Hypovolemic Shock and Tourniquets
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Objectives
- Discuss etiology of hypovolemic shock
- Discuss assessment & treatment of hypovolemic shock
- Discuss indications, precautions & use of tourniquets

Shock

Cellular hypoperfusion and subsequent hypoxia at the cellular level

Types of Shock
- Cardiogenic Shock
  - Pump failure or dysfunction
  - Myocardial infarction
  - Heart valve dysfunction
  - Arrhythmias
  - Congestive heart failure
Types of Shock

- Distributive Shock
  - Neurogenic Shock
  - Anaphylactic
  - Sepsis

- Obstructive Shock
  - Compression of heart
    - Tension pneumothorax
    - Cardiac tamponade

- Hypovolemic Shock
  - Whole blood loss
  - Plasma losses
    - Burns
    - Hyperthermia
  - Focus on hypovolemic shock

Body Systems Response

- Body will attempt to maintain cellular perfusion
- Vascular system
  - Carotid and aorta receptors
    - Pressure - < 80 mm/Hg
    - Oxygen - * in PaO2
    - Carbon dioxide - * in PaCO2

- Vascular system
  - Receptor activation stimulates cerebral vasomotor center
  - Immediate vasoconstriction
  - Arterial/venous constriction
    - Arterial = * systolic BP
    - Venous = * right heart return
Body Systems Response

- Vascular Response
  - Overall increase in diastolic blood pressure
  - Vasomotor center activity will also activate SNS

Body Systems Response

- Cerebral system
  - Vasomotor center
    - Also reacts to decreases in brain blood supply
      - SBP < 50 mm/Hg will cause ischemia & ↑ CO₂
      - CO₂ accumulation will activate vasomotor center
      - Immediate vasoconstriction as described above to ↑ BP

Body Systems Response

- Adrenal system
  - Focus of SNS stimulation
  - Nore- & Epinephrine released
  - Epinephrine increases
    - Heart rate
    - Cardiac contractility
    - Vasoconstriction
  - Norepinephrine → vasoconstriction
  - Both cause s/s of shock
    - Tachycardia
    - Pale, cool, clammy skin
    - Anxiety
Body Systems Response

- **Adrenal system**
  - Aldosterone
    - Released immediately
    - Causes kidneys to hold sodium
    - Water follows sodium
    - Powerful effect on BP
    - Takes about 20 minutes

Body Systems Response

- **Renal system**
  - Low BP will release renin from kidney
  - Renin combines with angiotensinogen → angiotensin I
  - Angiotensin I + ACE in lungs → Angiotensin II

Body Systems Response

- **Renal system** (continued)
  - Angiotensin II effects
    - Arteriole constriction = ↑ SBP
    - Vein constriction = ↑ pre-load to right ventricle
    - Release of more aldosterone from adrenal glands

Body Systems Response

- **Hepatic system**
  - Provides needed energy
  - Glycogen → glucose
  - Prolonged hypotension may cause “shock liver”
  - Affects lactic acid levels

Body Systems Response

- **Pulmonary system**
  - Switch from aerobic to anaerobic metabolism
  - Lactic acid produced → metabolic acidosis
  - ↑ respiratory rate & depth
  - “Blowing off” CO₂ will try to compensate for acidosis
Body Systems Response

- Pulmonary system
  - More oxygen taken in to offset hypoxia
  - Affected by respiratory disease and trauma
    - Chest
    - Abdomen
  - Brain

Assessment of Shock

- History
  - Trauma
    - Mechanism of injury?
    - Time from injury?
    - Underlying disease or illness?
    - Previous treatment of injuries?

Assessment of Shock

- History
  - Pulse
    - Will usually increase in shock
  - Ability to increase affected by:
    - Medications
    - Advanced age
  - Systolic blood pressure

Assessment of Shock

- History
  - Mean Arterial Pressure (MAP)
  - May more accurately reflect tissue perfusion than SBP
    - Normal = 70 – 100 mm/Hg
    - MAP = (SBP-DBP)/3 + DBP
      - Ex: (120-72)/3 + 72 = 88

  - Narrowing pulse pressure an ominous sign
Assessment of Shock

- History
  - Respiratory
    - Respiratory rate & depth usually
  - Underlying diseases may impact ability to
  - Pulse oximetry (SpO₂)

- History
  - Have the vital signs changed significantly?
  - In which direction are they trending?

Assessment of Shock

- History
  - Estimated blood loss
    - Hard to accurately estimate
    - May be affected by:
      - Body size
      - Cardiovascular fitness
      - Chronic disease

- Inspection
  - Level of consciousness (LOC)
    - Restlessness
    - Anxiety
    - Confusion
  - Breathing rate & effectiveness
  - Active external bleeding?

Assessment of Shock

- Inspection
  - Changes in skin
    - Color
    - Temperature
    - Moisture
  - Check mucous membranes in persons of color

- Inspection
  - Neck
    - External jugular distension
    - Tension pneumothorax
    - Cardiac tamponade
    - Trachea away from midline
    - Tension pneumothorax
    - Aortic arch dissection (right shift)
Assessment of Shock

- Inspection
  - Chest
    - Obvious fractures
    - Bruising
    - Impaled objects – Stabilize

Assessment of Shock

- Inspection
  - Abdomen
    - Bruising
      - Left upper quadrant – Spleen
      - Right upper quadrant – Liver
    - Distension
    - Impaled objects – Stabilize

Assessment of Shock

- Inspection
  - Abdomen
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Assessment of Shock

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Assessment of Shock

- Palpation
  - Skin
    - Temperature
    - Moisture
  - Pulses
    - Upper versus lower extremities
    - Strength

Assessment of Shock

- Palpation
  - Injured area
    - Chest - Fractures, soft tissue
    - Abdomen
      - Guarding
      - Rigidity
      - Both?

Assessment of Shock

- Palpation
  - Injured area
    - Pelvis
      - Iliac crests – anterior/posterior
      - Iliac crests – lateral/medial
      - Symphysis – anterior/posterior
    - Extremities – Soft tissue damage; deformities
Assessment of Shock

- Auscultation
- Blood pressures
  - Compare UE & LE, if pulses different
  - Use Doppler, if necessary
  - Pulse pressure = SBP – DBP
- Breath sounds
- Heart sounds

Shock Treatment

Controlling any serious external bleeding should take priority

- Controlling external bleeding
  - Direct pressure
  - Pressure dressing
  - Tourniquet

Shock Treatment

- Elevation of extremity
  - Not supported by research
  - May convert closed fracture to open fracture
  - **NOT RECOMMENDED**

Shock Treatment

- Pressure point compression
  - Not supported by research
  - Collateral circulation restores circulation with minute or two
  - One care provider removed from treatment
  - Difficulty to maintain while moving
  - **NOT RECOMMENDED**
Shock Treatment

- Fluid Resuscitation
  - Two, large, short bore (14–16 Ga)
  - Intraosseous (IO) devices
    - FAST 1
    - Bone Injection Gun (BIG)
    - EZ-IO

- Fluid Resuscitation
  - Use blood tubing, if available
  - Infuse warmed IV solution (LR, NS) to maintain SBP > 90 mm/Hg

- Fluid Resuscitation
  - Uncrossmatched blood after 2 L
    - O negative = universal donor
    - O positive – Ok for most men
      - 98% of black men
      - 85% of white men
      - Pre-menopausal women • Rh immunoglobulin after transfusion

“Persistent infusion of large volumes of fluids in an attempt to achieve a normal blood pressure is not a substitute for definitive control of bleeding.” - ATLS

Tourniquets

- History
  - First use noted by Roman surgeon Galen
  - French & German surgeons described in 16th and 17th centuries
  - Petit first used “tourniquet” (to turn) for screw-like device
Tourniquets

- Used in Crimean and US Civil War, basis for negative perceptions
  - Poor planning
  - Inadequate education
  - Prolonged time to care (> 24 hours)
  - Tourniquets thought to promote gangrene & amputations
  - CSA General Johnson

Tourniquets

- World War I
  - Shorter time to definitive care, but still long
  - Use of elastic tourniquets
  - Advocated removed as soon as identified
  - Advice to periodic loosen to allow for collateral circulation

Tourniquets

- World War II
  - More awareness of tourniquet applicability and placement
  - Literature still indicated that tourniquet = amputation

Tourniquets

- World War II
  - End of war tourniquet study found NO:
    - Gangrene
    - Thromboembolic events
    - Skin damage
    - Excessive edema
    - Nerve damage

- Advice to NOT periodically remove tourniquets
  - Shorter delays to definitive care but still > 12 hours
Tourniquets

- Korean War
  - Debunked myth that tourniquet = amputation
  - Shorter delays to definitive care but still > 9 hours

- Vietnam War
  - Ad hoc use of tourniquets d/t lack of awareness and training
  - Shorter delays to definitive care d/t helicopters, but still > 2 hours

- Recent research
  - Dorlac
    - Retrospective analysis of 5.5 years of data from 2 Level I trauma centers in Houston, TX
    - Evaluated extremity injuries & “+” vital signs in field with CPR on arrival
    - 8 of 14 patients had injuries that could have been successfully treated

- Recent research
  - Lakstein
    - Israeli experience from 1997 to 2000
    - 550 injured soldiers and civilians
    - Tourniquets 78% effective

- Recent research
  - Beekley
    - Operation Iraqi Freedom – 2003 to 2004
    - 165 patients with vascular injuries or amputations
    - Four of seven deaths potentially preventable with tourniquets
    - No identified complications

- Recent research
  - Kragh (multiple studies 2006 from Iraq)
    - 11% mortality with tourniquets in field vs. 22% applied in ED
    - 90% survival when placed prior to shock vs. 18% placed after shock
    - 0% survival for 10 patients where tourniquet indicated and not applied vs. 87% survival when indicated and applied
Tourniquet Take Home Points

- Most effective when applied BEFORE shock
- Hemorrhage control associated with:
  - Less blood loss
  - Less need for transfusion
  - Improved survival

Tourniquet Take Home Points

- Exsanguinating extremity trauma leading cause of preventable death in battle
- Tourniquet use
  - Permits more effective resuscitation
  - Lengthens survival time
  - Lengthens time for resuscitation
  - Allows concurrent resuscitation for patient or other

Proper training has the greatest influence on tourniquet effectiveness

Tourniquet Use

- Use the simplest measure to stop bleeding!
- Direct pressure
- Pressure dressing
- Tourniquet

Tourniquet Use

- Device options
  - Makeshift less effective & should be used with caution
  - “Spanish” windlass
    - Cravat dressing folded to 4” width
    - Knotted above wound
    - Rigid rod placed on knot
    - Second knot tied over rod
    - Rod twisted until bleeding stops
Spanish Windlass

Tourniquet Use

- Combat Application Tourniquet (CAT)
- Emergency Military Tourniquet (EMT)
- Special Operations Force Tactical Tourniquet (SOFTT)

CAT

EMT

SOFTT

Tourniquet Use

- Application Site
  - Apply just proximal to wound
  - Apply OVER clothing ONLY to rapidly move or extricate patient
- Avoid pockets
- Loosening of tourniquet MORE likely with movement
**Tourniquet Use**

- Application Site
  - **DO NOT COVER Tourniquet**
  - Never apply over a joint
  - When patient is in safe environment
    - Remove clothing to identify all wounds
    - Re-apply tourniquet 2 – 3 ABOVE bleeding site

- Application tightness
  - Complications if distal arterial flow is NOT stopped
    - MORE bleeding d/t vein compression
    - Expanding hematoma
    - Compartment syndrome
    - ♦ mortality  
      - [Kragh, 2008, J Trauma]  

- Application tightness
  - If bleeding continues with one correctly applied tourniquet:
    - Do NOT ♦ pressure of existing tourniquet
    - Apply 2nd tourniquet ABOVE 1st
    - 2nd tourniquet increases effectiveness from 82% to 92%

- Application tightness
  - The larger the limb, the tighter the tourniquet will need to be
  - Reassess wound & tourniquet after EVERY movement of patient

- Time limit
  - Note tourniquet placement:
    - Write “T” and time on patient’s forehead with indelible marker
    - Alternative: Write “T” and time on tape and attach to tourniquet
  - Remains in place until definitive care reached
  - Distal portions of limbs (hands, feet) can tolerate long tourniquet times
Tourniquet Use

- Pain management
  - Pain is typical in a conscious patient and does NOT indicate:
    - Incorrect tourniquet application
    - Need to remove tourniquet
    - Consider pain management for conscious patients

Tourniquet Use

- Complications
  - Tourniquet “palsy”
    - Usually incomplete, temporary and minor
    - More likely in upper extremity
    - May be more common with pre-existing neuropathies
  - Limb shortening rare

Tourniquet Use

- Complications
  - Muscle breakdown
    - May cause myoglobin release > acute renal failure
  - Monitor serum markers
    - Potassium
    - Acidosis
    - Myoglobin
    - Creatinine kinase

Tourniquet Errors

- Not using a tourniquet when it should be used
- Using a tourniquet when it should NOT be used
- Placing tourniquet too proximally
- Not tightening tourniquet effectively
- Not taking tourniquet off when possible
- Periodically loosening the tourniquet to allow intermittent blood flow

Tourniquets

“The fate of the wounded rests in the hands of the one who applies the first dressing.”

PHTLS
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Special thanks to
Sheila Crow
Stitchin’ Dreams Embroidery
wcsocrow@yahoo.com

For providing our Secret Question prize