TEAM

ANESTHESIA

435

IV Resuscitation & Blood Transfusion

{Color index: Important★| Notes | Book | 433 Notes | Extra | Editing File}

Objectives:

Let's start by having 2 cases to understand our objectives:

1) A patient came to the ER & diagnosed with appendicitis otherwise medically free. He has a history of 2 days of abdominal pain, nausea & vomiting. So, the plan was appendectomy. He is tachycardic & has low blood pressure.. This patient is dehydrated and will undergo shock. So, we can't give this patient oral volume replacement, we have to give him IV Fluid. What to give him and how to calculate the amount will be learn in this lecture..
2) Patient is came after RTA with laceration & bleeding otherwise medically free, he'll go to the OR for splenectomy. His hypotensive & tachycardic.. What does this patient loss ? Blood, so I have to give him blood but of course will give him volume resuscitation first until blood is reached. So, we will also learn about differents blood product and precaution before giving any blood

- To estimate the perioperative fluid requirement and to prescribe /calculate fluid therapy.
- Identify perioperative factors affect the patient fluid requirements.
- To detect 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 discuss the indications of each type and complications.

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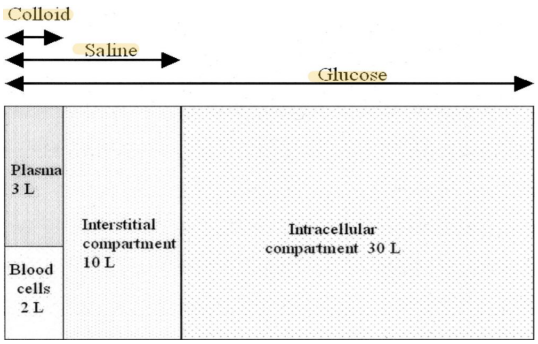
Physiology [1]



★ Total Body Water (TBW):

- Varies with age and gender.
- The 70 kg "standard male" contains 42L.
  → 60% body weight in male
  → 50% body weight in females
  → 80% body weight in newborns
- Less in obese: **bc**. fat contains little water.

★ Body Water Compartments:

- Intracellular water ⅔ of TBW
- Extracellular water ⅓ 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, Ca2+ & Mg2+

- **Primary ICF Cation is K**

Smaller contribution from Mg2+ & Na

★ Fluid & Electrolyte Regulation:

Volume Regulation	Plasma <u>Osmolality</u> Regulation	<u>Sodium</u> Concentration Regulation
- Antidiuretic Hormone - RAAS(renin-angiotensin-aldosterone system) - Baroreceptors in carotid & aorta - Stretch receptors in atrium & Juxtaglomerular apparatus - Cortisol If there is any change in the volume for example decreased volume: ADH will increase as a compensatory mechanism	- Arginine- Vasopressin (ADH) - Central & Peripheral osmoreceptors	- RAAS - Macula Densa of JG apparatus

The <u>Aim</u> of Maintenance of Fluid Electrolytes, Acid Base Balance and Blood Volume:

The **<u>final goal</u>** is delivery of adequate oxygen to the tissues. That's the important goal of the ABC in emergency.

★ Factors affecting oxygen delivery equation includes:

1. Cardiac Output = **Stroke Volume (SV)**[2] x Heart Rate (HR) When we work on the fluid management we work on the stroke volume (which have 3 factors: preload, contractility and afterload) by increasing the preload volume. "BP = CO*SVR, where CO=SV*HR. SV is a function of preload, afterload and contractility"
2. Hemoglobin Concentration managed by giving blood.

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[1] The osmolality is mentioned in slides
2*Na + Glucose 8 + Urea 7 = 295 mosm/Kg

[2] The amount of blood pumped by the **heart** per beat.

3. Oxygen Saturation: patient may be acidotic, hypovolemic & has electrolytes imbalance and u r trying to fix the PH, all of these to reach the adequate O2 delivery to the tissues.

★ Desirable Outcome of Fluid Resuscitation:

i want to give him adequate IV Fluid without reaching these complications

- No peripheral edema
- No ARDS

★ Assessment of Fluid Status:

1.Input & output chart more accurate in OR because anesthesiologist measures everything	2. BP: supine & standing Practically we just do spine but they said supine & standing bc of the possibility of dropping of the PB when change the posture which indicate hypovolemia	3. Heart rate increase in hypovolemic pt as compensation	4. Skin turgor & Capillary Refill more time in hypovolemic pt
5. Urinary Output decrease in hypovolemic pt 1ml/Kg/h	6. Serum electrolyte/ osmolarity increase osmolarity	7. Mental Status changes will happen in severe dehydration	8. CVP[3] "central venous pressure" (normal 4-8 mmHg) will be low in dehydration pt

★★Perioperative Fluid Requirements★★

عندنا عدة اشياء بيبلنا نعوضها:

➔ The following factors must be taken into account:

- Total requirements = maintenance + deficit + Ongoing loss.
- Average healthy adult requires approximately 2500 mL water/d.
- 200 ml/d GI losses + 800 ml/d insensible losses + 1500 ml/d urine = 2500!

1. Maintenance Fluid Requirements ممكن بيشنت في الوورد مافيه شي بس مو قاعد ياكل ويشرب فيقولون لك حطوا البيشنت بالمنتنس	- Insensible losses such as evaporation of water from: Respiratory tract, sweat, feces, urinary excretion occurs continually. So, it's normal and happened in all of us but we eat and drink so no problems with us. If we have a pt whos not eating or drinking he needs Maintenance Fluid Requirements - **"4-2-1 Rule"** **"Applies to crystalloids only"** - 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 the **subsequent kg** of body weight - "Increased requirements" = Extra fluid for fever, tracheotomy, denuded surfaces. Sweating, adrenal insufficiency, hyperventilation and polyuric renal disease. - Decreased requirements with anuria/oliguria, SIADH, highly humidified atmosphere and CHF.
2.NPO[4] & other	- Example of other deficits: NG suction & Bowel Prep. - **NPO deficit = Number of hours NPO x Maintenance Fluid**

[3] Trend CVP;
Give 250 ml of saline within 10 min to test the CVP; if slightly increase then continue the same > GOOD , if fast increase and fast drop > SEPSIS, if increase high then continue HIGH > HF

[4] **NPO:** Nothing by mouth is a **medical** instruction **meaning** to withhold food and fluids

Deficits usually when the pt comes for elective surgery he will fast for at least 6-8 h	**Requirements.** - Bowel prep[5] may **result in up to 1 L fluid loss** give extra 1000ml - Measurable fluid losses, e.g. NG suctioning, vomiting, ostomy output, biliary fistula & tube. Compensate the same amount as the loss. **Ex:** If a pt comes for an elective surgery fasting for the past 6h and wasn't connected to IV line during these hours .. We have to compensate for these NPO h But if he took his maintenance no need for this, **how?** Suppose we calculated his maintenance is = 1000, NPO = 6h NPO deficient = 1000 x 6 = 6000 mL. **How to give it?** 1st h (give ½) = 3000 ml , 2nd h (give ½ of the remaining half) = 1500ml, 3rd h (give the remaining ½) = 1500ml.
3. Third Space Losses Happens in procedure like laparotomy or thoracotomy	- Isotonic **transfer of ECF** from **functional body** fluid compartment to **non-functional** compartments. Happens in procedure like laparotomy or thoracotomy. *it's similar to ascites but it happens at the surgical site * - Depends on: 1. Location & duration of surgical procedure. 2. Amount of tissue trauma 3. Ambient pressure 4. Room ventilation E.g.: - **Superficial Surgical Trauma : 1-2 ml/kg/hr** - **Minimal Surgical Trauma: 3-4 ml/kg/hr** E.g. head & neck, hernia, knee - **Moderate Surgical Trauma: 5-6 ml/kg/hr** E.g. hysterectomy, chest surgery colon surgery with the opening below the umbilicus - **Severe Surgical Trauma 8-10 ml/kg/hr** (or more some time reach 50 ml) E.g. AAA[6] repair, nephrectomy bowel resection which extended above the umbilicus.

4. Blood Loss	- **Each 1 cc of blood loss is replaced by 3 cc of crystalloid solution 3:1** (crystalloid solution leaves the intravascular space) a 100 ml blood loss replaced by 300 ml crystalloid - When using blood products or colloids **replace blood loss volume per volume 1:1** a 100 ml blood loss replaced by 100 ml blood
5. Other additional losses	- Ongoing Fluid losses from other site: Gastric drainage, Ostomy output, Diarrhea. - Best fluid to give is crystalloid bc it has better perfusion - Ongoing losses are; losses from Foley catheter, NG, surgical solutions, third spacing "from pleura, GI, retroperitoneal, evaporation via exposed viscera and burns". - The average daily output of an ileostomy is about 500 ml per day, but may be up to 1,000-1,500 mls in a day. The average daily output of a colostomy is about 500 ml per day, with a range of about 200-700ml. - **Replace volume per volume with crystalloid solutions** as we said before Compensate the same amount as the loss

[5] Something given to flush the intestine preop
[6] Abdominal aortic aneurysm

➔ Example: What are his estimated intraoperative fluid requirements?

- 62 y/o male, 70 kg, for laparotomy bowel resection (hemicolectomy)
- NPO after 22:00(10 pm), surgery at 08:00 am. "So NPO for 10h", received bowel prep."which is usually equal to 1000 ml"
- 3h. Procedure, 500 cc blood loss.

Ans:

- **Maintenance:** "4,2,1 rule" =110 x 3 hrs = 330 ml
- **Fluid deficit (NPO):** Time of NPO is 10 hrs. → 110x 10 = 1100 ml
  Bowel prep= 1L = 1000ml → 2100 ml total deficit: (Replace ½ first hour, ¼ second hour, ¼ third hour)
- **Third Space Losses:** (Moderate Surgical Trauma = 6 ml/kg/hr) = 6x70x 3 = 1260ml
- **Blood Loss:** 1 cc of blood replaced by 3 cc of crystalloid → 500x 3 = 1500 ml
- **Total** = 330+ 2100+ 1260+ 1500 = **5190 ml.**

Intravenous Fluid

1.Conventional Crystalloid | **2.Colloid** | **3. Hypertonic solutions.** "type of crystalloid solutions" | **4.Blood, Blood Products & Blood Substitutes**

1- Crystalloids:

Combination of **water & electrolytes that differ in the concentrations**

- salt-containing solutions that distribute only within ECF.
- maintain euvolemia in patient with blood loss: **3 mL crystalloid infusion per 1 mL of blood loss for** volume replacement (i.e. 3:1 replacement).
- if large volumes are to be given, use balanced fluids such as Ringer's lactate or Plasmalyte, as too much normal saline (NS) may lead to hyperchloremic metabolic acidosis

2- 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).

- includes protein colloids (albumin and gelatin solutions) and non-protein colloids (dextrans and starches e.g. hydroxyethol starch [HES]).
- distributes within intravascular volume.
- **1:1 ratio (infusion:blood loss)** only in terms of replacing intravascular volume.
- HES colloids remain in intravascular space (metabolized by plasma serum amylase and renally excreted); two available in Canada: Voluven® and Pentaspan®.
- the use of HES solutions is controversial because of recent RCTs and meta-analyses highlighting their renal (especially in septic patients) and coagulopathic side effects, as well as a lack of specific indications for their use.
- colloids are being used based on mechanistic and experimental evidence but there is a

paucity of definitive studies investigating their safety and efficacy; routine use of colloids should be avoided.

it is preferred to be given for as a temporary Rx before Blood is arrived as it stayed intravascular

<table>
<tr><th colspan="4">Crystalloids</th></tr>
<tr><th colspan="2">Isotonic salt solution</th><th>Hypertonic salt solution</th><th>Hypotonic salt solution</th></tr>
<tr><td colspan="2">Electrolyte composition and osmolality <u>similar</u> to plasma.
E.g. Normal Saline (balanced salt solution), Lactated Ringer's, Plasmalyte, Normosol.</td><td>E.g. 2.7% NaCl
electrolyte composition higher than that of plasma</td><td>Electrolyte composition <u>lower</u> than that of plasma.
E.g. D5W, Half NS</td></tr>
<tr><th>Normal Saline (0.9% NaCl)</th><th>Lactated Ringer's</th><th>--</th><th>Dextrose 5% water</th></tr>
<tr><td>Composition:
Isotonic 0.9%: 9g/l
Na: 154, Cl: 154
Osmolarity:
304 mosmol/l

★Disadvantage:
Hyperchloremic acidosis
when given aggressively</td><td>Composition:
Na: 130, Cl: 109, K: 4, Ca: 3
Lactate: 28
Osmolarity:
273 mosmol/l
- Minor advantage over NACL so in resuscitation we can use either normal saline or LR but in OR they prefer LR because it is more compatible with normal fluid physiology.
Disadvantage:
- Not to be used as diluent for blood (Ca citrate in LR will cause clotting)
- Low osmolarity can lead to high ICP because it can go inside the cells and interstitial space
- Caution in kidney failure because it contain K
- brain injury because of the ICP and lactate which is transform to sugar in liver and increase the metabolism of brain
- high blood sugar because of lactate.</td><td>- 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 <u>cellular dehydration is a potential problem.</u>

That's why it is not used in resuscitation, the only use is treatment of electrolyte imbalance
Disadvantage:
- increase hemorrhage from open vessels
- Hypernatremia
- Hyperchloremia
- Metabolic acidosis
- Cellular dehydration.</td><td>Composition:
50 g/l

Osmolality:
253 *low*

Disadvantage:
- Enhances CO2 production because it increase the metabolism
- Enhance lactate production increase sugar production
- Aggravates ischemic brain injury

High risk of Tissue edema
Increase BP</td></tr>
<tr><td colspan="2">Crystalloid in trauma advantages:
- Balanced electrolyte solution
- Buffering capacity (Lactate) bc of K
- Easy to administer
- No risk of adverse reactions</td><td>Advantages:
-Small volume for resuscitation.
-Osmotic effect
-Inotropic effect (increase</td><td>--</td></tr>
</table>

- No disturbance of hemostasis helps in cardiac pts - Promote diuresis -Inexpensive But if it is given aggressively it may leads to : - Dilutional anemia - Dilution of coagulation factors and cause more bleeding	*calcium influx in sarcolemma)* - Increase MAP, CO - Increase renal, mesenteric, splanchnic, coronary blood flow.	

Colloids

Advantages:

- Prolonged plasma volume support since it will stay longer duration we give it in smaller amount
- Moderate Volume needed
- Minimal risk of tissue edema
- Enhance microvascular flow so we give it in severe hypotension with crystalloid to maintain BP

Disadvantage:

- Risk of volume overload
- Adverse effect of hemostasis it may affect the coagulation leads coagulopathies.
- Adverse effect on renal function
- Anaphylactic reaction like albumin
- Expansive

Dextran

- Inhibits platelet aggregation → **Bleeding** not used any more

Hetastarch 6%

- Synthetic, 6% preparation in isotonic saline.
- MW 240,000 D
- **Disadvantage:**

1. Hyperamylasemia 2. Allergy 3. Coagulopathy.

- Dose **20 ml/kg/day**

Pentastarch 10%

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

Tetrastarch (voluven)

- MW 130,000 D
- Used for Volume therapy
- Dose: **50 ml/kg/day**
- **it can leads to coagulopathies.**

Gelatins

- Derived from hydrolyzed bovine collagen
- Metabolized by serum collagenase
- can remain in blood vessels 0.5-5 hr

- **Disadvantage:**
  - Histamine release (H1 blockers recommended)
  - Decrease Von W Factor (VWF)
  - Bovine Spongiform Encephalopathy 1:1,000.000 very rare.

Albumins

- We have 2 forms:1) volume resuscitation 2) Hypoalbuminemia
- Heat treated preparation of human serum:
- **5% (50g/l)** is used for **volume expansion,** half of infused volume will stay intravascular. thick that's why it is used in resuscitation.
- **25% (250g/l)** is used only in case of **Hypoalbuminemia**
- **Disadvantage:**
  - Cardiac decompensation after rapid infusion of 20-25% albumin
  - Decreased Ionized Ca++
  - Impaired Na+ Water Excretion → Renal dysfunction

- IV fluids improve perfusion but NOT O2 carrying capacity of blood.

Fluid	Osmolarity	Na	Cl	K
D5W	253[7]	0	0	0
0.9 NS	308	154	154	0
LR	273	130	109	4.0
Plasmalyte	294	140	98	5.0
Hespan	310	154	154	0
5% Albumin	308	145	145	0
3% Saline	1027	513	513	0

مارح تجي الارقام بالاختبار بس لازم تفهموا ايش هيبو وايش هيبر اوزمولارتي كمان تعرفوا كل فلويد ايش مكوناته بدون الكميات

★ **Crystalloid OR Colloids:** Acs *american college of surgery* Protocol for ATLS: Replace each ml of blood loss with 3 ml of crystalloid fluid **(3 for 1 rule)**

Patient Response: First start with crystalloids because it will helps more in perfusion > goes to interstitial space and cells.

- Rapid
- Transient
- Non-Responsive here we can start with colloids.

	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

Transfusion Therapy:

- **60% of transfusions occur perioperatively.**
- Responsibility of transfusing perioperatively is with the anesthesiologist.
- Up to 30% of blood volume can be treated with crystalloids

[7] WORST ONE FORGET IT

- If blood loss exceeds 20% of blood volume and still there is ongoing bleeding this will necessitate blood transfusion.
- **Blood Volume Formula:**
  → Neonate - 90 ml/kg
  → Infants 2 years - 80 ml/kg
  → Adult male - 70 ml/kg
  → Adult female - 60 ml/kg
  So, if we have a 50 kg adult female it will be 50*60=3000ml

➔ Why should we transfuse?

- 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"*** **:** Hgb level at which transfusion should be given.
  - Varies with patients and procedures The lowest accepted Hb level in healthy ppl is 7, in compromised ppl is 10.
  - We put arterial line in suspicious pt to monitor the hgb, if it was 8 start transfusion
- **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 carries oxygen to tissues. if 2,3-DPG increase it will shift the Hb dissociation curve to the right > difficult for hemoglobin to bind to oxygen > lower affinity of Hb to O2 > release it quickly > improve tissue oxygenation ,, this mechanism happens in case of hypoxia.

★ Oxygen Delivery

- Oxygen Delivery (DO2) is the oxygen that is delivered to the tissues.
  DO2 = COP x CaO2
- **Cardiac output = HR x SV**
- **Oxygen Content (CaO2)= (Hgb x 1.39)O2 saturation + PaO2(0.003)**
- **Hgb is the main determinant oxygen content in the blood.**
- **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 and can tolerate **Hgb levels of 7 gm/dL.**
- **Compromised patients** may require Hgb levels above 10 gm/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: they order it in major procedure like AAA

Major	- **Donor's erythrocytes (packed cells) incubated with recipients plasma** they mix it to see if there's agglutination(incompatible) or not (compatible)
Minor	- Donor's plasma incubated with recipients erythrocytes
Agglutination	- Occurs if either is incompatible
Type Specific	- Only ABO-Rh determined; chance of hemolytic reaction is **1:1000** with TS blood اعطيه ع حسب فصيلة دمه بدون ما اسوي الاختبار

★ Type & Screen

- **Donated blood that has been tested for ABO/Rh antigens and screened for common antibodies** (not mixed with recipient blood). they order it for minor procedure(book it for the patient) like bowel resection (with no massive bleeding) just in case something happens they then just cross match it and give it to him.
- Used when usage of blood is unlikely, but needs to be available (hysterectomy).
- Allows blood to be available for other patients.
- Chance of hemolytic reaction: 1:10,000

★ Blood Components

- **Whole blood is separated by differential centrifugation.**
  - Packed Red Blood Cells (pRBCs)
  - Platelets
  - Fresh frozen plasma, Contain all clotting factors.
  - Cryoprecipitate contain factor VIII & Fibrinogen
  - Factor VIII
  - Albumin
  - Others: Antibody concentrate, Plasma Protein Fraction.

Blood Components			
Whole Blood	Packed Red Blood Cells	Platelet Concentrate	Plasma & FFP
Storage: 4° for up to 35 days **Indications:** - Massive Blood Loss - Trauma - Exchange transfusion **Considerations** : - Use filter - Donor & Recipient must be ABO identical	1 unit= 250 ml. Hct.= 70-80% **1 unit pRBC's raises Hgb 1gm/dL** 1 unit of pRBC will increase Hb by approximately 10 g/L or increase Hct by 4% **Mixed with Saline:** LR has Calcium which may cause clotting if mixed with pRBC's **Dose:** -Usual dose of 10 cc/kg infused over 2-4 hours -Maximum dose 15-20 cc/kg can be given to hemodynamically stable patient **Procedure:** - Filter use - routinely - Monitoring - Do NOT mix with medications *2 IV line* **Complications:** - Rapid infusion may result in Pulmonary edema - Transfusion reaction	**Storage:** Up to **5 days** at 20-24° **Indications:** - Thrombocytopenia, Plt <15,000 - Bleeding and Plt <50,000 - Invasive procedures and Plt < 50,000 **Considerations:** - Contain Leukocytes and cytokines (can lead to allergic reaction) **- 1 unit/ 10 kg of body weight increases Plt count by 50,000** - Donor & Recipient must be ABO identical	**Content:** Coagulation factors (1 unit/ml) **Storage:** FFP→ 12 months at 18° or colder **Indications:** - Coagulation factor deficiency -Fibrinogen replacement - DIC - Liver disease - Exchange transfusion -Massive transfusion. To prevent DIC - FP: emergency reversal of life-threatening bleeding secondary to warfarin overdose. **Considerations:** - Plasma should be recipient RBC ABO compatible **- In children, should also be Rh compatible** - usual dose is 20 cc/kg to raise coagulation factors approx 20%

when blood is required, several options are available:

- **1st** line: fully crossmatched blood, electronic crossmatch is becoming more widely used (not always available in emergency situations)
- **2nd** line: donor blood of the same group and Rh status as the recipient.
- **3rd** line: O- blood for females of reproductive age; O+ blood for all others.

★ Transfusion Complications

1. Hemolytic Reactions (acute or delayed):

- Wrong Blood type administered (oops)
- Activation of complement system leads to intravascular hemolysis, spontaneous hemorrhage.

➔ **signs:** if Pt is awake hypotension, fever, chills, dyspnea, skin flushing, substernal pain, back/abdominal pain, oliguria, dark urine, pallor

➔ **Signs are easily masked by general anesthesia:** So if you're in doubt do:

- Free Hgb in plasma or urine
- Acute renal failure do complete renal profile tests
- DIC (coagulation profile)

➔ Treatment:

- stop transfusion.
- notify blood bank and check for clerical error.
- maintain BP with vigorous IV fluids ± inotropes.
- maintain urine output with diuretics, crystalloids, dopamine.

2. Febrile Reactions (FNHTR)

Most common, due to alloantibodies to WBC, platelets or other donor plasma antigens, and release of cytokines from blood product cells, usually controlled by slowing infusion and giving antipyretics.

- Presents with fever ± rigors, facial flushing, headache, myalgia, hypotension.

➔ Treatment:

- rule out hemolytic reaction or infection
- if temperature <38°C, continue with transfusion but decrease rate and give antipyretics
- if temperature >38°C, stop transfusion, give antipyretics and anti-histamine.

3. Allergic Reactions:

- Increased body temp, pruritus, urticaria
  Rx: Antihistamines, discontinuation of blood transfusion. Examination of plasma and urine for free Hgb helps rule out hemolytic reactions.
  - occurs mainly in those with history of multiple transfusions or multiparous women.

➔ Treatment:

- mild: slow transfusion rate and give diphenhydramine..
- moderate to severe: stop transfusion, give IV diphenydramine, steroids, epinephrine, IV fluids, and bronchodilators

4. Transfusion Related Acute Lung Injury (TRALI)

- is currently the leading cause of transfusion-related morbidity and mortality.
- pathogenesis uncertain; perhaps due to binding of donor antibodies to WBC of recipient and release of mediators that increase capillary permeability in the lungs.
- Treatment: supportive therapy (oxygen).

5. Coagulopathy with massive transfusions "Dilutional coagulopathy"

- occurs with massive transfusion (>10 units).
- pRBC contains no clotting factors, fibrinogen, cryoprecipitate, or platelets.
- treatment: FP, cryoprecipitate, and platelets

6. Infection:

Bacterial Infection:

- Gram positive: S. aureus, S. epidermidis, Bacillus cereus
- Gram negative: Klebsiella, Serratia, Pseudomonas, Yersinia
  - overall risk is 1 in 100,000 for RBC and 1 in 10,000 for platelets
  - never store blood >4 h after bag has lef blood bank
  - treatment: stop transfusion, blood cultures, IV antibiotics, fuids.

7. Transmission of Viral Disease:

- Hepatitis C; 1:30,000 per unit most common complication in healthy individual
- Hepatitis B; 1:200,000 per unit
- HIV; 1:450,000 - 1:600,000 per unit
  22 day window for HIV infection and test detection
- CMV may be the most common agent transmitted, but only affects immunocompromised patients
- Parasitic and bacterial transmission very low

8. Decreased 2,3-DPG:

- With storage? Significance shift of the curve to left > more affinity to O2 and will not release it to tissue

9. Citrate toxicity:

- It's occur in the RBC's
- Metabolism to bicarbonate, calcium binding. So it may cause alkalosis and hypocalcemia
- occurs with massive transfusion in patients with liver disease – patients are unable to clear citrate from blood.
- citrate binds to Ca2+ and causes signs and symptoms of hypocalcemia
- treatment: IV calcium gluconate (10 mL for every 2 units of blood)

10. Microaggregates:

- (platelets, leukocytes): micropore filters controversial

11. Hypothermia:

- Warmers used to prevent it

12. Coagulation disorders:

Massive transfusion (>10 units) may lead to dilution of platelets and factor V and VIII

13. DIC:

Uncontrolled activation of coagulation system

14 **Hyperkalemia:**

- due to K+ release from stored RBC
- risk increases with storage time and if blood is irradiated and risk decreases if given fresh blood.
- occurs in 5% of massively transfused patients.

What to do if an AHTR[8] occurs?	Blood Bank Workup of AHTR	Monitoring in AHTR
1. STOP Transfusion 2. ABC's 3. Maintain IV access and run IVF (NS or LR) 4. Monitor and maintain BP/ pulse 5. Give diuretic 6. Obtain blood and urine for transfusion reaction workup 7. Send remaining blood back to blood bank	- Check paperwork to assure no errors - Check plasma for hemoglobin - Repeat crossmatch - Repeat blood group typing - Blood culture to exclude septic shock	- Monitor patient clinical status and vital signs - Monitor renal status (BUN, creatinine) - Monitor coagulopathies status (DIC panel - PT/PTT, fibrinogen, D-dimer/ FDP, Plt, ANtithrombin-III) - Monitor for signs of hemolysis (LDH, bili, haptoglobin)

★ Massive Blood Transfusion

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

★ Complications

1. **Coagulopathy** due to dilutional thrombocytopenia & dilution of the coagulation factors. we start to give FFP if the blood unit given to the pt exceed 4 units.
2. **Citrate Toxicity** does not occur in most normal patients unless the transfusion rate exceeds 1 U every 5 min
3. **Hypothermia** bc the transfused blood is cold
4. **Acid-Base balance,** the most consistent acid base abnormality after massive blood transfusion is postoperative **metabolic alkalosis.**
5. 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. if the pt developed metabolic alkalosis he will have the hypokalemia

[8] Acute hemolytic transfusion reaction

★ Administering Blood Products

- **Consent** necessary for elective transfusion
- Unit is checked by 2 people *doc & nurse* for Unit #, patient ID, expiration date.
- pRBC's are **mixed with saline** solution (not LR)
- Products are warmed mechanically and given slowly if condition permits
- Close observation of patient for signs of complications
- If complications suspected, infusion discontinued, blood bank notified, proper steps taken.

Autologous Blood	Autotransfusion
- 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 hours prior to surgery - Reduces chances of hemolytic reactions and transmission of bloodborne diseases - Not desirable for compromised patients	- Commonly known as "Cell-saver" - Allows collection of blood during surgery for readministration - RBC's centrifuged from plasma - Effective when > 1000ml are collected

TEAM MCQs

435

Q1) Which type of fluid can cause Hyperchloremic Acidosis?

a) D5W
b) Lactate Ringers
c) 5% Albumin
d) Normal Saline

Ans: D

Q2) A 23- year old patient booked for tonsillectomy. He was fasting for 8 hours. What is the solution that should be administered to this patient?

a) Lactated Ringers
b) D5W
c) 2.7% NaCl
d) 0.9% NaCl

Ans: A

Q3) A 39- year old woman with a known history of Von-Willebrand disease has been booked for elective hernia repair. Which of the following should be administered preoperatively?

a) Fresh Frozen Plasma
b) Cryoprecipitate
c) Low molecular weight Dextran
d) Whole blood

Ans: B

Q4) Which of the following is the intravascular half-life of a crystalloid solution?

a) 20-30 min
b) 40-60 min
c) 1-2 hours
d) 2-3 hours

Ans: A

Q5) What is the platelet count below which platelet transfusion is indicated preoperatively?

a) 150 x 10^9 /L
b) 100 x 10^9 /L
c) 80 x 10^9 /L
d) 50 x 10^9 /L

Ans: D

Q6) A 35 year old patient had postpartum hemorrhage and complaining of bleeding from surgical and veins puncture sites. Which one of the following is the management of choice?

a) Transfuse 1L of lactate ringer
b) Transfuse 500ml of hetastarch
c) Transfuse blood product
d) Transfuse 500ml of 5% albumin

Ans: C

Q7) What is the maximum shelf life for platelet concentrate?

a) 5 days
b) 10 days
c) 15 days
d) 20 days

Ans: A

Q8) How much one unit of packed red blood cells in adult patient raises hemoglobin?

a) 1 gm/dl
b) 1.5 gm/dl
c) 3 gm/dl
d) 4 gm/dl

Ans: A

Q9) A patient arrived in operating room with stab wound for an emergency laparotomy. BP ; 70/40 mmHg , HR is 118/min. which of the following fluid regimen is appropriate for resuscitation ?

a) Normal saline, at ratio of 3 ml per estimated 1 ml of blood lost
b) Blood, at ratio of 3 ml per estimated 1 ml of blood lost
c) Hetastarch, at ratio of 3 ml per estimated 1 ml of blood lost
d) D5W, at ratio of 3 ml per estimated 1 ml of blood lost

Ans: A

Q10) A 32 year old patient booked for right inguinal hernia repair, what is the adequate fluid replacement for third space loss?

a) 1-2 ml/kg/h
b) 3-4 ml/kg/h
c) 5-6 ml/kg/h
d) 8-9 ml/kg/h

Ans: B