


# Hypovolemic Shock and Tourniquets

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## Objectives

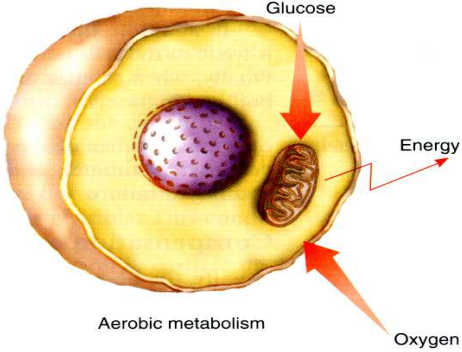
- Discuss etiology of hypovolemic shock
- Discuss assessment & treatment of hypovolemic shock
- Discuss indications, precautions & use of tourniquets


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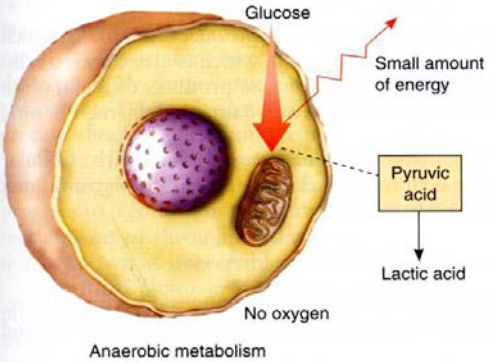
## Shock


### Cellular hypoperfusion and subsequent hypoxia at the cellular level

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## Types of Shock

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

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## Types of Shock

- **Distributive Shock**
  - Neurogenic Shock
  - Anaphylactic
  - Sepsis

## Types of Shock

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

## Types of Shock

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

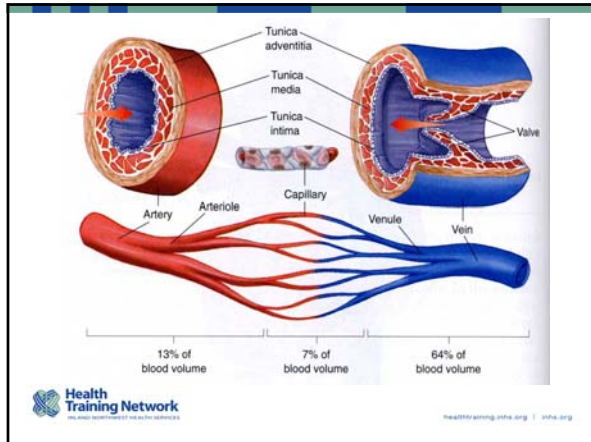


## Body Systems Response

- Body will attempt to maintain cellular perfusion
- **Vascular system**
  - Carotid and aorta receptors
    - Pressure - < 80 mm/Hg
    - Oxygen - ↓ in PaO<sub>2</sub>
    - Carbon dioxide - ↑ in PaCO<sub>2</sub>

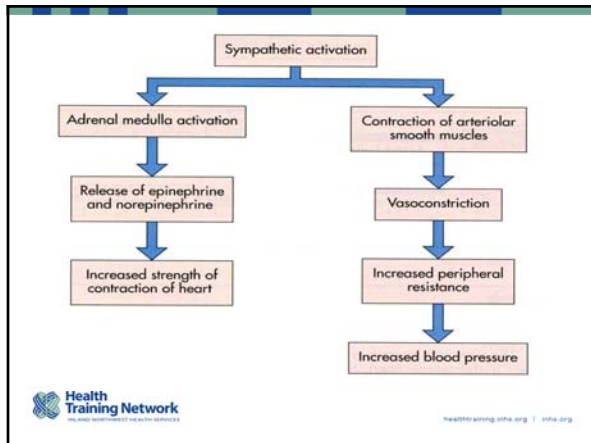
## Body Systems Response

- **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 & ↑ CO<sub>2</sub>
      - CO<sub>2</sub> accumulation will activate vasomotor center
    - Immediate vasoconstriction as described above to ↑ BP

## Body Systems Response

- **Adrenal system**
  - Focus of SNS stimulation
  - Nor- & Epinephrine released
    - Epinephrine increases
      - Heart rate
      - Cardiac contractility
    - Vasoconstriction

## Body Systems Response

- **Adrenal system**
  - **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



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## 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



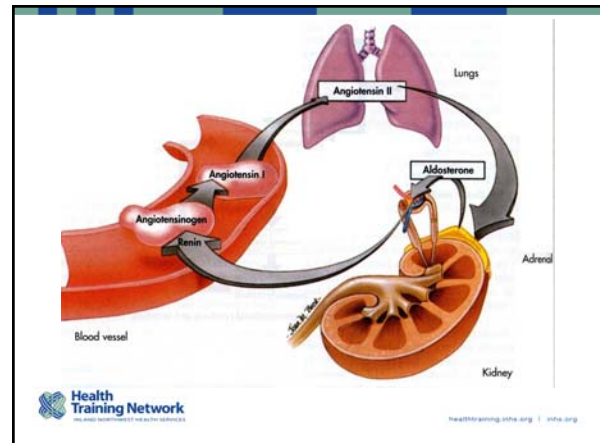
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## Body Systems Response

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



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## Body Systems Response

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



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## Body Systems Response

- Pulmonary system
  - Switch from aerobic to anaerobic metabolism
  - Lactic acid produced → metabolic acidosis
  - ↑ respiratory rate & depth
  - "Blowing off" CO<sub>2</sub> will try to compensate for acidosis



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## Body Systems Response

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



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## Assessment of Shock

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



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## Assessment of Shock

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



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## 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:  $(120 - 72) / 3 + 72 = 88$



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## Assessment of Shock

- History
  - Pulse pressure
    - $SBP - DBP = \text{Pulse pressure}$
    - Narrows as cardiac output fails and blood vessels constrict
    - Narrowing pulse pressure an ominous sign



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## Assessment of Shock

- **History**
  - **Respiratory**
    - Respiratory rate & depth usually ↑s
    - Underlying diseases may impact ability to ↑
    - Pulse oximetry (SpO<sub>2</sub>)

## Assessment of Shock

- **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

## Assessment of Shock

- **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**

## Assessment of Shock

- **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
  - Extremities
    - Bruising
    - Obvious deformities

## 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**

## Shock Treatment

- 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



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## Shock Treatment

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



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## Shock Treatment

- 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



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## Shock Treatment

**“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



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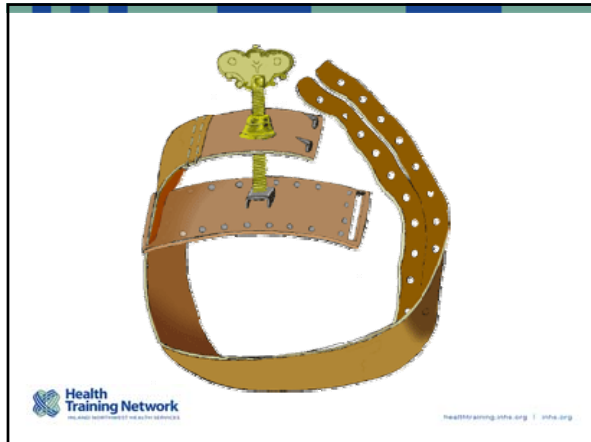
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## Tourniquets

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



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## 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



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## 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



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## Tourniquets

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



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## Tourniquets

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



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## Tourniquets

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



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## Tourniquets

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



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## Tourniquets

- **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



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## Tourniquets

- **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



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## Tourniquets

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



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## Tourniquets

- **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



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## Tourniquets

- **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



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### Tourniquet Take Home Points

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



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### 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



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### Tourniquet Take Home Points

**Proper training has the greatest influence on tourniquet effectiveness**



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### Tourniquet Use

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



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### 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



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## Spanish Windlass



ADAM.

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## Tourniquet Use

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

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## CAT



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## EMT



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## SOFTT



- **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

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## 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

## Tourniquet Use

- Application tightness
  - Tighten until:
    - Visual bleeding stops
    - No distal pulse is identified

## Tourniquet Use

- 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

## Tourniquet Use

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

## Tourniquet Use

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

## Tourniquet Use

- 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



**Questions?**

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