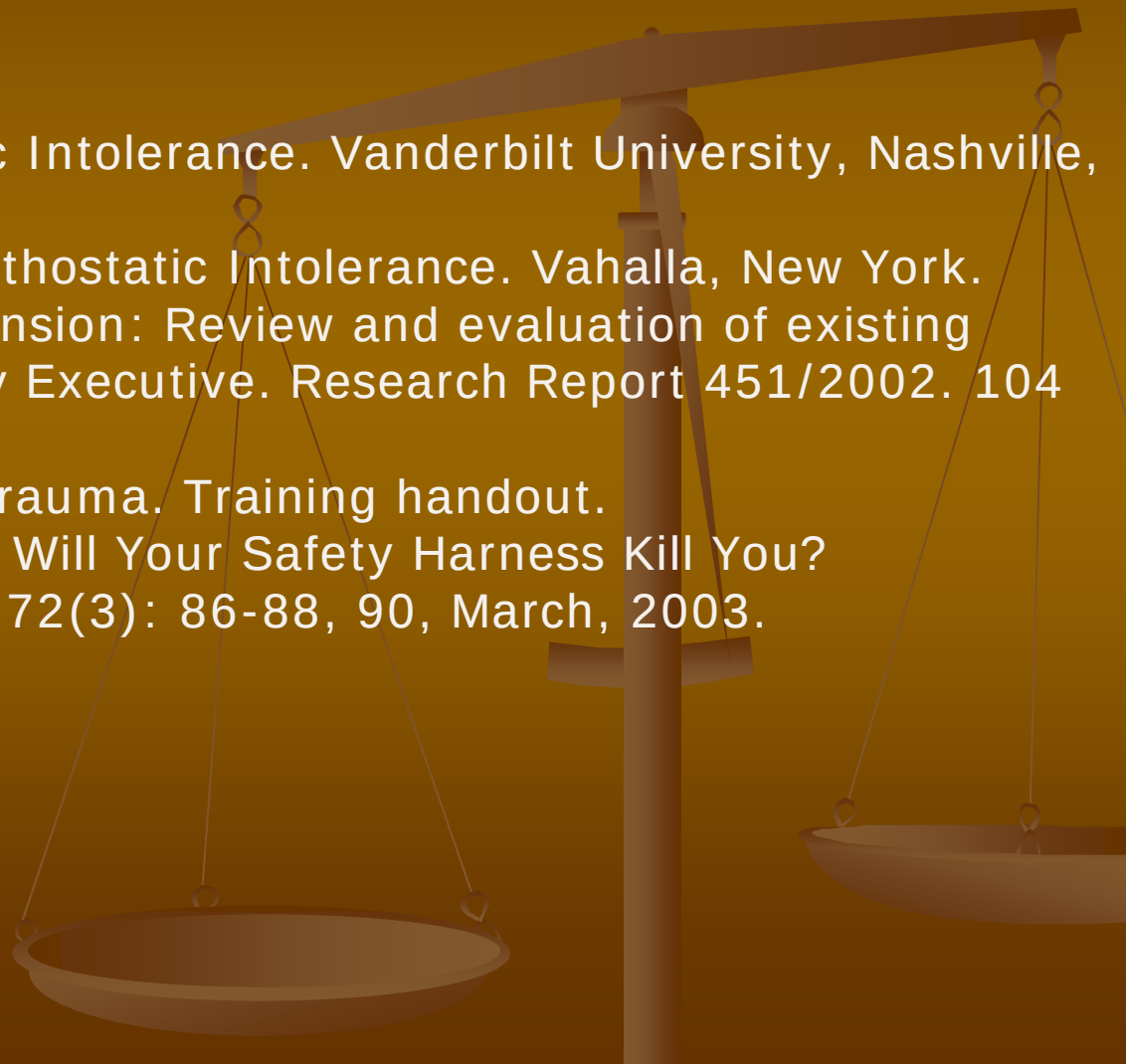
W-position

TRANSPORT

Transport the patient, in the sitting position, to the nearest hospital unless in arrest

NOTE TO PREHOSPITAL PROVIDERS:

Consider hypoglycemia and need for 50% Dextrose IV.



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•Seddon, Paul. Harness Suspension: Review and evaluation of existing information. Health and Safety Executive. Research Report 451/2002. 104 pp.

•Sheehan, Alan. Suspension Trauma. Training handout.

•Weems, Bill and Bishop, Phil. Will Your Safety Harness Kill You? Occupational Health & Safety. 72(3): 86-88, 90, March, 2003.

Geriatric Trauma

- Trauma is the fifth leading cause of death for persons over 65 years of age
  - 1/3 of traumatic deaths in persons 65 to 74 years of age are caused by vehicular trauma
  - 25 percent result from falls
  - In those over 72 years of age, falls is the leading cause of unintentional injury death
  - Burns are a major cause of disability and death in geriatric patients

Trauma

- Contributing factors that increase the severity of traumatic injury in geriatric patients
  - Osteoporosis and muscle weakness that increase the likelihood of falls and fractures
  - Reduced cardiac reserve that decreases the ability to compensate for blood loss
  - Decreased respiratory function that increases the likelihood of adult respiratory distress syndrome
  - Impaired renal function that decreases the ability to adapt to fluid shifts

Vehicular Trauma

- 15+ million licensed drivers are over 65 years of age
  - In 2008, 2,700+ deaths in this age group were attributed to motor vehicle crashes
  - Most are not related to high speed or alcohol
    - Related to errors in perception or judgment or to delayed reaction time
    - Large number of older adults are injured as drivers or passengers in moving vehicles
    - More than 2,000 pedestrian fatalities among older adults occur each year in U.S.
    - Accounts for 20 percent of all pedestrian deaths from trauma

Vehicular Trauma

- Risk of death from multiple trauma is estimated to be three times greater at 70 years of age than at 20 years of age
  - Geriatric patient is more susceptible to serious injury from equivalent degrees of trauma
  - Patient also is less capable of an appropriate, protective physiological response
  - Prompt identification of injuries and sources of hemorrhage is critical
    - Geriatric patient has much less cardiac reserve
    - Patient will succumb more quickly to shock

Head Trauma

- Head injury with loss of consciousness in geriatric patients often has poor outcomes
  - Brain becomes smaller in size with age (cerebral atrophy)
  - Atrophy produces increase in distance between surface of the brain and skull
  - As veins are stretched across this space, they are more easily torn
    - Results in subdural hematoma
    - Extra space within the skull often allows large amount of bleeding to occur before signs and symptoms of increased intracranial pressure are seen

Head Trauma

- Geriatric patients are at a high risk for injuries of the cervical spine because of arthritic and degenerative changes associated with aging
  - Structural changes lead to increased stiffening and decreased flexibility of the spine with narrowing of the spinal canal
    - Makes the spinal cord more at risk for damage from fairly minor trauma

Chest Injuries

- Any mechanism of injury that produces thoracic trauma in geriatric patients can be potentially lethal
  - Aged thorax is less elastic
    - More susceptible to injury
  - Pulmonary system also has marginal reserve because of
    - Reduced alveolar surface area
    - Decreased patency of small airways
    - Diminished chemoreceptor response

Chest Injuries

- Injuries to the heart, aorta, and major vessels are a greater risk to geriatric patients
- Due to decreased functional reserve in older patients
  - Anatomical changes make injury in these areas of greater significance
    - Myocardial contusion may be a complication of blunt injury to the chest
    - If severe, myocardial contusion may result in pump failure or life-threatening dysrhythmias
    - Rarely, cardiac tamponade occurs after blunt thoracic trauma

Chest Injuries

- Cardiac rupture, valvular injury (e.g., flail valves), and aortic dissection also may occur with significant blunt chest injury
  - First two entities are rare but rapidly fatal
  - When mechanism of injury produces rapid deceleration, the paramedic should always consider the possibility of dissecting aortic aneurysm
  - Aortic dissections often are not immediately fatal
  - Proper evaluation and treatment can be lifesaving

Chest Injuries

- In geriatric patients, the heart cannot respond as effectively to increased demand for oxygen as in younger people
  - This coupled with a slowed conduction system may cause ischemia and dysrhythmias when geriatric patients have significant trauma
  - These problems may occur even if the heart has not been damaged directly by trauma
  - Oxygenation and circulatory status must be closely monitored

Abdominal Injuries

- Abdominal injuries in geriatric patients have more serious consequences than injuries to any other body area
  - Often are less obvious
  - Call for a high degree of suspicion
  - Geriatric patient is less likely to tolerate abdominal surgery well
    - More likely to develop pulmonary complications and infection following surgery

Musculoskeletal Injuries

- Osteoporotic bones of geriatric patients are more at risk for fractures, even with mild trauma
  - Pelvic fractures are highly lethal in this age group
  - Can cause severe hemorrhage and soft tissue injury
  - When assessing for skeletal trauma, recall that the geriatric patient may have decreased pain perception
  - Often these patients have amazingly little tenderness with major fractures

Falls

- Falls are a major cause of morbidity and mortality in older adults, with overall fatality rate of 7 percent
  - About 1/3 of older adults living at home fall each year
  - 1 in 40 of these persons is hospitalized
  - Major cause of falls in older adults results from use of prescribed sedative-hypnotics
    - Affect balance and postural control
    - Alprazolam
    - Diazepam
    - Chlordiazepoxide
    - Flurazepam

Falls

- Fractures are the most common fall-related injuries, hip being the fracture that most often results in hospitalization
  - In those who survive hip fracture, most will have significant problems with walking and moving about
  - May become more dependent on others for help
  - Falls that do not result in physical injury may lead to self-imposed immobility from fear of falling again

Falls

- When immobility is strict and prolonged, this may result in:
  - Joint contractures
  - Pressure sores
  - Urinary tract infection
  - Muscle atrophy
  - Depression
  - Functional dependency

Falls

- Assume that any fall indicates an underlying problem until proved otherwise
  - Attempts should be made to uncover any medical, psychological, and environmental factors that may have been responsible for the fall
  - Patient history should include
    - Full review of all medical problems and medications
    - Precise details of the fall
  - Evaluate patient's cardiovascular, neurological, and musculoskeletal systems

Trauma Management

- Priorities of trauma care for geriatric patients are similar to those for all trauma patients
- Give special consideration to transport strategies and the geriatric patient's cardiovascular, respiratory, and renal systems

Cardiovascular System

- Special considerations for cardiovascular problems
  - Recent or past MI contributes to the risk of dysrhythmias and CHF
  - Adjustment of heart rate and stroke volume may be decreased in response to hypovolemia
  - Geriatric patients may need higher arterial pressures than younger patients for perfusion of vital organs
    - Because of atherosclerotic peripheral vascular disease

Cardiovascular System

- Special considerations for cardiovascular problems
  - Rapid IV fluid administration to geriatric patients may cause volume overload
    - Take care not to overhydrate
    - Older adults as group are more susceptible to CHF
    - Hypovolemia and hypotension are also poorly tolerated
    - Consider hypovolemia in any geriatric patient whose systolic BP less than 120 mm Hg
    - Tachycardia may not occur if patient takes beta-blockers
    - Monitor lung sounds and vital signs carefully and frequently during fluid administration

Respiratory System

- Special considerations for respiratory problems
  - Physical changes decrease chest wall compliance and movement
    - Diminish vital capacity
  - PaO2 decreases with age
  - Lower Po2 at same fractional inspired oxygen concentration occurs with each passing decade
  - All organ systems have less tolerance to hypoxia

Respiratory System

- Special considerations for respiratory problems
  - COPD (common in geriatric patients) requires the paramedic to carefully adjust airway management and ventilation support for appropriate oxygenation and carbon dioxide removal
    - High-concentration oxygen may suppress hypoxic drive in some patients
    - Oxygen should never be withheld from patient with clinical signs of cyanosis
    - May need to remove patient's dentures for adequate airway and ventilation management