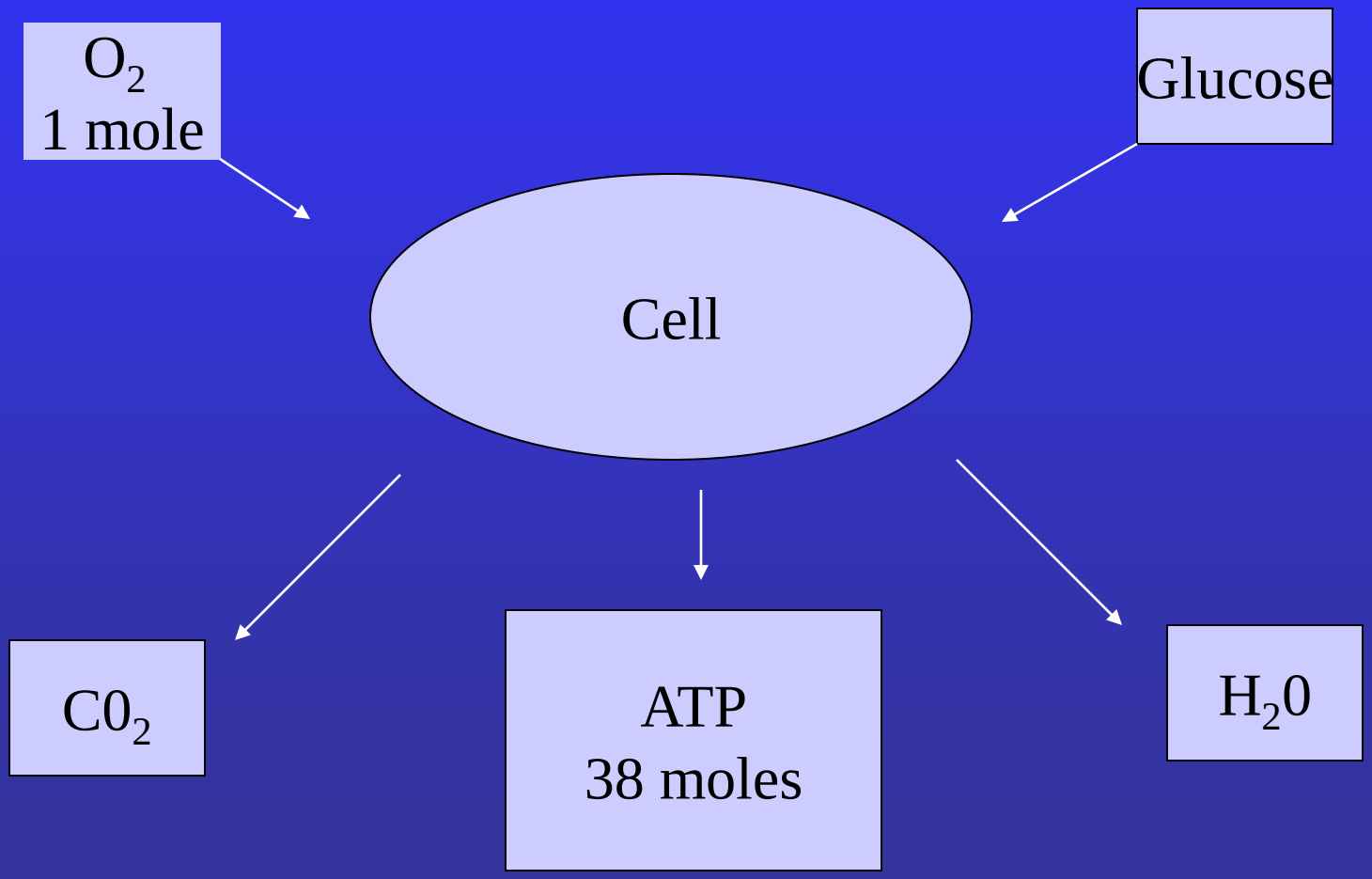
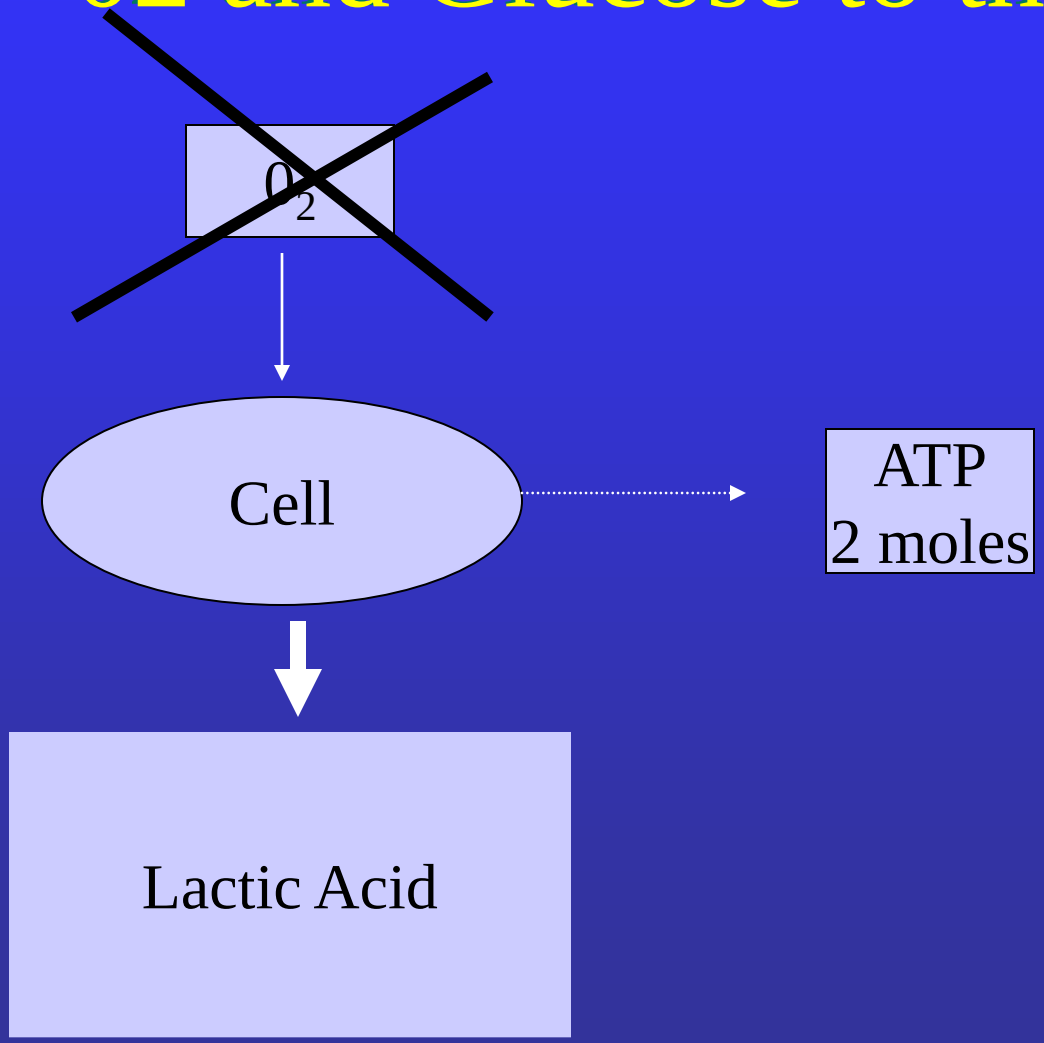
Shock

William Schecter, MD

The Cell as a furnace



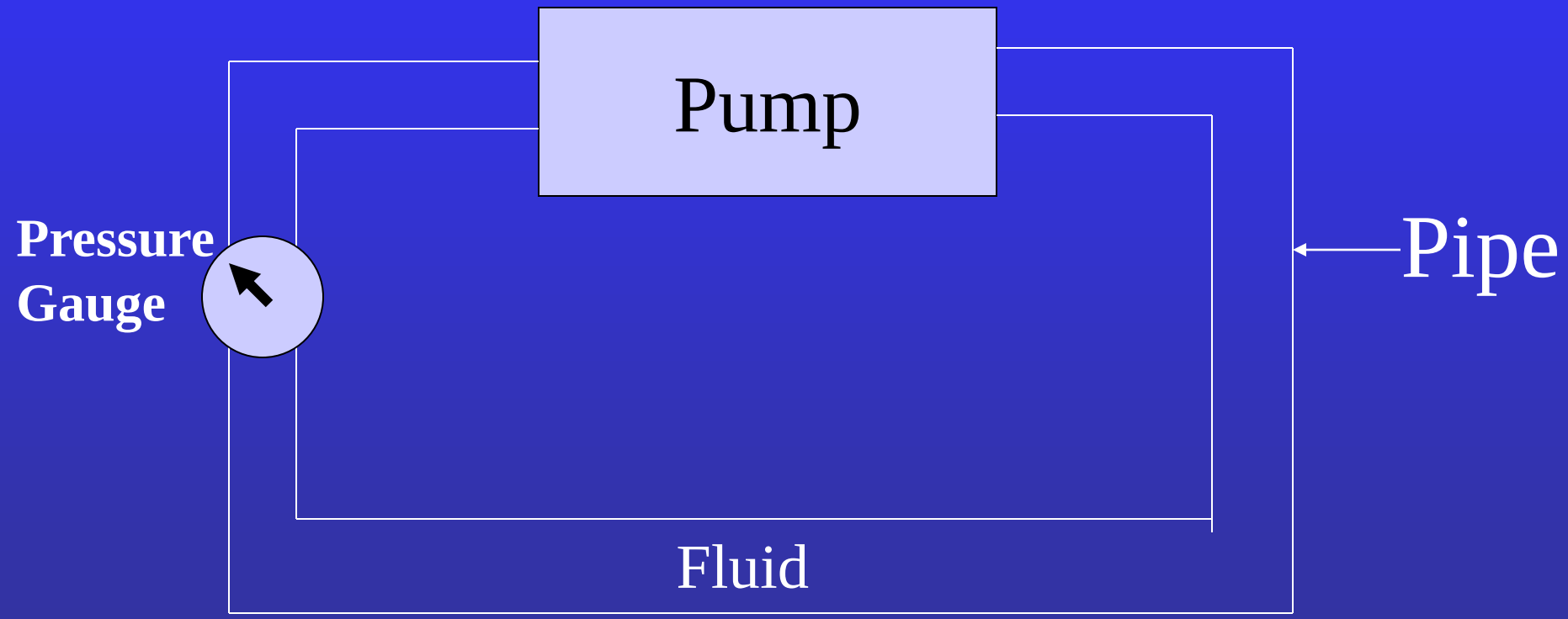
Shock = Inadequate Delivery of 02 and Glucose to the Cell



Treatment of Shock

Restoration of blood blow and substrate delivery to the cell

Circulatory System



Pump Problem

- Heart Failure
- Pericardial Tamponade
- Pulmonary Embolus
- Tension Pneumothorax

Case Presentation

- 46 year old woman presented to ER with abdominal pain
- After 6 hours of observation, patient has near cardiac arrest.
- Resuscitated. Profound Hypotension. Distended abdomen
- What would you do?????

Pipe Problem

- Vasodilation due to vasoactive drugs
  - Anesthetics
  - Antihypertensive drugs
- “Septic Shock”
- Neurogenic Shock
  - Spinal/Epidural Anesthesia
  - Spinal Cord Injury

Case Presentation

- 51 year old paraplegic man struck by car crossing the street in his wheel chair. Thrown 30 feet.
- Initial vital signs stable. CT of head, abdomen and chest normal. Films of Axial skeleton normal.
- Sent to ICU for observation. 2 hours later you get a call. Patient's BP =70 and HR =120.
- What would you do????

Fluid Problem

- HEMORRHAGE!!!!!
- BURN
- Pancreatitis
- Sepsis

Case Presentation

- 22 year old woman involved in a high speed roll over motor vehicle accident with an explosion resulting in a 20% burn
- Arrives in ER intubated, BP= 0, P= 130, absent breath sounds on the right.
- What would you do????

Monitoring the Shock Patient

- Continuous blood pressure monitor
- EKG
- Pulse Oximetry
- Foley Catheter
- Orthostatic Vital Signs
- CVP

Continuous Blood Pressure Monitor

http://www.ktl.fi/publications/ehrm/product2/part_iii3.htm

http://uscneurosurgery.com/graphics/procedures/aline/procedures%20a%20line%20insertion.htm

Treatment

- Solve the underlying problem
  - Stop bleeding
  - Drain pericardium
  - Drain pus/Antibiotics
- Give Fluid/Blood
- Monitor CVP and Urine Output

Class 1 Hemorrhage

- Mental Status normal
- BP, Pulse normal
- Urine Output Normal

Loss of up to 15% of Blood Volume (<750 cc)

Class 2 Hemorrhage

- Bp may be normal
- Pulse pressure (Systolic Pressure - Diastolic Pressure) decreased
- HR increased
- Agitated
- Urine output 20-30 cc/hour

Loss or 20% of blood volume (750-1200 cc)

Class 3 Hemorrhage

- Confused
- Hypotensive
- Tachycardic
- Sweating
- Urine output less than 20cc/hour

Loss of 20-30% of blood volume (1500 cc)

Class 4 Hemorrhage

- Unconscious
- No blood pressure
- No palpable pulse
- Sweaty
- anuric

Loss of 40% of blood volume (2000 cc)

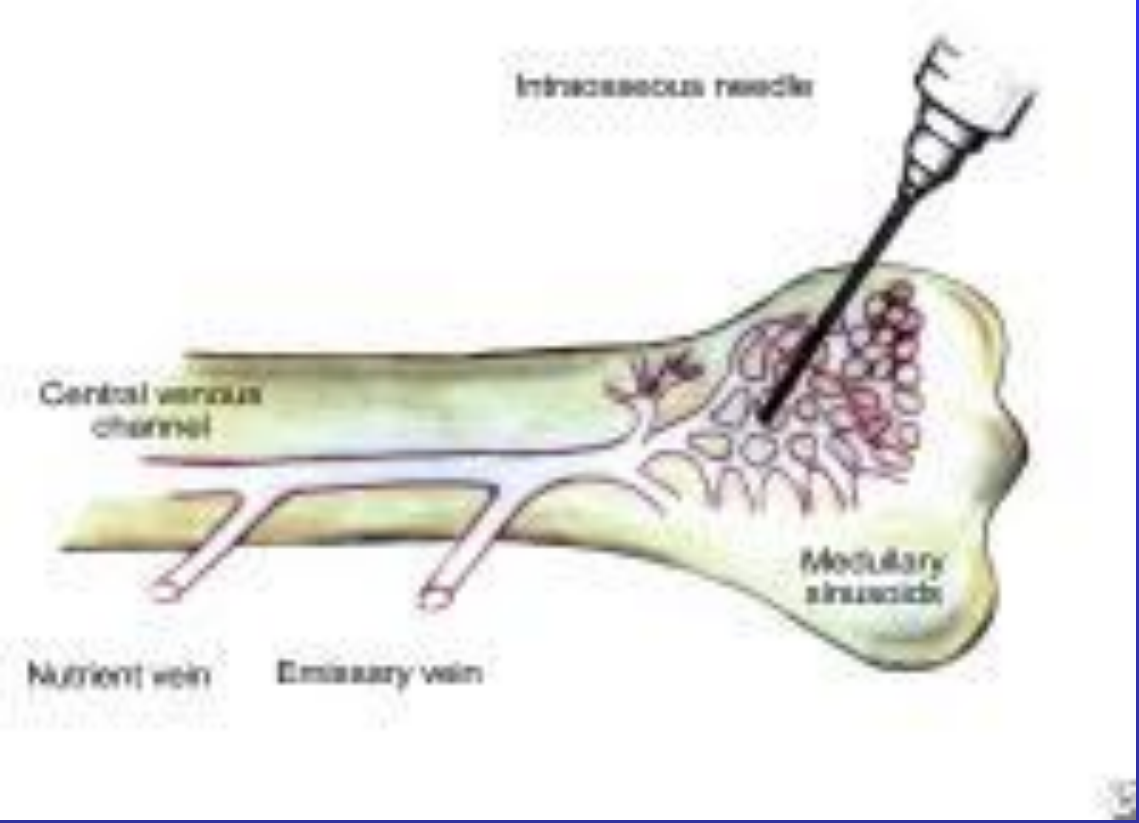
Vascular Access

- Two large bore iv catheters (14 gauge)
- Large bore (7 Fr) femoral vein catheter

Saphenous Vein Cutdown

http://www.emedicine.com/ped/topic3050.htm

Interosseous Needle



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Central Venous Access

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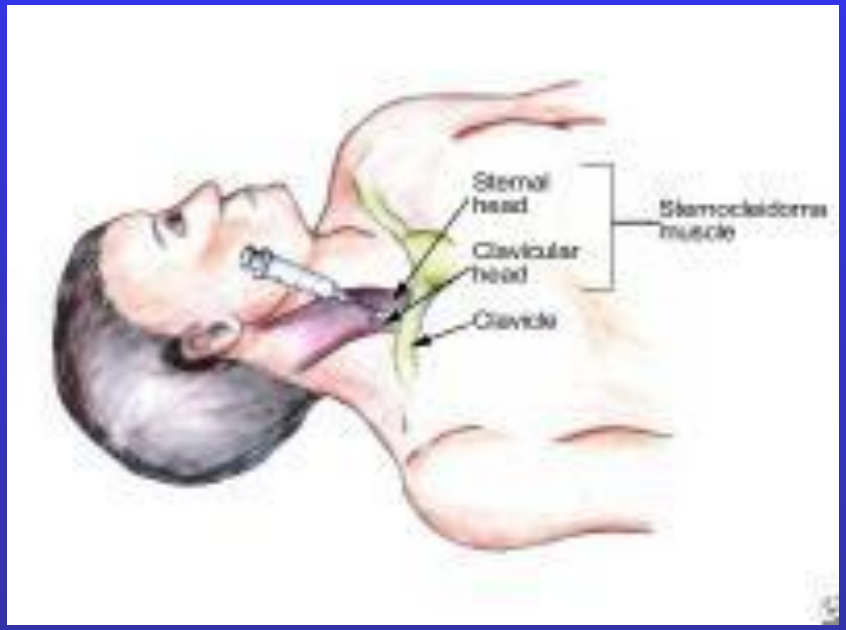


http://www.emedicine.com/ped/topic3050.htm

What is Resuscitation

- Organ Resuscitation
  - Heart
  - Brain
  - Kidney
- Organism Resuscitation – Restoration of Blood Flow to ALL vascular beds
  - Splanchnic bed (intestines, liver, kidney)
  - Extremities (“Dopamine Hands and Feets”)

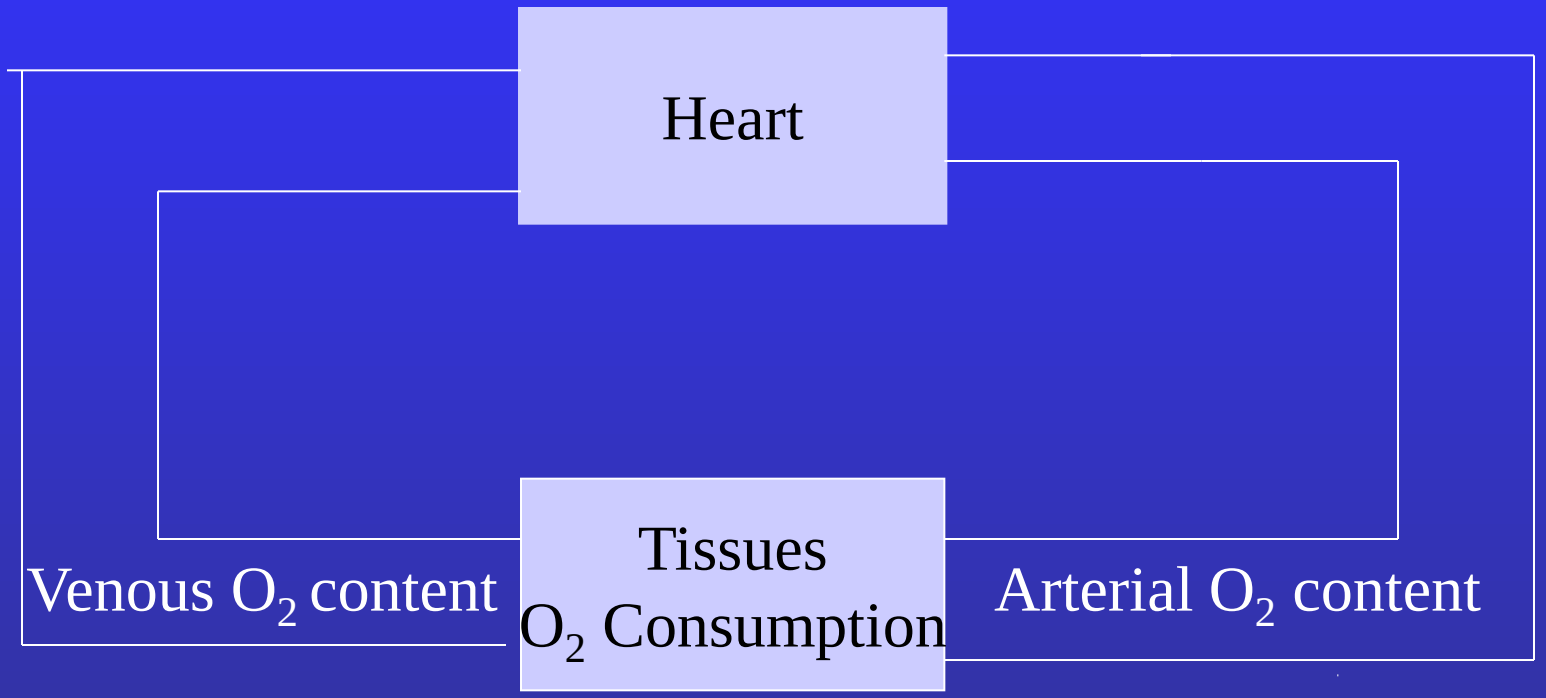
End Points of Resuscitation

- Clinical End Points
  - Mental Status
  - Blood Pressure
  - Pulse
  - Urine Output

End Points of Resuscitation

- Advanced Physiologic End points
  - CVP
  - Pulmonary Capillary Wedge Pressure
  - Cardiac Output
  - A-VdO_2
  - Cerebral Perfusion Pressure (MAP-ICP)
  - Tissue O_2 Probes

A-VdO_2



The lower the Cardiac Output the greater the 0_2 consumption

End Points of Resuscitation

- Biochemical End Points
  - Global Biochemical End Points
    - pH
    - Lactate
    - Base Deficit
  - Splanchnic Biochemical End Points
    - Gastric Mucosal pH
    - Gastric Mucosal PCO_2

History of 20th Century Thought on the Cause of "Shock"

- George W. Crile
- Late 19th and early 20th century
- Saline infusions necessary to treat "shock"

Walter B. Cannon, PhD, MD

- Walter Cannon
- "Wound Toxin" causes shock
- Early 20th century

Alfred Blalock

- 1930’s
- fluid problem due to wound edema
- No evidence of a wound toxin

Carl Wiggers, PhD

- Wiggers shock model
- 1947
- You have to replace more fluid than you withdraw in order to resuscitate an animal from hemorrhagic shock

G Tom Shires, MD

- 1970's
- Shock causes loss of integrity of cell membrane
- Salt and water migrate from interstitium to intracellular space

Hypotensive Resuscitation?

Walter B. Cannon

- **1918 Harvard Medical Unit France**
- ***"If the pressure is raised before the surgeon is ready to check any bleeding that may take place, blood that is sorely needed may be lost"***

Henry K. Beecher

- **U.S. Army Shock Research Unit North Africa and Italy, World War II**
- ***"When the patient must wait for a considerable period, elevation of his systolic blood pressure to 85 mmHg is all that is necessary"***

Hypotensive Resuscitation??

- Rapid cessation of hemorrhage is the key to survival
- Delay in the field or the ER to “stabilize” the patient in shock with penetrating trauma leads to poor outcome
- Large volume resuscitation prior to control of hemorrhage leads to increased bleeding

Combat Fluid Resuscitation Conference 1 – USUHS - Recommendations

- Fluid resuscitation for BP<85mmHg, decreasing BP, or decreasing mental status without head injury
- No fluids in presence of strong radial pulse
- Fluids for weak or absent radial pulse or decreasing mental status without head injury
- Choice of fluids: 500cc of colloid by gravity (Hetastarch colloid of choice for early care)

Champion HR. Combat Fluid Resuscitation: Introduction and Overview of Conferences. J Trauma. 2003;54:S7-S12.

Combat Fluid Resuscitation Conference 2 – Toronto – 2001 Recommendations

- Battlefield fluid resuscitation of choice should be an initial 250cc of 7.5% HTS + 6% Dextran (HSD) with 2nd dose of HSD only in those patients who fail to stabilize
- Follow HSD with isotonic crystalloid

Champion HR. Combat Fluid Resuscitation: Introduction and Overview of Conferences. J Trauma. 2003;54:S7-S12.

Israel Defense Forces Doctrine

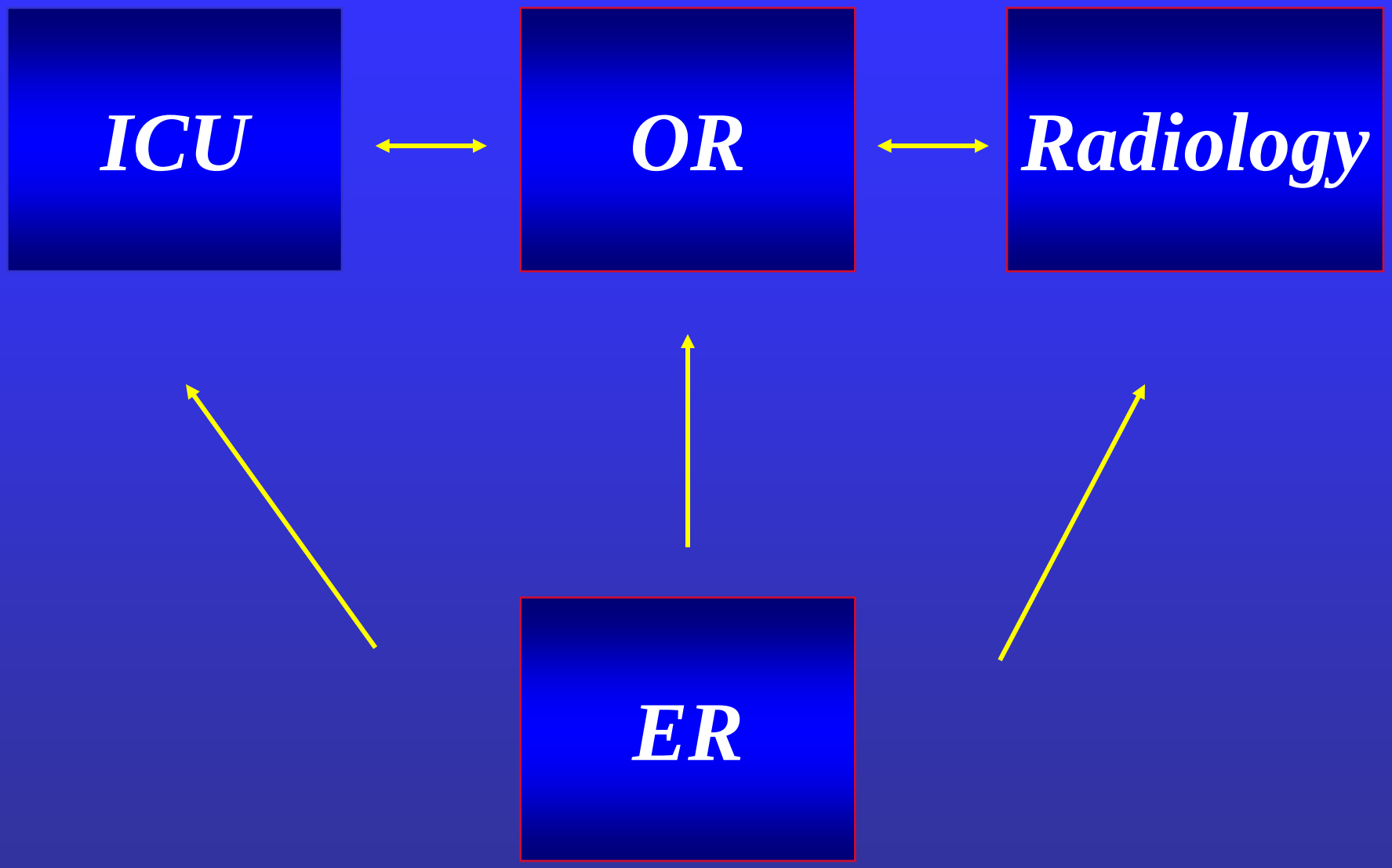
- In uncontrolled hemorrhagic shock, aggressive fluid resuscitation prohibited.
- In controlled hemorrhagic shock, fluid resuscitation is aimed toward normalization of hemodynamic parameters
- Estimated evacuation time < 1 hour: immediate evacuation after A & B
- Estimated evacuation time > 1 hour: crystalloid infusion, but limited to hypotensive resuscitation in uncontrolled hemorrhage.

Krausz M. Fluid Resuscitation Strategies in the Israeli Army. J Trauma 2003;54:S39-S42.

US Military Doctrine

- Significant Wound in coherent soldier with palpable radial pulse: saline lock, hold fluids
- Significant wound without radial pulse or in incoherent soldier: 500c of Hextend
  - Return of pulse or improvement in mental status: hold fluids
  - No improvement: additional 500 cc of Hextend
- No hypotensive resuscitation for head injury patient

Holcomb, JB. Fluid Resuscitation in Modern Combat Casualty Care: Lessons learned From Somalia. J Trauma 2003;54:S46-S51.


ICU
OR
Radiology
ER

Summary

- The goal of the treatment of shock is restoration of oxygen delivery to the cell
- Most patients in shock who are injured are bleeding!!!
- The key determinant of survival is the time between onset and cessation of hemorrhage
- Remember the Pump, pipes and fluids to sort out unusual causes of hypotension

CONCLUSION

- **Attempt to restore normotension with aggressive saline infusion markedly increases blood loss**
- **Survival is not improved with restoration of normotension**