Anesthesia
TEAM 437

Intravenous Fluid Resuscitation and Blood Transfusion

- To estimate the perioperative fluid requirements and to prescribe/calculate fluid therapy.
- Identify perioperative factors that affect the patient's fluid requirements.
- To detect the common conditions associated with preoperative fluid deficit.
- To assess a patient with a volume deficit.
- Describe different fluids components and illustrate the advantages and disadvantages of each type.
- Recognize the different types of blood and blood products and to discuss the indications of each type and complications.

Important - Golden Note- Notes-436 Notes

Important to know: Types of fluids and characteristic of each type (colloid, crystalloid, albumin), composition of NS and RL, how to calculate maintenance and NPO deficit, third space loss definition, complications and management of blood products transfusion. I know the lecture is too long, but stick to the basics only

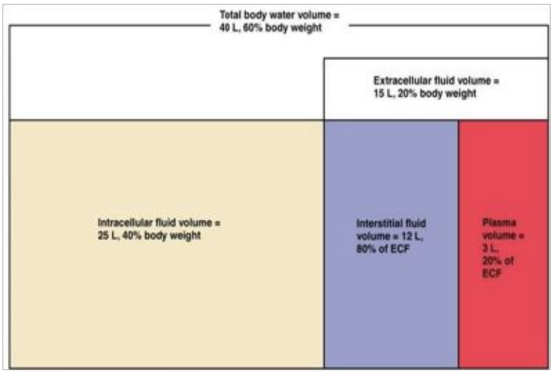
Scenarios Given By Doctor:

1- 25 y/o patient comes to the ER with acute appendicitis and they call surgical team and they assess that he needs an appendectomy. He had a 2 days history of nausea, vomiting and can't tolerate oral intake. In ER he is febrile with tachycardia and hypotension. - He needs blood or fluid? Fluids
2- Same patient but involved in RTA, and had severe splenic rupture and severe bleeding, he lost more than 20% of his total blood volume, with Tachycardia and hypotension. - We will start fluid and then for sure he needs blood.

Physiology

Total body water (TBW):

- It varies with age and gender
- The 70 kg (standard male) contains 42L
  - 60% body weight in males
  - 50% body weight in females
  - 80% body weight in newborn.
- Less in obese: fat contains little water



Body Water Compartments:

- Intracellular water: 2/3 of TBW
- Extracellular water: 1/3 of TBW
  - Extravascular water: ¾ of extracellular water
  - Intravascular water: ¼ of extracellular water

Electrolyte Physiology

- Primary ECF cation is Na
  - Very small contribution of K, Ca +2 , & Mg +2
- Primary ICF cation is K (controlled by cell membrane Na/K ATPase pump)
  - Smaller Contribution from Mg +2& Na
- Water moves through cells by osmotic pressure

Fluid & Electrolyte Regulation

- Volume regulation (volume sensors)
  - Antidiuretic hormone
  - Renin-angiotensin-Aldosterone system
  - Baroreceptors in carotid arteries & aorta
  - Stretch receptors in atrium & juxtaglomerular apparatus
  - Cortisol stress hormone
- Plasma osmolality regulation (osmotic sensors)
  - Arginine-vasopressin (ADH)
  - Central and peripheral osmoreceptors
- Sodium Concentration regulation (osmotic sensors)
  - Renin-angiotensin/aldosterone system
  - Macula Densa of JG apparatus

The aim of maintenance of fluid, electrolytes, acid-base balance & blood volume

- The final goal is the delivery of adequate oxygen to the tissues.
- Factors affecting oxygen delivery equation includes:
  - Cardiac output = Stroke volume X Heart rate (SV is the amount of blood pumped by the heart per beat.)
  - Hemoglobin concentration
  - Oxygen saturation
- The desirable outcomes of fluid resuscitation (Avoid overhydration)
  - No peripheral edema
  - No ARDS (acute respiratory distress) or pulmonary edema

Assessment of Fluid Status

- Input & output chart
- Blood pressure: supine & standing if there is a difference between the readings of more than 20 in systolic or 10 in diastolic it called Orthostatic hypotension.
- Heart rate (when pt is dehydrated or hypovolemic there will be reflex tachycardia).
- Skin turgor decreases & capillary refill takes more time
- Urinary output decrease
- Serum electrolyte/osmolarity especially if the patient is vomiting or has diarrhea
- Mental status affected with severe dehydration
- As monitors: Non/minimal invasive: arterial line wave & measurement of Stroke volume variation, Cardiac index, Transthoracic/Esophageal Echo, Massimo measurement of Pleth Variability Index (PVI)[1]
- As monitors: Invasive: CVP (normal 4-8 mmHg), pulmonary artery catheter

1. is an automatic measure of the dynamic change in Pi that occurs during the respiratory cycle.

Perioperative Fluid Requirement (Important)

➔ 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

Maintenance Fluid Requirements

➔ Insensible losses such as evaporation of water from the respiratory tract, sweat, feces, urinary excretion occur continually.

➔ How to calculate? by "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 of body weight
- 1 ml/kg/hr for subsequent body weight
- Extra fluid for fever, tracheotomy, denuded surfaces.

E.g: Pt 60 kg = (10x4) + (10x2) + (40x1) = 100. So his maintenance is 100 ml/h.
Take in consideration if pt is febrile or tracheostomy, he will need more.

NPO & other deficits (like a pt fasting for 8h or more after a procedure)

➔ NPO deficit = number of hours NPO x maintenance fluid compartment.

For previous pt, if he was fasting for 8h: 100 x 8 = 800 Given in this pattern: in first hour ½, second hour ¼, third hour ¼, so 400>200>200.

إذا العمليّة مدتها ساعة، أعطيه نصف الكمّية (400 وبس هو لما يصحى يصير يعّوض الباقي ^ بنفسه.

➔ Measurable fluid losses e.g. NG suctioning, vomiting, ostomy output, biliary fistula & tube

Don't forget additional losses.

Third space losses

- Isotonic transfer of ECF from functional body fluid compartments to non-functional compartments.
- E.g. in open abdominal procedure, fluids will move to abdominal cavity(non-functional). In open procedures we need more fluid replacement than in close procedures.
- Depends on:
  - Location, duration and type of surgical procedure.
  - Amount of tissue trauma. The bigger the more fluid you give
  - Ambient temperature
  - Room ventilation
- Replacing third space losses
  - Superficial surgical trauma: 1-2 ml/kg/hr
    - Laparoscopy
  - Minimal surgical trauma: 3-4 ml/kg/hr
    - Head & 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) we might reach 15m/kg
    - Abdominal Aortic Aneurysm(AAA) repair, open nephrectomy, open laparotomy.

    Don't forget Maintenance all the same time

Blood loss

- Not every blood loss in surgery is replaced by blood, to some extent it can be replaced by fluids. Here we are talking about when we can replace blood loss with fluid.
- Each 1 cc of blood loss is replaced by 3 cc of crystalloid solution (the crystalloid solutions leave the intravascular space, that's why we need more).
- When using blood products or colloids replace blood loss volume by volume 1:1. Cause colloids have bigger molecules which will remain intravascular

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 (hemi-colectomy), NPO after 22:00, surgery at 8:00, 3 hours procedure, 500 cc blood loss. What are his estimated intraoperative fluid requirements?
- Maintenance: 110 x 3h = 330 ml
- Fluid deficit (NPO): 110 x 10h = 1100 ml (replace ½ first h, ¼ 2nd hour, ¼ 3rd hour).
- Third space losses: 6 ml/kg/hr x (70) x 3 hrs = 6x70x3= 1260 ml.
- Blood loss: 500 ml x 3 = 1500 ml. If colloid 500 ml
- Total = 330 + 1100 + 1260 + 1500 = 4190 ml. Total by the end of the surgery should be taken

For each one, it's important to know what does it mean and how to calculate it

في الواقع
Maintenance is per hour= 110 ml/hr
3rd space loss 420 ml/hr (6x70)
110+420 ml/hr = 530 ml/hr

Intravenous Fluids

- Conventional crystalloids
- Colloids
- Hypertonic solutions
- Blood/blood products & blood substitutes.

Crystalloids

Combination of water & electrolytes. EXTRA: Its half-life is 20-30m.
- Isotonic salt solution
  - Electrolyte composition & osmolality is similar to plasma.
  - Examples: normal saline. (balanced salt solution): lactated Ringer's, plasmlyte, Normosol.
- Hypotonic salt solution
  - Electrolyte composition is lower than that of plasma.
  - Examples: D5 half normal saline, D5W (water & dextrose).
- Hypertonic salt solution
  - Electrolyte composition more than the plasma
  - 2.7% NaCl

Normal Saline (0.9% NaCl)		
Composition	Osmolarity	Disadvantages
Isotonic 0.9%: 9g/L, Na 154, Cl 154.	304 mosmol/l, nearly similar to plasma.	Hyperchloremic acidosis

Lactated Ringer's		
Compositions	Osmolarity	Disadvantages
Na 130, Cl 109, K 4, Ca 3, Lactate 28. Similar to plasma	-273 mosmol/l, nearly similar to plasma. But less than normal saline. -Sydney Ringer 1880, old name then after adding lactate it called Hartman RL. -Hartmann added lactate = LR -Minor advantage over NaCl, it means that both are nearly similar.	-Not to be used as diluent for blood (Ca citrate). Not used with blood, it has Ca and blood has citrate, together they cause blood clot. NS used instead. -Low osmolarity, may lead to high ICP. Better not given to pt with high ICP or with neurological surgery. -Caution in kidney failure (mainly because of K), in brain injury (trauma patients), high blood sugar (Lactate converted to sugar in the liver. Don't give to uncontrolled DM)

Hypertonic saline		
Composition	Osmolarity	Disadvantages
-Fluids containing sodium concentrations **greater** than normal saline. -Available in 1.8 %, 2.7%, 3% (we use this in our hospital,) 5%, 7.5%, 10% solutions. -Hyperosmolarity creates a gradient that draws water out of cells; therefore, cellular dehydration is a potential problem. (increases blood osmolarity) Just to correct electrolyte not volume resuscitation.	- Small volume for resuscitation. Because it may cause cellular dehydration. - Osmotic effect - Inotropic effect (increase calcium influx in sarcolemma) - Increase MAP, CO - Increase renal, mesenteric, splanchnic, coronary blood flow. - Used in pts with decreased Na (Renal dis)	- Increase hemorrhage from open vessels. Bc it increases blood flow - Hypernatremia - Hyperchloremia - Metabolic acidosis - Not given as bolus

Dextrose 5% water no sodium, just sugar and water		
Composition	Osmolarity	Disadvantages
50g/l dextrose & water.	253 low (hypotonic)	- Enhances CO_2 production. - Enhances lactate production - Aggravate ischemic brain injury.

Crystalloids in trauma

- Advantages:
  - Balanced electrolyte solutions
  - Buffering capacity (Lactate)
  - Easy to administer
  - No risk of adverse reactions, no anaphylactic effect.
  - No disturbance of hemostasis
  - Promote diuresis increases perfusion
  - Inexpensive

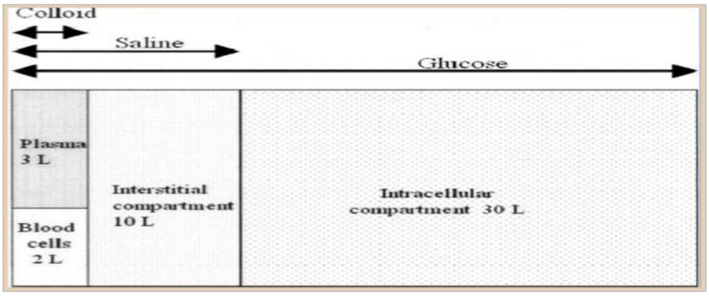
Colloids

- Fluids containing molecules sufficiently large enough to prevent transfer across capillary membranes.
- Solutions stay in the space into which they are infused (remain intra-vascular).
- Advantages:
  - Prolonged plasma volume support, long term hemodynamic stability.
  - Moderate volume needed
  - Minimal risk of tissue edema can not move into tissue
  - Enhances microvascular flow
- Disadvantages:
  - Risk of volume overload. Careful in cardiac and renal problems pts.
  - Adverse effect on hemostasis unlike crystalloids
  - Adverse effect on renal function
  - Anaphylactic reaction
  - Coagulopathy
  - Expensive

- ➔ Examples: the doctor just mentioned Gelatins and Albumin.
- ➔ Gelatins
  - Derived from hydrolyzed bovine collagen
  - Metabolized by serum collagenase
  - 0.5-5 hrs
  - Disadvantages:
    - Histamine release (H1 blockers recommended)
    - Decrease Von W factor (VWF) and cause bleeding.
    - Bovine spongiform encephalopathy, 1:1000.000 rare.
- ➔ Albumin
  - Heat treated preparation of human serum
  - 5% (50 g/l) is used for volume expansion, half of infused volume will stay intravascular. (volume support; diluted in normal saline).
  - 25% (250 g/l) used only in case of hypoalbuminemia (not bolus only infusion)
  - Disadvantages:
    - Cardiac decompensation after rapid infusion of 20-25% albumin.(in cardiac diseases)
    - Decreased ionized Ca +2 cause calcium binds to it
    - Impaired Na+/water excretion from renal dysfunction. rare
- ➔ Hetastarch (Hespan): synthetic, 6% preparation in isotonic saline MW 240,000, dose 20ml/kg/day. Stopped All starches big molecules , causes coagulopathy, allergic reaction, renal insufficiency
  - Disadvantages:
    - Hyperamylasemia
    - Allergy
    - Coagulopathy
- ➔ Pentastarch 10%: MW: 200,000D, DS 0.5 Stopped
  - Low cost
  - Extensive clinical use in sepsis, burns
  - Potential to diminish vascular permeability & reduces tissue edema.
- ➔ Tetrastarch (Voluven): MW 130,000 D Stopped
  - Used for volume therapy
  - Dose: 50 ml/kg/day.
- ➔ Dextran: it inhibits platelet aggregation (bleeding)

Only the red	Osmolality	Na	Cl	K
LD5W	253	0	0	0
0.9 NS	308	154	154	0
LR	273	130	109	4.0
Plasma-lyte	294	140	98	5.0
Hespan	310	154	154	0
5% Albumin	308	145	145	0
3% Saline	1027	513	513	0

Important Table	Crystalloid	Colloid
Intra-vascular resistance	poor	Good
Hemodynamic stabilization	Transient	Prolonged (better)
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 or high
Cost	inexpensive	More expensive



Crystalloid or Colloids?

- ACS protocol for ATLS [2]:
  - Replace each ml of blood loss with 3 ml of crystalloid fluid (3 for 1 rule).
- Patient response:
  - Rapid
  - Transient
  - Non-responsive

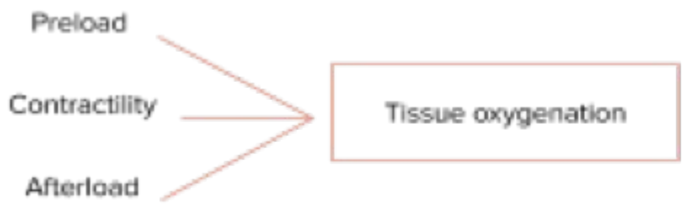
Goal directed fluid therapy in the perioperative setting

- Briefly, we don't want to give pt too much fluid and put him in positive balance (edema), and we don't want to put him in a negative balance (dehydration), our goal is Zero balance.
- GDT is a term used to describe the use of cardiac output (CO) or similar parameters to guide the IV fluids & inotropic therapy.

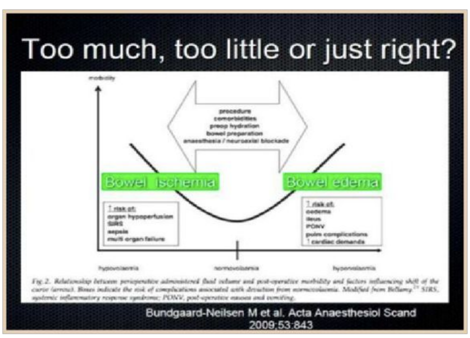
2. American Trauma Life Support

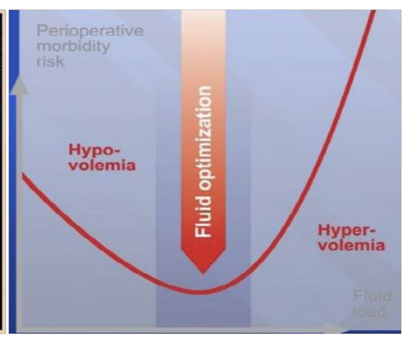
- ➔ It involves goal directed manipulation of: when treating, we look into theses three parameters for tissue oxygenation, not only give fluid.

Preload: Give fluids
Contractility: inotropic
Afterload: dilated? Give vasopressors



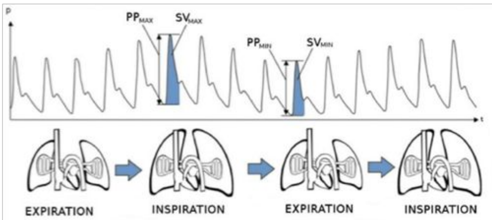
- ➔ Optimal perioperative fluid management is an important component of the ERAS pathways (Enhanced Recovery After Surgery).
- ➔ It can reduce postoperative complications.
- ➔ In some low-risk patients undergoing low-risk surgery, a "**zero-balance**" approach is encouraged.

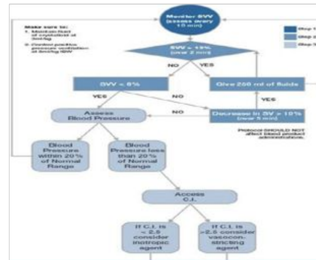
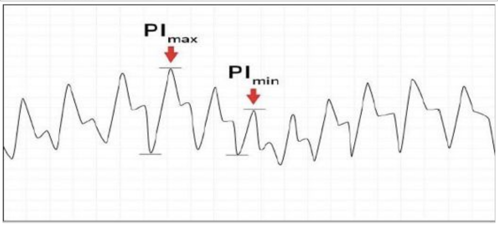




Non/Minimal invasive measures: "for your information"

- ➔ **Edwards life-science** (connected with arterial line): measures stroke volume variation (SVV), the more increase in variation means more fluid need to be given. That is "the change in the amount of blood ejected from the left ventricle into the aorta with each heartbeat"
- ➔ This is reflected by arterial blood pressure changes in relation to the pattern of respiration.
- ➔ Stroke volume variation (For use on control ventilated patients). Variation in arterial pulsations caused by volume changes during positive pressure inspiration. The more the variation the more the patient needs fluid
- ➔ **Masimo measurement of PVI (Pleth Variability Index)**, a noninvasive and continuous measurement of the dynamic changes in perfusion index (Pi) that occur during respiratory cycles, as the basis of a goal-directed fluid therapy (GDFT).
- ➔ Pi reflects the amplitude of the pulse oximeter waveform. Pi is expressed as a percentage (0.02- 20%) the higher the variation -> give fluids
- ➔ If the variability is not high , look for another cause.



Transfusion Therapy

- ➔ 60% of transfusions occur perioperatively
- ➔ The responsibility of transfusing perioperative is with the anesthesiologist.
- ➔ Up to 30% of blood volume can be treated with crystalloids. Less? no need blood
- ➔ Up to 30% we can give fluids , more? Blood.
- ➔ If blood loss exceeds 20% of blood volume & still there is ongoing bleeding this will necessitate blood transfusion.
- ➔ In OR we don't wait for the 30% as soon as we lose 20% we give blood.
- ➔ Blood volume formula (It's different from male to female, from adult to neonate...)
  - Neonate – 90 ml/kg
  - Infants 2 years old – 80 ml/kg
  - Adult female – 60 ml/kg
  - Adult male – 70 ml/kg
  - E.g. female with 50 kg, what is her blood volume? 50 x 60 = 3000ml = 3 L, whats 20% of her body volume? 3000x20/100 = 600ml . she will only bare 600ml loss. After that, I have to request blood. If male with 70 kg, his blood volume: 70 x 70 = 4900ml = around 5 L and ...

Why Blood Transfusion?

- ➔ Improvement of oxygen transport
- ➔ Restoration of red cell mass
- ➔ Correction of bleeding caused by platelet dysfunction
- ➔ Correction of bleeding caused by factor deficiencies

When is transfusion necessary?

- ➔ Transfusion trigger: Hb level at which transfusion should be given.
  - It varies among patients & procedures.
- ➔ Tolerance of acute anemia depends on:
  - Maintenance of intravascular volume.
  - Ability to increase cardiac output.
  - Increases in 2,3-DPG to deliver more of the carried oxygen to tissues. Hb dissociation curve will shift to the right which leads to more release of oxygen to the tissues

Oxygen delivery

- Oxygen delivery (DO2) is the oxygen that is delivered to the tissues.
- DO2 = CO x CaO2
  - Cardiac output (CO) = HR x SV
  - Oxygen content (CaO2)
    - (Hb x 1.39)[3] O2 Saturation + PaO2 (0.003)
    - Hb is the main determinant of oxygen content in the blood. Most imp
    Therefore, DO2= HR x SV x CaO2
- If HR or SV are unable to compensate, Hgb is the major determinant factor in O2 delivery.
- Healthy patients have excellent compensatory mechanisms & can tolerate Hgb levels of 7 mg/dL.
- Compromised patients may require Hb levels above 10 mg/dL

Blood Groups

Blood Group	Antigen on Erythrocyte	Plasma antibody
A	A	Anti-B
B	B	Anti-A
AB	AB	NONE
O	NONE	Anti-A & Anti-B
Rh	Rh	

Cross Match

We ask for crossmatch when we are sure we need blood transfusion,

- Major: donor's erythrocytes (packed cells) incubated with recipient's plasma. To see if there is any agglutination, hemolysis or complications, which means it's not compatible
- Minor: donor's plasma incubated with recipient's erythrocyte.
- Agglutination: occurs if either is incompatible.
- Type specific:
  - Only ABO-Rh determined. The chance of hemolytic reaction is **1:1000** with TS blood.

Type & Screen

without cross match, we do it when we are not sure we need blood. Just to book it

Donated blood that has been tested for ABO/Rh antigens and screened for common antibodies (NOT mixed with recipient blood).

- Used when usage of blood is unlikely, but needs to be available (as in hysterectomy).
- Allows blood to available for other patients. When i didn't use it
- Chance of hemolytic reaction: 1:10,000.

- Just take the blood of the pt and test the type, take blood from the bank with the same blood type and keep it without mixing, when needed we do cross match.

3. Fixed number

Blood components

- Whole blood is separated by differential centrifugation
  - Packed red blood cells (pRBC's)
  - Platelets
  - Fresh frozen plasma; it contains all clotting factors
  - Cryoprecipitate; it contains factor VIII & fibrinogen. Extra: Used in cases of hemophilia & Von Willebrand disease. Should be administered Preoperatively.
  - Factor VIII
  - Albumin
  - Others such as antibody concentrate, plasma protein fraction

Whole blood

- The whole blood is stored at 4C o for up to 35 days. For your information
- Indications:
  - Massive blood loss cause all components are lost
  - Trauma
  - Exchange transfusion
- Considerations:
  - Use I.V filters
  - Donor & recipient must be ABO identical. Should crossmatch

Packed red blood cells

only RBC

- 1 unit = 250 ml.
- Hct= 70-80%.
- 1 unit pRBC's raises Hb 1gm/dl
- Mixed with saline: LR has calcium which may cause clotting if mixed with pRBC's.
- RBC transfusions administration
- Dose:
  - Usual dose of 10 cc/kg infused over 2-4 hours. If i need to give fast in ER as bolus warm the blood. Why not always warming anyway? Heat cause blood hemolysis. So when u have time no need to warm.
  - Maximum dose of 15-20 cc/kg can be given to a hemodynamically stable patient. Unstable ? give until bleeding is controlled
- Procedure:
  - Filter is used routinely.
  - Monitoring.
  - DO NOT mix with medications. USE 2 I.V LINES, one for blood one for meds.
- Complications:
  - Rapid infusion may result in pulmonary edema.
  - Transfusion reaction.

Platelet concentrate

- It is stored up to 5 days at 20-24°
- Indications:
  - Thrombocytopenia, platelet <15,000.
  - Bleeding & platelet <50,000.
  - Non-invasive procedures and platelet <50,000.
  - Invasive major procedures and platelet less than 100,000.
  - Each unit increase platelet count by 10,000-20,000.
- Considerations:
  - Contain leukocytes and cytokines.
  - 1 unit/10 kg of body weight increases platelet count by 50,000.
  - Donor & Recipient must be ABO identical. No need for Rh compatible except in children.

Plasma & FFP

- Content: coagulation factors (1 unit/ml)
- Storage: FFP for 12 months at -18 degrees or colder. Once out we warm it. If warmed and not used? Throw away
- Indications:
  - Coagulation factor deficiency.
  - Fibrinogen replacement
  - DIC
  - Liver disease
  - Exchange transfusion
  - Massive transfusion. When reaching 4 units blood transfusion it's better to give plasma and FPP. the ratio then should be 1:1:1 , so give 4 plts and 4 FFP by then
- Each unit increases the level of coagulation factors by 2-3%.
- Considerations:
  - Plasma should be recipient RBC ABO compatible.
  - <u>In children, it should also be Rh-compatible.</u>
  - Usual dose is 20 cc/kg to raise coagulation factors approximately 20%.

Transfusion complications

- Hemolytic reactions (acute or delayed)

Wrong blood type administered. Most common cause.
Activation of complement system leads to intravascular hemolysis, spontaneous hemorrhage. Despite ABO compatibility
Signs:

- Hypotension
- Substernal pain, Back/abdominal pain
- Fever /Chills
- Dyspnea , Skin flushing
- Oliguria, Dark urine
- Pallor

<u>Signs are easily masked by General Anesthesia :</u>

1) Free Hgb in plasma or urine
2) Acute Renal Failure
3) Disseminated intravascular coagulopathy (DIC)

- Febrile reactions (FNHTR): non hemolytic
  - Most common & is usually controlled by slowing infusion & giving antipyretics.
- Allergic reactions: It resembles hemolytic reaction
  - Increased body temperature, Pruritus, Urticaria.
  - Rx:
    -Antihistamine
    -Discontinuation
  - Examination of plasma & urine for free hemoglobin helps rule out hemolytic reactions. That's why blood transfusion is always under monitor.
- Infection:
  - Transmission of viral diseases:
    - Hepatitis C: 1:300,000 per unit most common
    - Hepatitis B: 1:200,000 per unit
    - HIV 1:450,000-1:600,000 per unit
    - 22 day window for HIV infection & test detection
    - CMV may be the most common agent transmitted, but only affects immune-compromised patients.
    - Parasitic & bacterial transmission is very low
- Transfusion Related Acute Lung injury (TRALI) > injury not edema
- Coagulopathy with massive transfusions.
- Other complications:
  - Decreased 2,3-DPG: wit storage ? significance> shift of the curve to the left > ↑affinity of O2 to Hb
  - Citrate metabolism to bicarbonate; calcium binding > Hypocalcemia
  - Microaggregates (platelets & leukocytes) micropore filters controversial.
  - Hypothermia: warmers are used to prevent it. In rapid transfusion.
  - Coagulation disorders: massive transfusion (>10 units) may lead to dilution of platelets, Factor V & Factor VIII
  - DIC: uncontrolled activation of coagulation system.

What to do if an AHTR (acute hemolytic transfusion reaction) occurs

- Stop transfusion
- ABC's: give O2, protect the airway and intubation if needed, IV line.
- Maintain IV access & run IVF (NS or LR)
- Monitor & maintain BP/Pulse
- Give diuretics to protect the kidney
- Obtain blood & urine for transfusion reaction workup
- Send remaining blood back to blood bank

Blood bank workup of AHTR

- Check paperwork to assure no errors.
- Check plasma for hemoglobin.
- Repeat crossmatch from the blood bank
- Repeat blood group typing. For patient
- Blood culture. To exclude sepsis.

Monitoring in AHTR

- Monitor patient clinical status & vital signs
- Monitor renal status (BUN, creatinine)
- Monitor coagulation status (DIC panel- PT/PTT, fibrinogen, D-dimer/FDP, platelet, anti-thrombin-III)
- Monitor for signs of hemolysis (LDH, bilirubin, haptoglobin).

Massive blood transfusion

- Massive transfusion is generally defined as the need to transfuse one or two times the patients' blood volume. For most adult patients, that is the equivalent of 10-20 units.
- Complications:
  - Coagulopathy due to dilutional thrombocytopenia & dilution of the coagulation factors. So in 4th unit we immediately give platelet and FPP.
  - Citrate toxicity does not occur in most normal patients unless the transfusion rate exceeds 1 U every 5 mins. We have to monitor Ca+2 level, Most patients need calcium replacement.
  - Hypothermia, use warmer
  - Acid-base balance: The most consistent acid-base abnormality after massive blood transfusion is postoperative metabolic alkalosis.
  - Serum potassium concentration increase:
    - The extracellular concentration of potassium in stored blood steadily increases with time.
    - Hypokalemia is commonly encountered postoperatively, particularly in association with metabolic alkalosis.

Administering blood products

- Consent necessary for elective transfusion.
- Unit is checked by 2 people for unit #, patient ID, expiration date.
- RBC's are mixed with saline solution (NOT LR lactated ringer's).
- Products are warmed mechanically and given if condition permits.
- Close observation of patient for signs of complications. In OR, already monitored. In wards patient already connected to vital signs.
- If complications are suspected, infusion discontinued, blood bank notified & proper steps are taken.

Autologous blood

- Pre-donation of patient's own blood prior to elective surgery.
- 1 unit donated every 4 days (up to 3 units)
- Last unit donated at least 72 hrs prior to surgery. Not 48 hours not 24 hours.
- Reduces chance of hemolytic reactions and transmission of blood-borne diseases.
- Not desirable for compromised patients.
- We take blood from the same patient & transfuse their own blood back in case they need it. Done for patients who cannot accept any type of blood.
- Done in elective surgeries

Autotransfusion

- ➔ Commonly known as (cell-saver)
- ➔ Allows collection of blood during surgery for re-administration difficult to collect.
- ➔ RBC's are centrifuged from plasma.
- ➔ Effective when > 1000 ml are collected.

Questions

1. **If a newborn's weight is 4.3 Kilograms, how many kgs are attributed to Total Body Water?**
   A. 2 kgs
   B. 1.7 kgs
   C. 3 kgs
   D. 3.4 kgs

2. **Which of the following statements is true?**
   A. The primary cation in extracellular fluid is potassium
   B. The primary cation in the intracellular fluid is sodium
   C. The primary cation in the intracellular fluid is potassium
   D. The primary cation in the extracellular fluid is magnesium

3. **A 45 year old gentleman was admitted for laparoscopic cholecystectomy . His vital signs are stable , and is well hydrated with normal electrolytes. He weighs 70 kg. Which of the following would be his maintenance IV fluid?**
   A. 110 ml/hr
   B. 160 ml/hr
   C. 140 ml/hr
   D. 120 ml/hr

4. **A multiparous woman is undergoing emergency cesarean hysterectomy for a deeply implanted placenta. You are anticipating third space loss. Which of the following would be the most appropriate replacement?**
   A. 3-4 ml/kg/hr
   B.1-2 ml/kg/hr
   C. 5-6 ml/kg/hr
   D. 8-10 ml/kg/hr

5. **Each 1 cc of blood loss is replaced by :**
   A. 1 cc of crystalloid solution
   B. 2 cc of crystalloid solution
   C. 3 cc of crystalloid solution
   D. 4 cc of crystalloid solution

6. **Which of the following is administered preoperatively specifically for patients with Von Willebrand disease?**
   A. Packed red blood cells
   B. Fresh frozen plasma
   C. Albumin
   D. Cryoprecipitate

Q1 : D | Q2 : C | Q3 : A | Q4:C | Q5 : C | Q6 : D

Thank You

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Special thank you to
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