

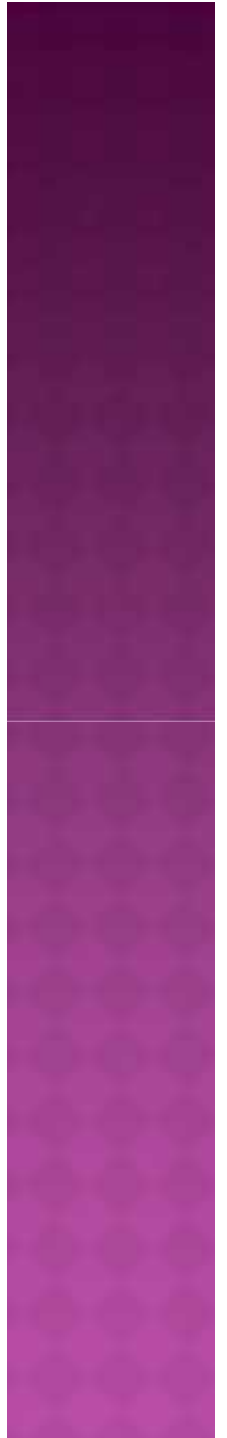
FLUID MANAGEMENT AND SHOCK RESUSCITATION

Presented by:

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OUTLINE

- ◉ Normal Fluid Requirements
- ◉ Resuscitation Fluids
- ◉ Goals of Resuscitation



IMMEDIATE MANAGEMENT

- Place the victim in shock position
- Keep the person warm and comfortable
- Turn the victim's head to one side if neck injury is not suspected



IMMEDIATE MANAGEMENT

- ⦿ Maintain normal body temperature
- ⦿ In most cases, elevate the feet and legs above the level of the heart
- ⦿ Exceptions include:
 - Neck injury - immobilize in the position found
 - Head injury - elevate the head and shoulders
 - Leg fracture - splint and elevate

BODY FLUID COMPARTMENTS

- Total Body Water = 60% body weight
 - 70Kg TBW = 42 L
- 2/3 of TBW is intracellular (ICF)
 - 40% of body weight, 70Kg = 28 L
- 1/3 of TBW is extracellular (ECF)
 - 20% of body weight, 70Kg = 14 L
 - Plasma volume is approx 4% of total body weight, but varies by age, gender, body habitus

BLOOD VOLUME

	Blood Volume (mL/kg)
Premature Infant	90
Term Infant	80
Slim Male	75
Obese Male	70
Slim Female	65
Obese Female	60

4 - 2 - 1 RULE

- ⦿ 100 - 50 - 20 Rule for daily fluid requirements
- ⦿ 4 mL/kg for 1st 10 kg
- ⦿ 2 mL/kg for 2nd 10 kg
- ⦿ 1 mL/kg for each additional kg

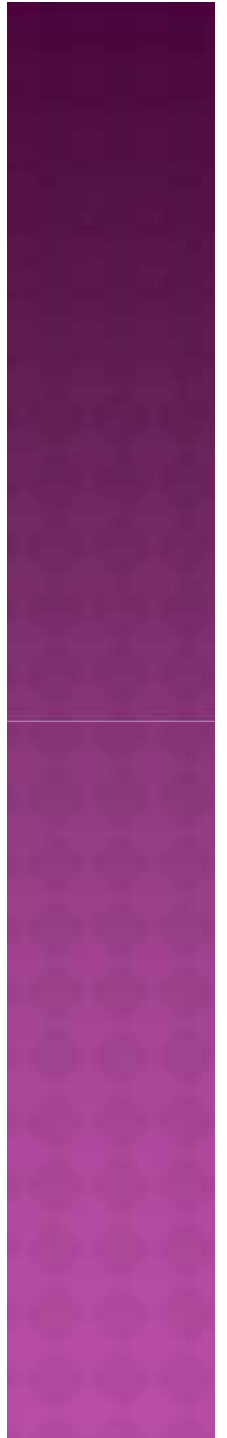
MAINTENANCE FLUIDS: EXAMPLE

60 kg female

- ⊙ 1st 10 kg: $4 \text{ mL/kg} \times 10 \text{ kg} = 40 \text{ mL}$
- ⊙ 2nd 10 kg: $2 \text{ mL/kg} \times 10 \text{ kg} = 20 \text{ mL}$
- ⊙ Remaining: $60 \text{ kg} - 20 \text{ kg} = 40 \text{ kg}$
 $1 \text{ mL/kg} \times 40 \text{ kg} = \underline{40 \text{ mL}}$
- ⊙ Maintenance Rate = 120 mL/hr

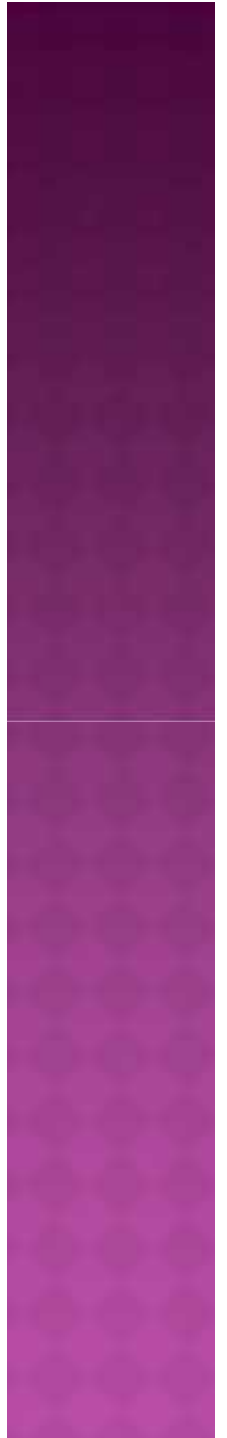
FLUID DEFICITS

- ⦿ Fasting
- ⦿ Bowel Loss (Bowel Prep, vomiting, diarrhea)
- ⦿ Blood Loss
 - Trauma
 - Fractures
- ⦿ Burns
- ⦿ Sepsis
- ⦿ Pancreatitis



INSENSIBLE FLUID LOSS

- ◉ Evaporative
- ◉ Exudative
- ◉ Tissue Edema (surgical manipulation)
- ◉ Fluid Sequestration (bowel, lung)
- ◉ Extent of fluid loss or redistribution (the “Third Space”) dependent on type of surgical procedure
- ◉ Mobilization of Third Space Fluid



INSENSIBLE FLUID LOSS

- ⦿ 4 - 6 - 8 Rule
- ⦿ Replace with Crystalloid (NS, LR, Plasmalyte)
- ⦿ Minor: 4 mL/kg/hr
- ⦿ Moderate: 6 mL/kg/hr
- ⦿ Major: 8 mL/kg/hr

EXAMPLE

- ⦿ 68 kg female for laparoscopic cholecystectomy
- ⦿ Fasted since midnight, OR start at 8am
- ⦿ Maintenance = $40 + 20 + 48 = 108$ mL/hr
- ⦿ Deficit = 108 mL/hr \times 8hr
= 864 mL
- ⦿ 3rd Space (4 mL/kg/hr) = 272 mL/hr

EXAMPLE

- ⦿ Intra-operative Fluid Replacement of:
 - Fluid Deficit 864 mL
 - Maintenance Fluid 108 mL/hr
 - 3rd Space Loss 272 mL/hr
 - Ongoing blood loss (crystalloid vs. colloid)

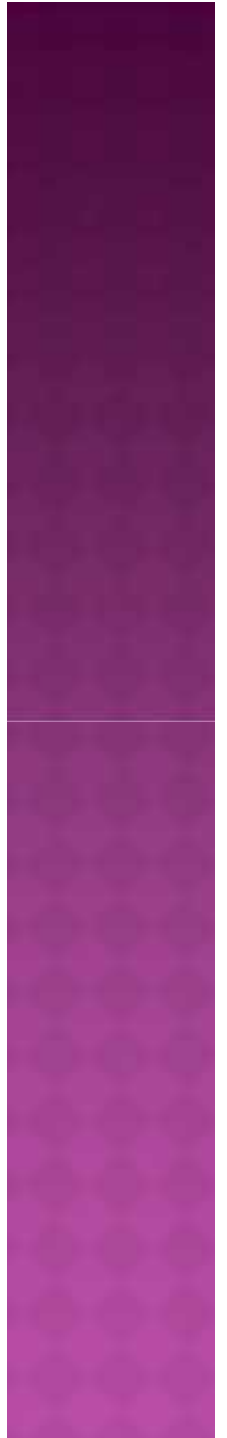
FLUID RESUSCITATION OF SHOCK

○ Crystalloid Solutions

- Normal saline
- Ringers Lactate solution
- Plasmalyte

○ Colloid Solutions

- Pentastarch
- Blood products (albumin, RBC, plasma)

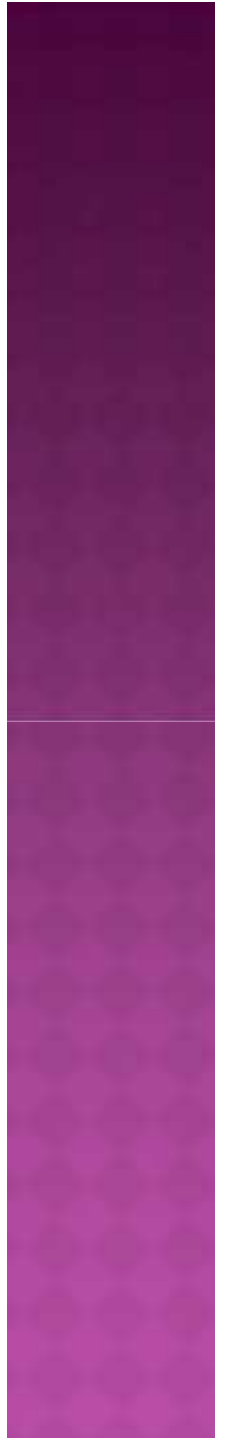


CRYSTALLOID SOLUTIONS

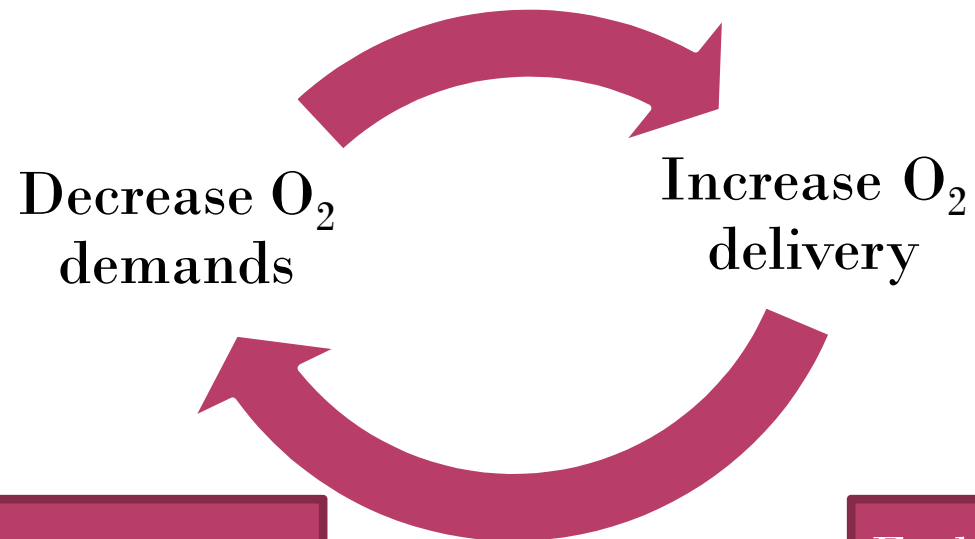
- ⦿ Normal Saline
- ⦿ Lactated Ringers Solution
- ⦿ Plasmalyte
- ⦿ Require 3:1 replacement of volume loss
e.g. estimate 1 L blood loss, require 3 L of
crystalloid to replace volume

COLLOID SOLUTIONS

- Pentaspan
- Albumin 5%
- Red Blood Cells
- Fresh Frozen Plasma
- Replacement of lost volume in 1:1 ratio



TREATMENT



Increase O₂ contents
Increase cardiac output
Increase blood pressure

Early intubation
Sedation
Analgesia

OXYGEN CARRYING CAPACITY

- Only RBC contribute to oxygen carrying capacity (hemoglobin)
- Replacement with all other solutions will
 - Support volume
 - Improve end organ perfusion
 - Will NOT provide additional oxygen carrying capacity

RBC TRANSFUSION

- BC Red Cell Transfusion Guidelines recommend transfusion only to keep Hgb >70 g/dL unless
 - Comorbid disease necessitating higher transfusion trigger (CAD, pulmonary disease, sepsis)
 - Hemodynamic instability despite adequate fluid resuscitation

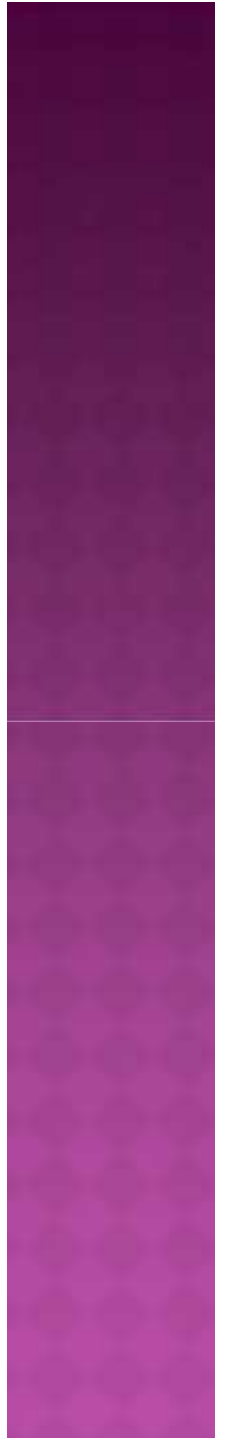
CRYSTALLOID VS. COLLOID

- SAFE study (Saline vs. Albumin Fluid Evaluation)
 - Critically ill patients in ICU
 - Randomized to Saline vs. 4% Albumin for fluid resuscitation
 - No difference in 28 day all cause mortality
 - No difference in length of ICU stay, mechanical ventilation, RRT, other organ failure

NEJM 2004; 350 (22), 2247- 2256

GOALS OF FLUID RESUSCITATION

- Easily measured
 - Mentation
 - Blood Pressure
 - Heart Rate
 - Jugular Venous Pressure
 - Urine Output



GOALS OF FLUID RESUSCITATION

- A little less easily measured
 - Central Venous Pressure (CVP)
 - Left Atrial Pressure
 - Central Venous Oxygen Saturation $S_{cv}O_2$

GOALS OF FLUID RESUSCITATION

- A bit more of a pain to measure
 - Pulmonary Capillary Wedge Pressure (PCWP)
 - Systemic Vascular Resistance (SVR)
 - Cardiac Output / Cardiac Index

THERAPY MONITORING

- ⊙ **Central venous pressure**
 - Intravascular volume
 - Goal 6 mmHg (nl 4-8 mmHg)
- ⊙ **Mixed venous saturation (SvO₂)**
 - Goal >70% (nl 65-70%)
 - Indicate oxygen extraction by the tissues
 - Best obtained from CVL: SC or IJ
- ⊙ **Lactate clearance: indication of anaerobic metabolism**
 - >10%
 - Follow trends

MIXED VENOUS OXYGENATION

- ⦿ Used as a surrogate marker of end organ perfusion and oxygen delivery
- ⦿ Should be interpreted in context of other clinical information
- ⦿ True mixed venous is drawn from the pulmonary artery (mixing of venous blood from upper and lower body)
- ⦿ Often sample will be drawn from central venous catheter (superior vena cava, R atrium)

MIXED VENOUS OXYGENATION

- ⊙ Normal oxygen saturation of venous blood 68% - 77%
- ⊙ Low $S_{cv}O_2$
 - Tissues are extracting far more oxygen than usual, reflecting sub-optimal tissue perfusion (and oxygenation)
- ⊙ Following trends of $S_{cv}O_2$ to guide resuscitation (fluids, RBC, inotropes, vasopressors)

GOALS OF RESUSCITATION

- Rivers Study- Early Goal Directed Therapy in Sepsis and Septic Shock
 - Emergency department with severe sepsis or septic shock, randomized to goal directed protocol vs standard therapy prior to admission to ICU
 - Early goal directed therapy conferred lower APACHE scores, indicating less severe organ dysfunction

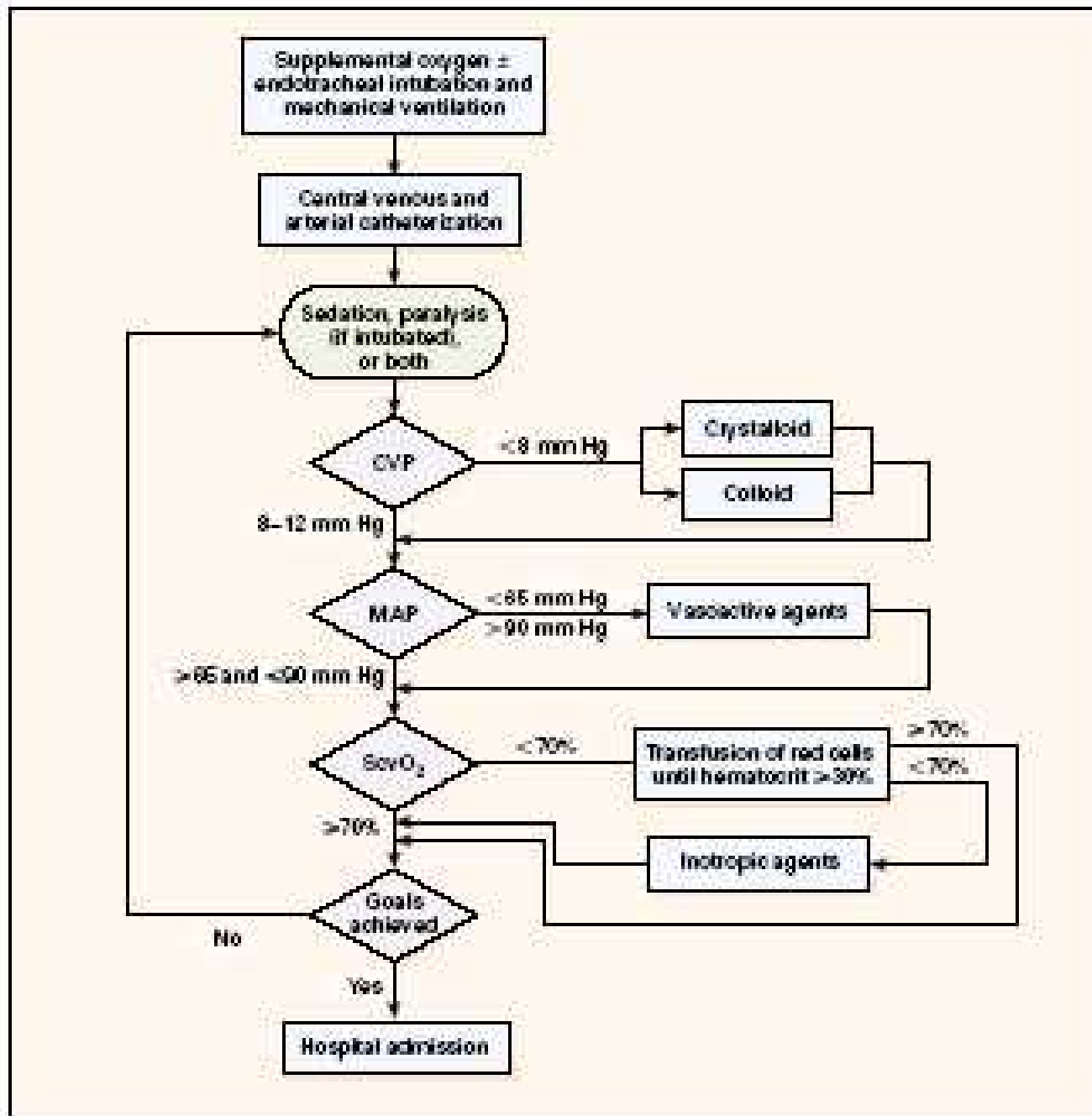
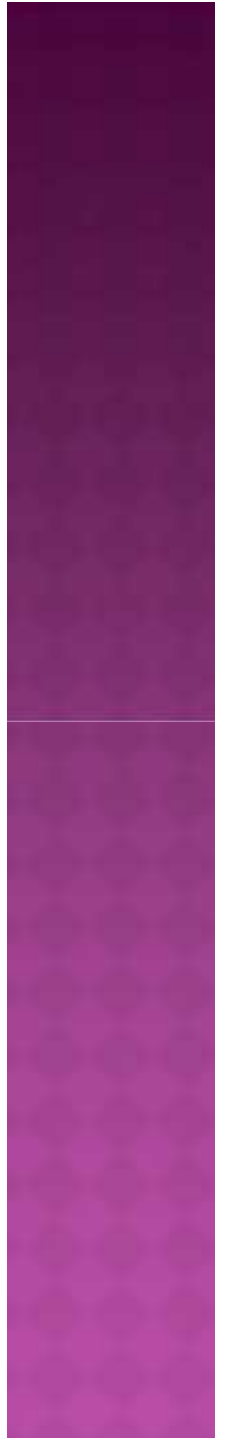


Figure 2. Protocol for Early Goal-Directed Therapy.

CVP denotes central venous pressure, MAP mean arterial pressure, and SovO₂ central venous oxygen saturation.

BOTTOM LINE

- ⦿ Resuscitation of Shock is all about getting oxygen to the tissues
- ⦿ Initial assessment of volume deficit, replace that (with crystalloid), and reassess
- ⦿ Continue volume resuscitation to target endpoints
- ⦿ Can use mixed venous oxygen saturation to estimate tissue perfusion and oxygenation



THE END

