PERIOPERATIVE FLUID THERAPY

DEPARTMENT OF of Anaesthesia

Lecture Objectives

- To understand body fluid composition.
- To understand the basic physiologic principles to guide Fluid therapy.
- To know the available types of Intravenous fluid.
- To Describe different fluids components and illustrate the advantages and disadvantages of each type.
- To Identify perioperative factors which affect the patient fluid requirements.
- To assess a patient with a volume deficit.
- Recognize the different types of blood and blood products and to discuss the indications of each type and complications.

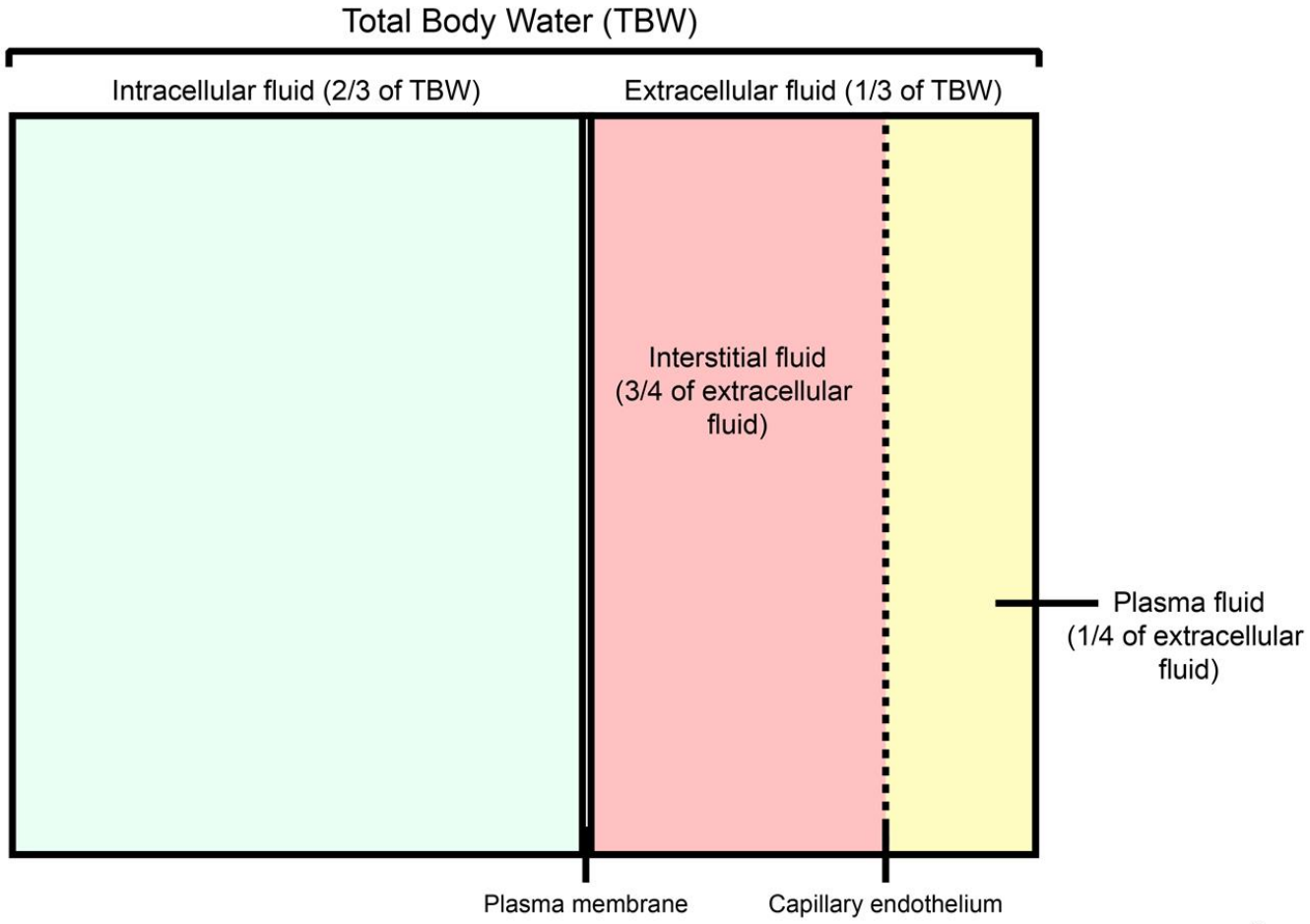
Total Body Water (TBW)

- The 70 kg Person (male) contains 42L of H_2O
- 60% body weight in males
  - 50% body weight in females
  - 80% body weight in new born
  - Less in obese: fat contains little water

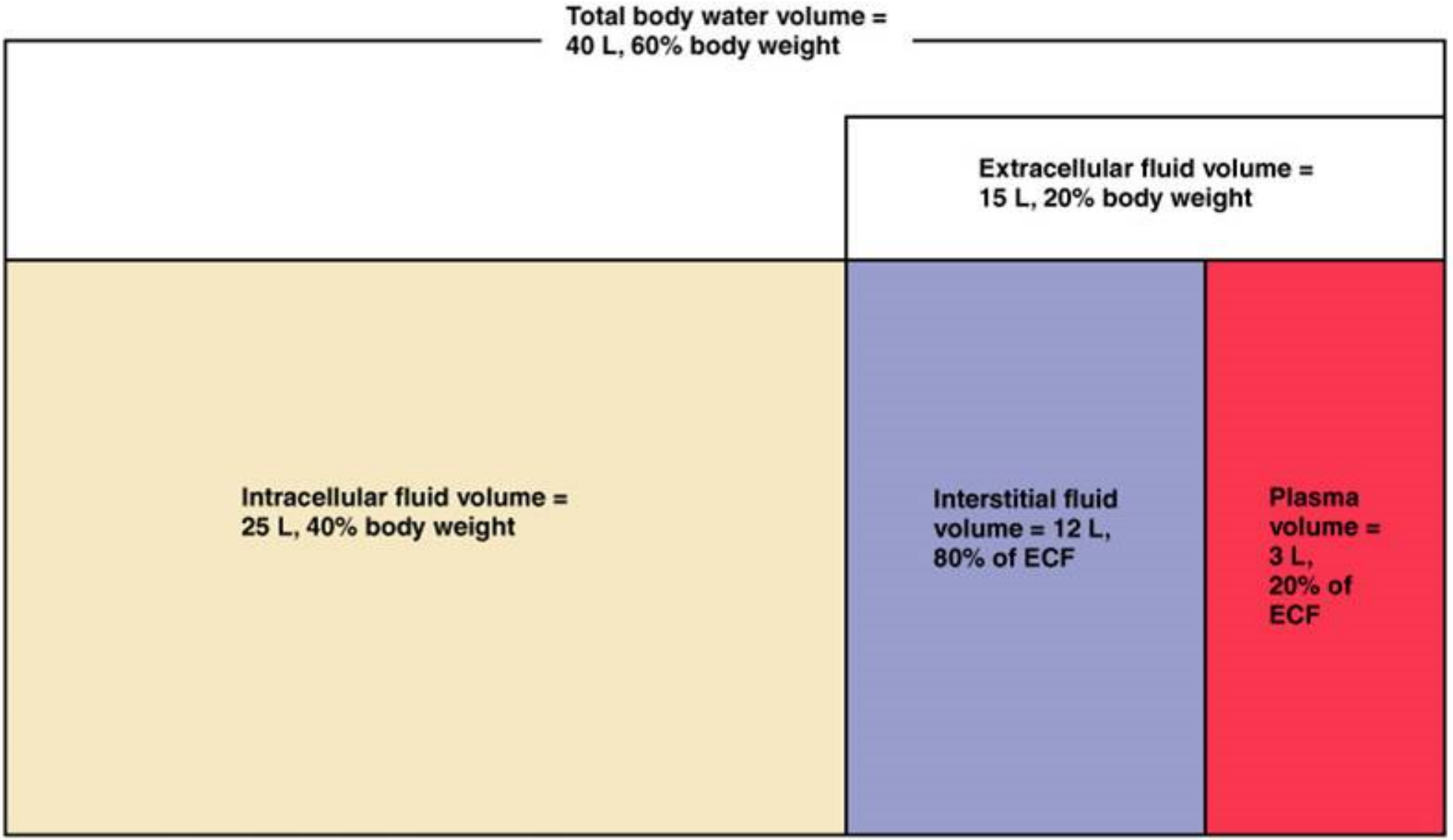
Body Water Compartments

- Intracellular water: 2/3 of TBW
- Extracellular water: 1/3 TBW
  - - Extravascular water: 3/4 of extracellular water
  - - Intravascular water: 1/4 of extracellular water

Body Fluid Compartments



Moises Dominguez


Total body water volume =
40 L, 60% body weight
Extracellular fluid volume =
15 L, 20% body weight
Intracellular fluid volume =
25 L, 40% body weight
Interstitial fluid
volume = 12 L,
80% of ECF
Plasma
volume =
3 L,
20% of
ECF

Electrolyte physiology:

- Primary ECF cation is Na
- Very small contribution of K , Ca 2+ , and Mg 2+
- Primary ICF cation is K
- Smaller contribution from Mg $^{2+}$ & Na

Fluid and Electrolyte Regulation

- Volume Regulation
  - Antidiuretic Hormone
  - Renin/angiotensin/aldosterone system
  - Baroreceptors in carotid arteries and aorta
  - Stretch receptors in atrium and juxtaglomerular aparatus
  - Cortisol

Fluid and Electrolyte Regulation

- Plasma Osmolality Regulation
  - Arginine-Vasopressin (ADH)
  - Central and Peripheral osmoreceptors
- Sodium Concentration Regulation
  - Renin/angiotensin/aldosterone system
  - Macula Densa of JG apparatus

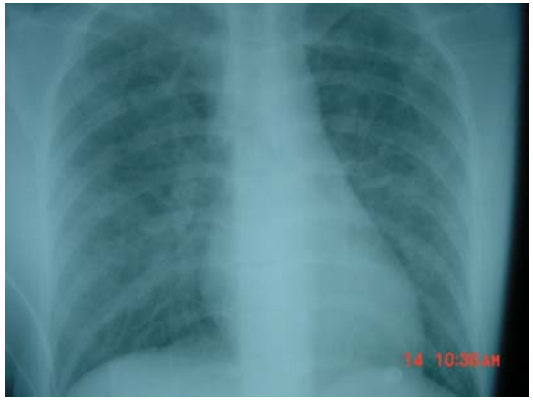
The aim of fluid, electrolytes, and blood therapy

- The final goal is delivery of adequate oxygen to the tissues.
- Factors affecting oxygen delivery equation includes:
- cardiac output (= stroke volume × heart rate);
- haemoglobin concentration;
- oxygen saturation

Desirable outcome of fluid resuscitation

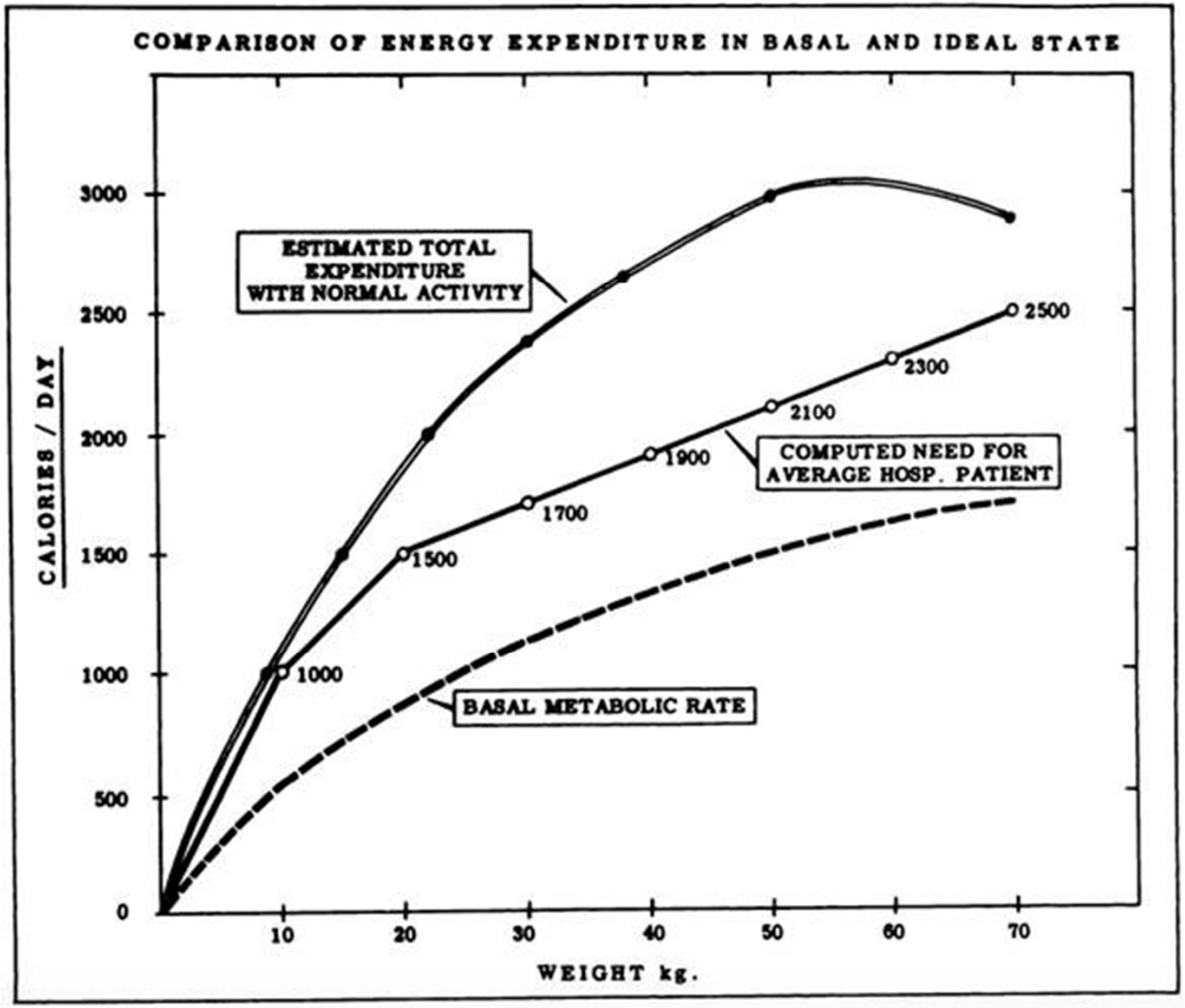
- No hypo perfusion

- -No volume overload.



History of fluid therapy

- Blackfan and Maxcy[1] in 1918 gave 0.8% saline by intraperitoneal injection to nine infants with dehydration and all recovered.



Pediatrics 1957.
Holliday Segar

Assessment of Fluid Status

- - Input and output chart
- blood pressure: supine and standing
- heart rate
- skin turgor and capillary refill
- - urinary output
- serum electrolytes/osmolarity
- mental status
- Non/Minimal invasive: arterial line wave and measurement of SVV,CI, TTE or TEE, Massimo measument of PVI.
- Invasive: CVP (normal 4-8 mmHg), pulmonary artery –capillary wedge pressure.

Perioperative Fluid Requirements

- The following factors must be taken into account:
- 1- Maintenance fluid requirements
- 2- NPO and other deficits e.g NG suction
- 3- Third space losses
- 4- Replacement of blood loss
- 5- Special additional losses: diarrhea

1- Maintenance Fluid Requirements

- Insensible losses such as evaporation of water from respiratory tract, sweat, feces, urinary excretion. Occurs continually.
- "4-2-1 Rule"
  - - 4 ml/kg/hr for the first 10 kg of body weight
  - - 2 ml/kg/hr for the second 10 kg body weight
  - - 1 ml/kg/hr subsequent kg body weight
  - - Extra fluid for fever, tracheotomy, denuded surfaces

2- NPO and other deficits

- NPO deficit = number of hours NPO x maintenance fluid requirement.
- Measurable fluid losses, e.g. NG suctioning, vomiting, ostomy output, biliary fistula and tube.

3- Third Space Losses

- Isotonic transfer of ECF from functional body fluid compartments to non-functional compartments.

- Depends on location and duration of surgical procedure, amount of tissue trauma, ambient temperature, room ventilation.

Replacing Third Space Losses

- Superficial surgical trauma: 1-2 ml/kg/hr
- Minimal Surgical Trauma: 3-4 ml/kg/hr
  - - head and neck, hernia, knee surgery
- Moderate Surgical Trauma: 5-6 ml/kg/hr
  - - hysterectomy, chest surgery
- Severe surgical trauma: 8-10 ml/kg/hr (or more)
  - AAA repair, open nephrectomy

4- Blood Loss

- Each 1cc of blood loss is replaced by 3 cc of crystalloid solution (crystalloid solutions leave the intravascular space)

- When using blood products or colloids replace blood loss volume per volume

5- Other additional losses

- Ongoing fluid losses from other sites:
  - - gastric drainage
  - - ostomy output
  - - diarrhea
- Replace volume per volume with crystalloid solutions

Example

- 62 y/o male, 70 kg, for laparotomy bowel resection (hemicolectomy)
- NPO after 2200, surgery at 0800.
- 3 hour procedure, 500 cc blood loss
- What are his estimated intraoperative fluid requirements?

Example (cont.)

- Maintenance: 110 x 3hrs = 330mls
- Fluid deficit (NPO): 110 x 10 hrs = 1100 ml : (Replace 1/2 first hr, 1/4 2nd hr, 1/4 3rd hour).
- Third Space Losses: 6 ml/kg/hr x 3 hrs = 1260 mls
- Blood Loss: 500ml x 3 = 1500ml
- Total = 330 +1100+1260+1500=4190mls

Intravenous Fluids:

- Conventional Crystalloids
- Colloids
- Hypertonic a
- Blood/blood products and blood substitutes

Crystalloids

- Combination of water and electrolytes
  - Isotonic salt solution:
  - electrolyte composition and osmolality similar to plasma; example: normal saline. (Balanced salt solution): lactated Ringer's, Plasmlyte, Normosol.
  - Hypotonic salt solution:
  - electrolyte composition lower than that of plasma; example: D5 Half normal saline, D5W(water and dextrose).
  - Hypertonic salt solution:
  - 2.7% NaCl.

Crystalloid solutions
Normal saline
0.9 %NaCl

- Composistion: Isotonic 0.9%: 9g/l ,
- Na 154, Cl 154.
- Osmolarity: 304mosmol/l

- Disadvantages: Hyper-chloremic acidosis

Crystalloids
Lactated Ringer's

- Composition: Na 130, cl 109, K 4, ca 3, Lactate 28.
- Osmolarity 273mosmol/l
- -Sydney Ringer 1880
- -Hartmann added Lactate=LR
- -Minor advantage over NaCl
- Disadvantages:
- -Not to be used as diluent for blood (Ca citrate)
- -Low osmolarity, may lead to high ICP
- - Caution in kidney failure, in brain injury, high blood sugar.

Crystalloids in trauma Advantages:

- -Balanced electrolyte solutions
- -Buffering capacity (Lactate)
- -Easy to administer
- -No risk of adverse reactions
- -No disturbance of hemostasis
- -Promote diuresis
- -Inexpensive

Hypertonic Solutions

- Fluids containing sodium concentrations greater than normal saline.
- Available in 1.8%, 2.7%, 3%, 5%, 7.5%, 10% solutions.
- Hyperosmolarity creates a gradient that draws water out of cells; therefore, cellular dehydration is a potential problem.

Hypertonic saline

- Advantages:
- -Small volume for resuscitation.
- -Osmotic effect
- -Inotropic effect (increase calcium influx in sarculima)
- -Increase MAP, CO
- -Increase renal, mesenteric,splanchnic, coronary blood flow.

Hypertonic saline

- Disadvantages:
- increase hemorrhage from open vessels.
- Hypernatremia
- Hyperchloremia.
- Metabolic acidosis.

Crystalloids
Dextrose 5%water

- Composition: 50g/l dextrose and water.
- Osmolality : 253
- Disadvantages:
- -enhance CO2 production
- -enhance lactate production
- -aggravate ischemic brain injury

Colloids

- Fluids containing molecules sufficiently large enough to prevent transfer across capillary membranes.
- Solutions stay in the space into which they are infused (remain intravascular).
- Examples: hetastarch (Hespan), albumin, dextran.

Colloids

- Advantages:
- -Prolonged plasma volume support
- -Moderate volume needed
- -minimal risk of tissue edema
- -enhances microvascular flow