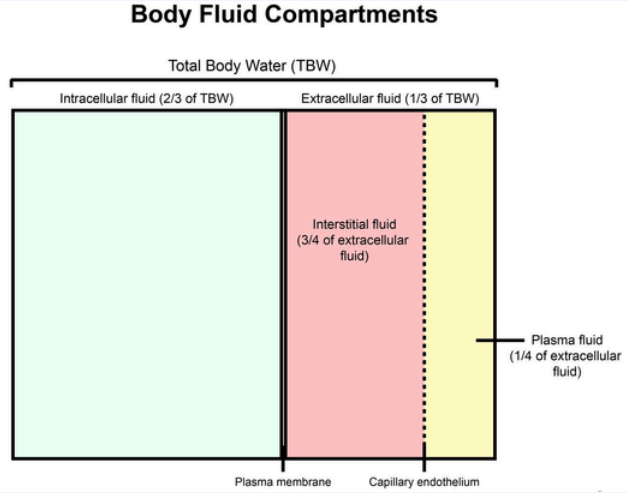
FLUID MANAGEMENT FACTSHEET

MUM IMS

Body water compartments

- Intracellular fluid: 2/3 of TBW
- Extracellular fluid: 1/3 of TBW
  - Intravascular (plasma): 1/4 of ECF
  - Extravascular (interstitial fluid): 3/4 of ECF



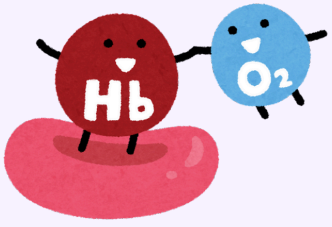
Electrolyte physiology

- Primary ICF cation: K+
- Primary ECF cation: Na+

Fluid & electrolyte regulation

- Volume regulation
  - Antidiuretic hormone
  - Renin-angiotensin-aldosterone system
  - Baroreceptors in carotid arteries and aorta
  - Stretch receptors in atrium and juxtaglomerular apparatus
  - Cortisol
- Plasma osmolality regulation
  - ADH
  - Central and peripheral osmoreceptors
- Sodium concentration regulation
  - Renin-angiotensin-aldosterone system
  - Macula densa of juxtaglomerular apparatus

The aim of maintenance of fluid, electrolytes, acid-base balance and blood volume
Final goal: delivery of adequate O2 to tissues



Assessment of fluid status

- Input and output chart
- Blood pressure: supine and standing
- Heart rate
- Skin turgor and capillary refill
- Serum electrolytes / osmolarity
- Mental status
- Central venous pressure (normal 4-8 mmHg)

Perioperative fluid requirements

The following factors must be taken into account:

1. Maintenance fluid requirements	Insensible losses e.g. evaporation of water from respiratory tract, sweat, faeces, urinary excretion. Occurs continually.	4-2-1 Rule • 4 ml/kg/hr for first 10kg of body weight • 2 ml/kg/hr for second 10kg of body weight • 1 ml/kg/hr for subsequent body weight
2. NPO and other deficits	• NPO deficit = number of hrs NPO x maintenance fluid requirement • Bowel prep = may result in up to 1L fluid loss • 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 temp, room ventilation.
		• 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, nephrectomy

4. Blood loss	• Each 1cc of blood loss is replaced by 3cc of crystalloid solution • When using blood products or colloids, replace volume per volume	
5. Other additional losses	• Ongoing fluid losses from other sites (e.g. gastric drainage, ostomy output, diarrhoea)	• 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, received bowel prep
- 3 hr procedure, 500 cc blood loss

What are his estimated intraoperative fluid requirements?

- Maintenance: 110 x 3hrs = 330 mL
  - Using "4-2-1 Rule": (4x10) + (2x10) + (1x50) = 110mL/hr
- Fluid deficit
  - NPO deficit: 110 x 10hrs = 1100mL
  - Bowel prep: 1000mL
  - Total deficit: 2100mL
- Third space losses: 6mL/kg/hr x 3hrs = 1260mL
- Blood loss: 500mL x 3 = 1500mL
- **Total: 330 + 2100 + 1260 + 1500 = 5190mL**

FLUID MANAGEMENT FACTSHEET

MUM IMS

Intravenous fluids

Crystalloids

Combination of water and electrolytes

Normal saline

- Isotonic
- Composition: Na 154, Cl 154
- Osmolarity: 304 mOsm/L
- Disadvantages: hyperchloremic acidosis

Dextrose 5% water

- Composition: 50g/L
- Osmolality: 253 mOsm/L
- Disadvantages:
  - Enhance CO2 production
  - Aggravate ischemic brain injury

Lactated Ringer's solution

- Balanced salt solution
- Composition: Na 130, Cl 109, K 4, Ca 3, lactate 28
- Osmolarity: 273 mOsm/L
- Minor advantage over NaCl
- Disadvantages:
  - Not to be used as diluent for blood (Ca citrate)
  - Low osmolarity can lead to high ICP
  - Caution in kidney failure, brain injury, high blood sugar

Hypertonic solutions

- Fluids containing sodium conc. greater than normal saline
- Available in 1/8%, 2.7%, 3%, 5%, 7.5%, 10% solutions
- Advantage:
  - Small volume for resuscitation
  - Osmotic effect
  - Inotropic effect (increase Ca influx in sarcolemma)
  - Increase MAP, CO
  - Increase renal, mesenteric, splanchnic, coronary blood flow
- Disadvantages
  - Increase hemorrhage from open vessels
  - Hypernatremia
  - Hyperchloremia
  - Metabolic acidosis

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

- Dextran
- Gelatins
- Albumin
- Hetastarch 6%
- Pentastarch 10%
- Tetrastarch (voluven)

Advantages

- Prolonged plasma volume support
- Moderate volume needed
- Minimal risk of tissue oedema
- Enhances microvascular flow

Disadvantages

- Risk of volume overload
- Adverse effect on hemostasis
- Adverse effect on renal function
- Anaphylactic reaction
- Expensive

	Crystalloid	Colloid
Intravascular persistence	Poor	Good
Hemodynamic stabilization	Transient	Prolonged
Required infusion volume	Large	Moderate
Risk of tissue edema	Obvious	Insignificant
Enhancement of capillary	Poor	Good
Risk of anaphylaxis	-	Low to moderate
Colloid oncotic pressure	Reduced	Maintained
Cost	Inexpensive	More expensive

FLUID MANAGEMENT FACTSHEET

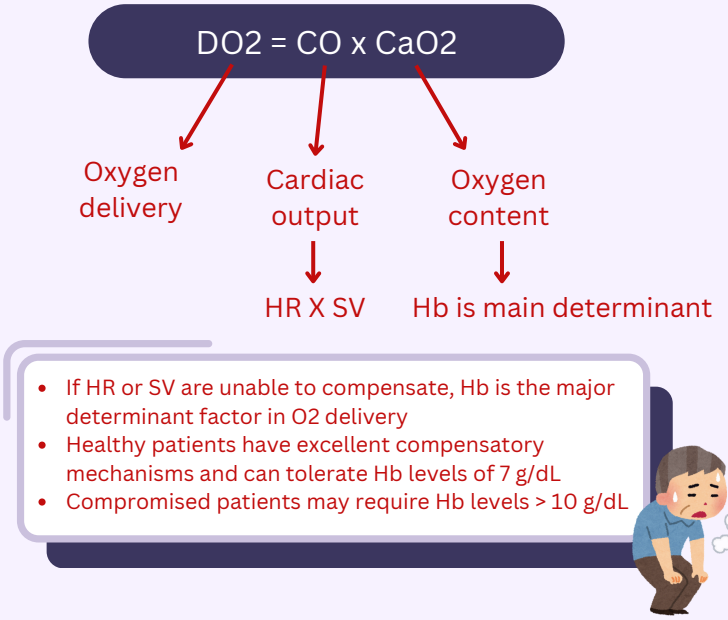
MUM IMS

Transfusion therapy

- Responsibility of transfusing perioperatively is with the anesthesiologist
- Up to 30% of blood volume can be treated with crystalloids. If blood loss >20% of blood volume and there is still on-going bleeding, this will necessitate blood transfusion

When is transfusion necessary?

- Transfusion trigger (Hb level at which transfusion should be given) varies with patients and procedures
- Tolerance of acute anaemia depends on:
  - Maintenance of intravascular volume
  - Ability to increase cardiac output
  - Increases in 2,3-DPG to deliver more of the carried O2 to tissues



Blood groups

	Group A	Group B	Group AB	Group O
Red blood cell type	A	B	AB	O
Antibodies in plasma	Anti-B	Anti-A	None	Anti-A and Anti-B
Antigens in red blood cell	A antigen	B antigen	A and B antigens	None

Cross match

	Donor's		Recipient's
Major cross match	Red cells	mixed with	Plasma
Minor cross match	Plasma		Red cells

- Agglutination occurs if either is incompatible

Type and screen

- Determination of the ABO and Rh grouping and screening for unexpected red cell antibodies
- Used when usage of blood is unlikely but needs to be available (e.g. hysterectomy)

Transfusion complications

- Hemolytic reactions
- Febrile reactions
- Allergic reactions
- TRALI
- Coagulopathy with massive transfusions
- Infection

Blood components

- **Whole blood**
  - Massive blood loss / trauma
  - Exchange transfusion
- **Packed red blood cells**
- **Platelets**
  - Thrombocytopenia, Plt <15 000
  - Bleeding and Plt <50,000
- **Fresh frozen plasma (contains all clotting factors)**
  - Coagulation factor deficiency
  - Fibrinogen replacment
  - DIC
  - Liver disease
  - Exchange transfusion
  - Massive transfusion
- **Cryoprecipitate (contains factor VIII & fibrinogen)**
- **Factor VIII**
- **Albumin**
- **Others: antibody concentrate, plasma protein fraction**