Aeromedical and Shock

E. James Radin, MD
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Shock

Definition: The inability to provide adequate oxygenation to the tissues

Combination of the effects of . . . . . .

- Inadequate BP
- Inadequate Cardiac Output
- Inadequate Hemoglobin
- Inadequate Oxygenation
- Other
Shock

Classification:

1. Inadequate Delivery

2. Inadequate Utilization
Shock

- Multi - system
- Single system
- Progressive organ failure
- Adequate perfusion of one organ may not be adequate for another
- Regulation of flow to organ normally well controlled, but shock disrupts normal auto-regulation
Inadequate Delivery

1. Extracellular:
   - Inadequate blood volume
     - Heart Failure

2. Types:
   - Respiratory
     - Hypovolemic
     - Cardiogenic
     - Neurogenic
     - Allergic
     - Obstructive
Inadequate Utilization

1. Intracellular Process:
   - Oxygen / Glucose not converted to energy
   - Normal cellular disruption

2. Types:
   - Infectious or Septic Shock
   - Metabolic Shock
ROGER RUDDER

SAY ROG, SINCE WE'RE ON INSTRUMENTS - HOW ABOUT CHECKING THE OL' ATTITUDE GYRO?
Pathophysiology

**Oxygen Transport:**

Oxygen Content 18 vols %

\[ \text{Oxygen Transport} = [ \text{Hgb} \times \text{SaO2} \times 1.34 ] + [ \text{PaO2} \times 0.0031 ] \]

**Oxygen Delivery:**

\[ \text{Oxygen Delivery} = [ ( \text{Hgb} \times \text{SaO2} \times 1.34 ) + ( \text{PaO2} \times 0.0031 ) ] \times \text{C.O} \]
Pathophysiology

Oxygen Consumption:

Arterial Oxygen Content - Mixed Venous Content

\[
[ \text{Hgb} \times \text{SaO}_2 \times 1.34 ] \times [ \text{PaO}_2 \times 0.0031 ] \quad \text{minus} \quad [\text{Hgb} \times \text{SvO}_2 \times 1.34 ] \times [ \text{PvO}_2 \times 0.0031 ]
\]
Pathophysiology

Extraction Ratio:

Oxygen Delivery / Oxygen Consumption

- Normally 0.24
- < 0.18 Not Utilizing
- > 0.35 Not delivering enough
Pathophysiology

Blood Gas . . . . . .

- Measures only dissolved O2 . . . . Value for whole blood the same as plasma ! ! !
- PaO2 not that useful
- Hgb and SaO2 much more helpful
- pH, perhaps the other most useful part of the ABG
- pH allows the differentiation of compensated vs non - compensated shock
Pathophysiology

- ABG
  - pH 7.37, PaCO2 25, PaO2 100
  - pH 7.28, PaCO2 25, PaO2 75
  - pH 7.25, PaCO2 75, PaO2 55
  - pH 7.18, PaCO2 60, PaO2 60
Pathophysiology

- Pitfalls . . . . . .
- Insidious onset
- Unrecognized
- Pediatric
- Organ status changes moment - to - moment

Don’t put too much faith in the SaO2 . . . . You need the right amount of Hgb to get the O2 where it needs to go
Ever hear of the super secret TLR-1 bombsight in fighters?

*That looks about right*

(P.S. Unclipped nails could throw you off up to 200 yds)
Clinical

- Ashen
- Tachypnea
- Hypotension
- Tachycardia
- Restlessness
- Combative
- Listless
Respiratory

- Inadequate O2 to the lungs - to the cells
- Anaerobic metabolism results
- Causes:
  - airway obstruction
    - asthma
  - pulmonary edema
  - carbon monoxide
  - Muscular fatigue
Respiratory

- Signs . . . . .
  - Increased work of breathing
    - stridor
    - wheezes
    - rales
    - cyanosis
    - fatigue
    - altitude
“Now don’t forget, Gorok! . . . THIS time punch some holes in the lid!”
Hypovolemic

- Decreased cardiac output
- Decreased Hgb - O2 transport to the tissues
- Anaerobic metabolism
- Causes . . . . .
  - Hemorrhage
  - Dehydration
  - Inadequate volume replacement
  - Burns
Hypovolemic

- Thirst
- collapsed veins
- poor skin turgor
- tachycardia
- concentrated urine
- oliguria
- hypotension
- can have normal SaO2
Cardiogenic

- Damage to the heart
- decreased pump function
- complicated by pulmonary edema
- Causes . . . . .
  - Myocardial Infarction
  - Myocardial Contusion
  - Valvular Dysfunction
  - Metabolic Derangement like sepsis
Cardiogenic

- Signs . . . . .
- Chest Pain
- SOB
- Dysrhythmias
- Pulmonary edema
- Diaphoresis
- Fever
Neurogenic

- Sympathetic nervous system dysfunction
- Dilation of arteries and veins
- Venous pooling, reduced venous return to the heart
- Decreased cardiac output, hypotension
- Causes . . . . . .

- Spinal cord injury
  - Sympathetic nervous system dysfunction
    - Head trauma
    - Encephalitis / Meningitis
    - Neurosurgical
Allergic

- Similar to neurogenic
- reaction to foreign substance [ allergen ]
- auto - immune cascades initiated
- varied spectrum of reaction
- usually reversible
- Causes . . . . .

- Venom exposure
- medication exposure
- unknown
Allergic

- Signs . . . . . .
  - Hives
  - Bronchospasm
  - SOB
  - Flushing
  - Swelling
  - Coughing
  - Hypotension
  - Tachycardia
  - restless / sense of doom
Obstructive

- Pulmonary - Heart obstructions
- Causes . . . .

  - Pulmonary embolism
  - Pericardial tamponade
  - Valvular obstruction
  - Tension pneumothorax
  - Aortic dissection
  - Post operative
"Well, I guess both Warren and the cat are okay. . . But thank goodness for the Heimlich maneuver!"
Obstructive

- Signs . . . . .
  - Chest pains
  - Tearing back pain
    - SOB
    - JVD
  - Distended veins
    - Hypotension
    - Tachycardia
  - Tracheal deviation
Sepsis

- Toxins produced by infectious organisms
- Endotoxins, Exotoxins, cell breakdown products
- Inhibits utilization of O2 and nutrients
- Effects organ function
- Precipitates immune cascade
Sepsis

- Fever
- Chills
- Diaphoresis
- Hypotension
- Tachycardia
- Hypothermia
- Metabolic failure
- Cardiac pump failure
Metabolic

- Hormonal and endocrine dysfunction
- Cellular dysfunction
- Medication error
- Toxins
- Causes . . . .

- Diabetes mellitus
- Diabetes insipitus
  - Adrenal
  - Thyroid
  - Pituitary
Metabolic

- Signs . . . . .
  - Hypotension
  - Hypertension
  - High output failure
  - Tachycardia
  - ALOC
  - Pregnancy
  - Trauma
  - Post operative
WE HAD A LOT TO LEARN ABOUT INSTRUMENT FLYING -

HEY BLINDMAN LEADER! YOU HAPPEN TO NOTICE WHICH WAY OUR TIP TANKS WENT?
Space Constraints

- Limits the type and amount of equipment
- Parts of the patient may inaccessible
- Limits the number of crew
- Restraining devices may hinder observations and procedures
- Weight and balance considerations
- Fuel capacities
- Comfort
Cross section of the bombardier and navigator working (?) in the 24'6" spacious nose section.

What sadist designed this?!
High Background Noise

- Limits communications
- Difficult to assess subtle patient changes
- Electronic communication needed
- Auscultation difficulties
- Audible alarms ineffective
- Need to rely on visual signs
- Fatigue and stress
Vibration

- Distorts you and the monitoring equipment
- Exceeds limits of equipment
- Makes monitoring decisions difficult
Lighting

- White lighting interferes with pilot vision at night
- Red lighting limits your ability to assess your patient
- Lighted displays necessary on monitors

THE DROPPED FLASHLIGHT BIT:

Roger Army 1234 understand. P-38 on instruments 9000, cockpit lights out - expect approach...
Electromagnetic Interference

- Fields produced by monitors and electrical equipment can interfere with each other . . . Ex. MRI
- Require shielding
- Interfere with navigational instruments
- Interferes with medical instruments
- Combined with vibration can alter even the ability to follow an arterial line let alone Swan-Ganz.
Treatment of Shock
Over view

- Medical vs Traumatic
- Single system vs multi - system
- Inter - facility vs Scene
- Transport Time
- In - flight Protocols
- Composition of flight crew
- Special needs of the Patient
Airway

- Remove obstruction
- Ventilate / Oxygenate
- Secure Airway . . . . BVM , ET , Other
- Cuff pressure at altitude
- assessment / re - assessment of cuff leaks
- Lighting , Noise , Vibration , etc.
- Space in aircraft for procedure
- Transport ventilators
Cardiovascular

- Not just the vital signs
- Mean arterial pressures, auto-regulation
- Volume, type of fluids needed
- Lactic acidosis
- Limit the progression of shock or reverse
- Indwelling monitoring devices . . . . .
  - A - lines
  - Swan - Ganz
  - Balloon pumps
Hemodynamic Status

- Assessment of capillary refill not that good
- Assessment of neck veins, difficult to interpret in air
- G - forces can radically alter status in the right patient
- IV fluids, blood products, temperature, air pressure can alter in flight
- Pressure bags, cuff pressures, FiO2 can change
- PASG - last resort, should be limited to BLS, not even good limb immobilizer
- Vasopressors in euvolemia
- Even shivering can increase O2 demand
Hemodynamic Status

- Vasopressors
  - Epinephrine
  - Dopamine
  - Dobutamine
  - Norepinephrine
  - Amrinone
  - Nitroprusside
  - Combinations
Hemoglobin

Arterial O2 Content . . . . . .

[ Hgb x SaO2 x 1.34 ] + [ PaO2 x 0.0031 ]

Hgb is the critical factor in O2 delivery

Hematocrit needs to be around 32%, especially in multi-system shock, especially at altitude
Gastric Decompression

- Nasogastric or oral gastric tube
- Decompresses the stomach and bowel
- Decreases the likelihood of aspiration
- Allows a route for some medications
- Can block sinus drainage and cause baro-traumatic effects
Chest Decompression

- Indicated for management mechanically ventilated patient with any pneumothorax, even BVM
- Chest tube the most ideal
- Should use a flutter valve
- Difficult to monitor in the aircraft
- Malfunction can be subtle and rapid
- May not see the usual signs in the aircraft
- Pneumothorax undetected on ground
Renal

- Urine output is a good indicator of renal perfusion
- Foley catheter to drain bladder
- Foley balloon can be effected by flight
- On the other hand, not much artifact as a result of flight
- Usual other catheter considerations
- Record volumes as a vital sign
Summary

- Complex and Dynamic
- Difficult to assess changes without complex technology
- Can change with altitude and G - forces
- Your selection of tools is limited
- Anticipation means as much as anything
- Re - assessment and Modification of treatment enroute is necessary
"Thank God, Sylvia! We're alive!"