Editing file

Anesthesia 438 Team

# Intravenous Fluid Resuscitation and Blood Transfusion

## Objectives:

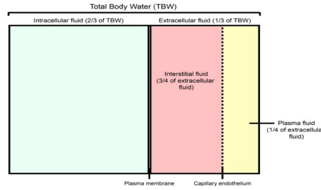
- To estimate the perioperative fluid requirement and to prescribe /calculate fluid therapy.
- Identify perioperative factors affect the patient fluid requirements
- To identify the common conditions associated with preoperative fluids deficit
- To assess a patient with a volume deficit
- Describe different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

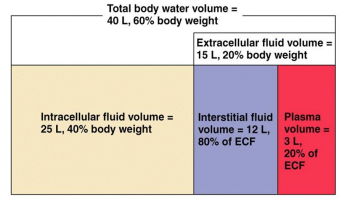
Color index:

- Red: important / IMPORTANT
- Black: content slides
- Gray: extra
- Green: dr. Notes

Anesthesia 438 teamwork

# 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 [2]

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 and the water by simple diffusion)
- Smaller Contribution from $Mg^{+2}$ & Na

## Fluid & electrolyte regulation:

| Volume regulation | Plasma osmolality regulation | Sodium concentration regulation |
|---|---|---|
| Volume sensors | Osmotic sensors | |
| •Antidiuretic hormone<br>•Renin-angiotensin-Aldosterone system<br>•Baroreceptors in carotid arteries & aorta<br>•Stretch receptors in atrium & juxtaglomerular apparatus<br>•Cortisol stress hormone | •Arginine-vasopressin (ADH)<br>•Central and peripheral osmoreceptors | •Renin-angiotensin/aldosterone system<br>•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

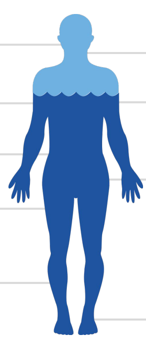
- Cardiac output = Stroke volume X Heart rate [1]
- Hemoglobin concentration
- oxygen saturation

## The desirable outcomes of fluid resuscitation

Avoid overhydration

- No peripheral edema or pulmonary edema
- No ARDS

## Assessment of fluid status



- Input & output chart
- Heart rate
- Urinary output
- Mental status affected with dehydration
- **Invasive monitors**: CVP (normal 4-8 mmHg), pulmonary artery catheter
- Blood pressure: supine & standing
- Skin turgor & capillary refill
- Serum electrolyte/osmolarity especially if there is vomiting and diarrhea
- **Non/minimal invasive monitors**: arterial line wave & measurement of Stroke volume variation (SVV), Cardiac index (CI), Transthoracic/transesophageal Echo (TTE/TEE), Massimo measurement of Pleth Variability Index (PVI)

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1- Also by preload, afterload and contractility.
2- Water moves through cells by osmotic pressure passively, normal electrolyte balance is important for normal myocardial, neurological function and acid-base balance and eventually normal O2 delivery to tissues

- **Doctor started with a 2 scenarios:**

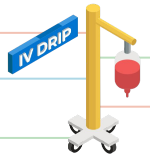
**1)** 25 y/o patient comes to the ER with acute appendicitis, they called the surgical team for assessment and they decided that he needed an appendectomy. He has a 2 day history of nausea, vomiting and can't tolerate oral intake. In ER he is febrile with tachycardia and hypotension.
- Does he need blood or fluids? Fluids.

**2)** A patient involved in RTA, had severe splenic rupture, liver laceration and severe bleeding, he lost more than 20% of his total blood volume and had tachycardia and hypotension.
- Does he need blood or fluids? We will start with fluids and then for sure he will need blood.

# Preoperative fluid requirement

## The following factors must be taken into account:

- Maintenance fluid requirements
- Third space losses
- Special additional losses: Nausea, Vomiting, Diarrhea




- NPO and other deficits e.g. NG suction
- Replacement of blood loss

## 1 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"[1]
    - 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.

## 2 NPO and other deficits

- NPO deficit = number of hours NPO x maintenance fluid requirements .[2]
- Measurable fluid losses e.g. NG suctioning, vomiting, ostomy output, biliary fistula & tube.

## 3 Third space losses

- Isotonic transfer of ECF from functional body (intravascular) fluid compartments to non-functional (interstitial) compartments.
- Depends on:
    - Location, duration and type of surgical procedure.[3]
    - Amount of tissue trauma.
    - Ambient temperature
    - Room ventilation
- Replacing third space losses:
    - Superficial surgical trauma: 1-2 ml/kg/hr, eg. 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) : Abdominal Aortic Aneurysm(AAA) repair, open nephrectomy.

## 4 Blood loss [4]

- Each 1 cc of blood loss is replaced by 3 cc of crystalloid solution (the crystalloid solutions leave the intravascular space.
- When using blood products or colloids replace blood loss volume per volume.

## 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 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 = 1260 ml.
- Blood loss: 500 ml x 3 = 1500 ml.
- Total = 330 + 1100 + 1260 + 1500 = 4190 ml

1- For example pt 60 kg > first hour 10 x 4 = 40 > second hour 10 x 2 = 20 > we have 40 kg left so 40 x 1 = 40 > total = 100 ml/hr
2- Continue on example (if the Pt is on NPO for 10 hours) then 10 x 100 = 1000 ml
3- In open procedures we need more fluid replacement than in closed procedures.
4- 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.

# Intravenous fluids

01 Conventional crystalloids

02 Colloids

03 Hypertonic Solutions

04 Blood/blood products & blood substitutes

## Crystalloids

Combination of water & electrolytes.

**Crystalloids**

**Hypotonic salt solution**

- Electrolyte composition is lower than that of plasma.
- Examples: D5 half normal saline, D5W (water & dextrose).

**Isotonic salt solution**

- Electrolyte composition & osmolality is similar to plasma.
- Examples: normal saline. (balanced salt solution), lactated Ringer's, plasmalyte, Normosol.

**Hypertonic salt solution**

- 2.7% NaCl
- Electrolyte composition is more than the plasma

| | Composition | Osmolarity | Disadvantages |
|---|---|---|---|
| Normal saline (0.9% NaCl): | Isotonic 0.9%: 9g/L, Na 154, Cl 154 | 304 mosmol/l nearly similar to plasma | Hyperchloremic acidosis |
| Lactated ringer [1]: | Na 130, Cl 109, K 4, Ca 3, Lactate 28 [2] | - 273 mosmol/l nearly similar to plasma.<br>- Sydney Ringer 1880<br>- Hartmann added lactate = LR<br>- Minor advantage over NaCl, both are similar. | - Not to be used as diluent for blood (Ca citrate [3]).<br>- Low osmolarity, may lead to high ICP[4].<br>- Caution in kidney failure, in brain injury, high blood sugar [2] |
| Dextrose 5% water (D5W): | 50 g/l dextrose & water | 253 (hypotonic, low) | - Enhances CO2 production.<br>- Enhances lactate production.<br>- Aggravate ischemic brain injury. |

1- LR is preferred in resuscitation unless there is contraindication, also known as Hartman solution
2- Lactate is converted to sugar in the liver which lead to increase blood sugar.
3- Risk of clot formation
4- Example in head injury > we use normal saline

# Intravenous fluids

## Hypertonic saline

- 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 [1]

**Advantages**

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

**DisAdvantages**

- Increase hemorrhage from open vessels.
- Hypernatremia
- Hyperchloremia
- Metabolic acidosis

### Advantages of Crystalloids in trauma

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

## 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).
- Examples: hetastarch (Hespan), albumin, dextran.

**Advantages**

- Prolonged plasma volume support.[2]
- Moderate volume needed.
- Minimal risk of tissue edema.
- Enhances microvascular flow

**DisAdvantages**

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

1- Not used in fluid resuscitation, we use it in electrolytes balance
2- Gives long term hemodynamic stability.

# Colloids examples

## Gelatins [1]

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

## Albumin [1]

Heat treated preparation of human serum.
**-5% (50 g/l) is used for volume expansion,** half of infused volume will stay intravascular used in volume resuscitation
**-25% (250 g/l) used only in case of hypoalbuminemia,** given by infusion
-20% (200 g/l)
**Disadvantages:**

- Cardiac decompensation after rapid infusion of 20-25% albumin.
- Decreased ionized Ca+2. [2]
- Impaired Na+/water excretion from renal dysfunction [3]

## Hetastarch (Hespan) [3]

Synthetic, 6% preparation in isotonic saline
MW 240,000D, dose 20 ml/kg/day.
Disadvantages:

- Hyperamylasemia
- Allergy
- Coagulopathy

## Pentastarch

10%: MW: 200,000D, DS 0.5
Low cost.
Extensive clinical use in sepsis, burns.
Potential to diminish vascular permeability & reduces tissue edema

## Tetrastarch (Voluven)

MW 130,000 D
Used for volume therapy.
Dose: 50 ml/kg/day

## Dextran [4]

It inhibits platelet aggregation (bleeding).

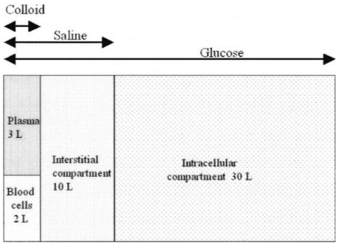
| | Osmolality | Na | Cl | K |
|---|---|---|---|---|
| D5W | 253 | 0 | 0 | 0 |
| 0.9 NS | 308 | 154 | 154 | 0 |
| LR | 273 | 130 | 109 | 4.0 |
| Plasma-lyte | 294 | 140 | 98 | 5.0 |
| Hespan | 310 | 154 | 154 | 0 |
| 5% Albumin | 308 | 145 | 145 | 0 |
| 3% Saline | 1027 | 513 | 513 | 0 |

1- Gelatins and Albumins are the most common colloids used in the OR, these two are the most important..
2- Because $Ca^{2+}$ will bind with albumin and will be in the non-ionized form.
3- You have to pay a special care for patients with renal dysfunction
4- polysaccharide

# Crystalloids OR Colloids?

| | Crystalloid | Colloid |
|---|---|---|
| **Intra-vascular resistance** | Poor | Good |
| **Hemodynamic stabilization** | Transient | Prolonged (advantage) |
| **Required infusion volume** | Large [1] | 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 |

**ACS protocol for ATLS:**
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

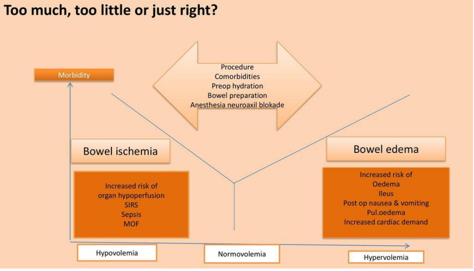
**GDT** is a term used to describe the use of cardiac output (CO) or similar parameters to guide the IV fluids & inotropic therapy.

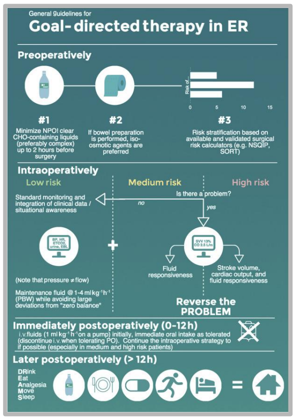
- It involves goal directed manipulation of:

Preload, Contractility, Afterload [3] → Tissue Oxygenation [2]

- 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.

| GDT approach | Zero-balance approach |
|---|---|
| requires invasive monitoring of dynamic hemodynamic parameters | ( restrictive ) replaces only fluid lost during the procedure |

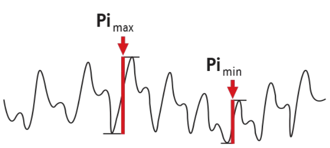


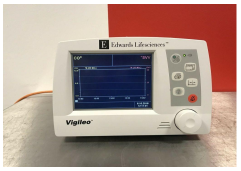




1- Because it will leave the intravascular space and only ⅓ will remain
2- When we give fluids we work on the preload, but the management should include all factors (contractility by administering inotropes and afterload by administering vasoconstrictors) to achieve the goal.
3- Describe cardiac function in septic patient where there's vasodilation & we need to give vasopressors to increase the afterload

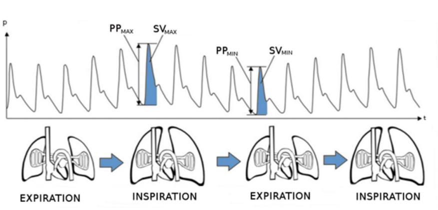
# Non/Minimal invasive measures

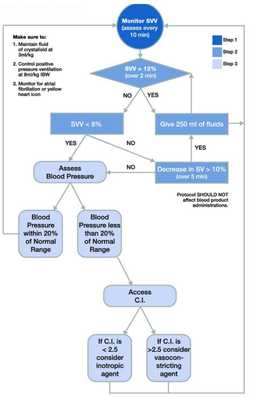
- **Edwards life-science**: measures stroke volume variation (SVV). That is "the change in the amount of blood ejected from the left ventricle into the aorta with each heartbeat".
- This is reflected by arterial blood pressure changes in relation to the pattern of respiration [1].
- Stroke volume variation (For use on control ventilated patients). Variation in arterial pulsations caused by volume changes during positive pressure inspiration [2,3].
- **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%).



Edward machine





If the cardiac index is less than 2.5 it's probably problem with the contractility, while if it's more than 2.5 it could be problem with the afterload

# Transfusion Therapy

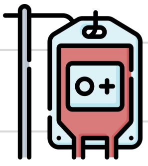
- 60% of transfusions occur perioperatively.
- The responsibility of transfusing perioperative is with the anesthesiologist.
- Up to 30% of blood volume can be treated with crystalloids.
- **If blood loss exceeds 20% of blood volume & still there is ongoing bleeding this will necessitate blood transfusion.**
- Blood volume formula:
  - Neonate – 90 ml/kg
  - Infants 2 years old – 80 ml/kg
  - Adult female – 60 ml/kg
  - Adult male – 70 ml/kg

1) **Estimate the blood volume of an adult female with weight of 50 Kg ?**
   - Answer: 60 ml X 50 Kg = 3000 ml = 3L
   - **How much blood she needs to lose for us to start blood transfusion?** 3000 x 0.2 (20%) = 600 ml
2) **Estimate the blood volume of an adult female with weight of 70 Kg ?**
   - Answer: 60 ml X 70 Kg = 4200 ml = 4.2 L

## Why blood transfusion

Improvement of oxygen transport

Correction of bleeding caused by platelet dysfunction




Restoration of red cell mass

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:

1. Maintenance of intravascular volume.
2. Ability to increase cardiac output.
3. Increases in 2,3-DPG to deliver more of the carried oxygen to tissues.[4]

1- That's why pts should be intubated and ventilated

2- ↑ Variation mean pt need fluids, ↓ or ↔ variation mean pt doesn't need fluids and if hypotensive other problem need to be sourced

3- Connected with arterial line.

4- Hb dissociation curve will shift to the right which leads to more release of oxygen to the tissues.

# Transfusion Therapy

## Oxygen delivery

**Oxygen delivery ($DO_2$)** is the oxygen that is delivered to the tissues.

$$DO_2 = CO \times CaO_2$$

**CO** Cardiac output
- HR x SV

**$CaO_2$** Oxygen content
- (Hb x 1.39[1]) $O_2$ Saturation + $PaO_2$ (0.003)
- Hb is the main determinant of oxygen content in the blood.

Therefore, $DO_2 = HR \times SV \times CaO_2$

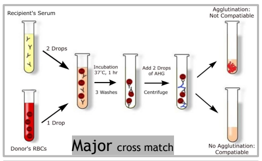
- If HR or SV are unable to compensate, Hb is the major determinant factor in $O_2$ delivery.
- Healthy patients have excellent compensatory mechanisms & can tolerate Hb levels of 7 mg/dL.
- Compromised patients may require Hb levels above 10 mg/dL.

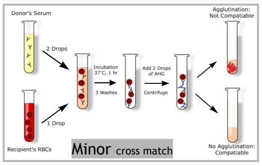
## Blood group

| 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

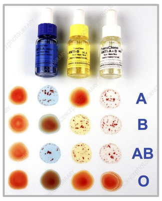
- Major: donor's erythrocytes (packed cells) incubated with recipient's plasma.
- Minor: donor's plasma incubated with recipient's erythrocyte.
- Agglutination: occurs if either is incompatible.
- Type specific: Only ABO-Rh determined.
  - The chance of hemolytic reaction is 1:1000 with TS blood.




## Type & screen [2]

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 be available for other patients.
- Chance of hemolytic reaction: 1:10,000.




1- Amount of maximum oxygen carrying capacity by Hb

2- Is the first thing you do, it only focus and tests the recipient blood, it doesn't look at the donor bag of blood. (without cross-match)

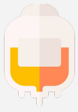
**Typing**: determines the patient's blood type.

**Screening**: screens the patients for the presence of other known antigens on the patient's RBCs.

# Blood components

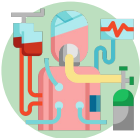
**Whole blood is separated by differential centrifugation into:**

- Packed red blood cells (pRBC's)
- Fresh frozen plasma; it contains all clotting factors
- Factor VIII
- Others such as antibody concentrate, plasma protein fraction
- Platelets
- Cryoprecipitate; it contains factor VIII & fibrinogen.[2]
- Albumin

| | Overview | Dose | Indication | Considerations |
|---|---|---|---|---|
| Whole blood  | The whole blood is stored at 4 ° for up to 35 days. | | •Massive blood loss<br>•Trauma<br>•Exchange transfusion | •Use I.V filters<br>•Donor & recipient must be ABO identical |
| Packed red blood cells  | •1 unit = 250 ml.<br>•Hct= 70-80%.<br>•Mixed with saline: LR has calcium which may cause clotting if mixed with pRBCs [1] | •1 unit pRBC raises Hb 1 gm/dl<br>•Usual dose of 10 cc/kg infused over 2-4 hours.[3]<br>•Maximum dose of 15-20 cc/kg can be given to a hemodynamically stable patient. | | **Procedure**:<br>•Filter is used routinely.<br>•Monitoring.<br>•DO NOT mix with medications.<br>**Complications**:<br>•Rapid infusion may result in pulmonary edema.<br>•Transfusion reaction. |
| Platelet concentrate  | It is stored up to 5 days at 20-24°<br><br>Contain leukocytes and cytokines. | Each unit increase platelet count by 10,000-20,000. | •Thrombocytopenia, platelet <15,000.<br>•Bleeding & platelet <50,000.<br>•Non-invasive procedures and platelet <50,000.<br>•Invasive major procedures and platelet less than 100,000. | 1 unit/10 kg of body weight increases platelet count by 50,000.<br>•Donor & Recipient must be ABO identical [4] |
| Plasma & FPP  | **Content**: coagulation factors (1 unit/ml)<br><br>**Storage**: FFP for 12 months at 18 degrees or colder. | •Each unit increases the level of coagulation factors by 2-3%.<br>•Usual dose is 20 cc/kg to raise coagulation factors approximately 20% | •Coagulation factor deficiency.<br>•Fibrinogen replacement<br>•DIC<br>•Liver disease<br>•Exchange transfusion<br>•Massive transfusion. | •Plasma should be recipient RBC ABO compatible.<br>•In children, it should also be Rh-compatible. |

1- But can be transfused in separate with 2 lines.
2- Used in cases of hemophilia & Von Willebrand disease. Should be administered Preoperatively.
3- If we need to give it fast in the ER, we give it as a bolus after warming the blood. Why don't we always warm it? because it can cause hemolysis.
4- No need for Rh compatibility except in children.

# Transfusion complications



## Hemolytic reactions acute / delayed

Wrong blood type administered (oops) → Activation of complement system → intravascular hemolysis, spontaneous hemorrhage

**Signs:**

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

The signs are easily masked by general anesthesia.

- Free Hb in plasma or urine.
- Acute renal failure.
- Disseminated intravascular coagulopathy (DIC)

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

1. Stop transfusion
2. ABC's
3. Maintain IV access & run IVF (NS or LR)
4. Monitor & maintain vital signs (BP/Pulse)
5. Give diuretics [1]
6. Obtain blood & urine for transfusion reaction workup
7. Send remaining blood back to blood bank

### Blood bank workup of AHTR

- Check paperwork to assure no errors.
- Check plasma for hemoglobin.
- Repeat crossmatch.
- Repeat blood group typing.
- Blood culture.

### Monitoring during AHTR

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

## Febrile reaction ( FNHTR )

Most common non-hemolytic reaction & is usually controlled by slowing infusion & giving antipyretics

1- To protect the kidney

# Transfusion complications

## Allergic reaction

**Sx**: Increased body temperature, Pruritus, Urticaria.
**Rx**: Antihistamine and Discontinuation
**Prevention**: Examination of plasma & urine for free hemoglobin helps rule out hemolytic reactions

## Infection

Transmission of viral diseases:

- Hepatitis C: 1:30,000 per unit
- 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 immunocompromised patients.
- Parasitic & bacterial transmission is very low.

## Others

### Transfusion Related Acute Lung injury (TRAL)

### Coagulopathy with massive transfusions [1]

- Decreased 2,3-DPG: with storage ? significance [2]
- Citrate metabolism to bicarbonate; calcium binding → hypocalcemia
- Microaggregates (platelets & leukocytes) micropore filters controversial.
- Hypothermia: warmers are used to prevent it.
- Coagulation disorders: massive transfusion (>10 units) may lead to dilution of platelets, Factor V & Factor VIII [1].
- DIC: uncontrolled activation of coagulation system

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1- We need to give coagulation factors
2- Increased affinity of O2 to hemoglobin> decrease O2 delivery to tissue> hypoxia

# Transfusion Therapy

## Massive blood transfusion

Massive transfusion is generally defined as the need to transfuse one or two times the patient's' blood volume. For most adult patients, that is the equivalent of 10-20 units

### Complications:

**Citrate toxicity**

does not occur in most normal patients unless the transfusion rate exceeds 1 U every 5 mins.

**Acid- base imbalance**

The most consistent acid-base abnormality after massive blood transfusion is postoperative **metabolic alkalosis**.


**Coagulopathy**

due to dilutional thrombocytopenia & dilution of the coagulation factors.[1]

**Hypothermia**

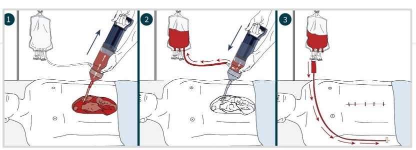
**Increase serum potassium concentration**

- 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.
- pRBCs are mixed with saline solution (NOT LR).
- Products are warmed mechanically and given slowly if condition permits [2].
- Close observation of patient for signs of complications.
- If complications are suspected, infusion discontinued, blood bank notified & proper steps are taken..

| Autologous blood | Autotransfusion |
| --- | --- |
| Pre-donation of patient's own blood prior to elective surgery [3].<br>• 1 unit donated every 4 days (up to 3 units)<br>• Last unit donated at least 72 hrs prior to surgery.<br>• Reduces chance of hemolytic reactions and transmission of blood-borne diseases.<br>• Not desirable for compromised patients. | • Commonly known as (cell-saver)<br>• Allows collection of blood during surgery for re-administration<br>• RBC's are centrifuged from plasma.<br>• Effective when > 1000 ml are collected |



1- Give platelets and FFP.
2- No need for warmers if we're in the OR with an elective case and we are correcting a small decrease in Hgb and using slow infusion because warmers may cause hemolysis of RBCs but we must use it in case of an emergency and rapid infusion
3- Used if the patient has many complaints and can't find a compatible donor. Done in elective surgeries.

# Lecture Quiz

Answers: 1(C ) 2( A) 3(A&D) 4( C) 5( C)

**Question 1: All of the following fluids are generally considered to be isotonic,except:**

A. Lactated Ringer
B. Normal saline
C. D5 normal saline
D. D5¼ normal saline

**Question 2: Regarding central venous pressure (CVP) monitoring**

A. Low values of <5 mm Hg may be considered normal in the absence of other signs of hypovolemia
B. CVP readings can be interpreted independently of the clinical setting
C. CVP monitoring is never indicated in patients with normal cardiac and pulmonary function
D. In a patient with right ventricular dysfunction, a CVP of 10 mmHg should be considered elevated

**Question 3: which of the following about blood transfusion are false?**

A. A hemoglobin level of 10 g/dL or less is now considered a typical indication
B. FFP is considered as the first line therapy in coagulopathic hemorrhage
C. Cryoprecipitate is useful in low-fibrinogen states and in factor VIII deficiency
D. Platelets have a shelf life of 3 weeks
E. Patients can pre donate blood up to 3 weeks before surgery for autologous transfusion

**Question 4: All of the following are signs of dehydration, except**

A. Progressive metabolic acidosis
B. Urinary specific gravity > 1.010
C. Urine osmolality < 300 mOsm/kg
D. Urine sodium < 10 mEq/L

**Question 5: The most common cause of an acute hemolytic transfusion reaction is**

A. An error during type and screen
B. An error during type and crossmatch
C. Misidentification of the patient, blood specimen, or transfusion unit
D. Defective blood filter

Explanation File

# Good Luck

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