HEMATOLOGY 1

Erythrocytes

120 days lifespan

No nucleus or mitochondria

Has 4 globin chains

Each with heme + iron

2-3 DPG helps with oxygen binding affinity

Carbon monoxide poisoning = bright red blood but no oxygen present

21% concentration of oxygen in atmosphere

Areas affecting oxygen are due to **pressure shifting**

Erythropoiesis

Requirements for RBC production

Vitamin B12

Vitamin B9

Vitamin B6

Needed for DNA synthesis of RBC

Intrinsic Factor from stomach -> **cannot absorb B12 if low**

Bariatric surgery

RBC Destruction

Heme -> Biliverdin -> Bilirubin I (not water soluble) -[via liver]> Bilirubin II (can be removed thru urine via urobilinogen, or feces via stercopinin)

Globin -> back to liver storage

Jaundice -> in the brain -> **kernicterus** -> Coma

Leukocytes

4000-11000/mm2

Two categories:

Granulocytes

Agranulocytoses (mono and lympho)

High neutrophils = ACUTE infections

Basophil = PARASITIC

Eosinophil = allergic reaction

Monocytes migrate from the blood -> now called to macrophage - if brain, dendritic cells

Lymphocytes from myeloids cells -> **B** (stay in **Bone**) or **T** (**thymus** for maturing) cells -> T cells directly kill thru **phagocytosis or substance releasing**; B cells are needed for **antibodies production** => **Memory B cells to memorize in exposed microorganism (VACCINES)**

Platelets

Thrombopoetin, **megakaryocytes**

It starts hemostasis -> **nitric oxide and prostaglandin** -> vasoconstriction to decrease blood loss

Collagen for elasticity -[in contact with blood]> bind with Von W Factor -> activation of platelet -> thrombocin 7 will call more platelet

GP2A, GP3D will cause the platelet to clump together -> **initial clot**

Hemostasis

Clot formation and dissolution

Coagulation cascade

Intrinsic happens in the blood (Coagulation of platelet); Extrinsic outside the blood (injuries)

Extrinsic pathway (3,7,4,12,11,9,8)

Tissue factor (clotting factor **3**) -> activates clotting factor **7** + Ca (CF **4**) -> CF 7a

CF **12** -> CF12a -> CF **11** -> CF11a -> CF **9** -> CF **8** -> CF 8a

Intrinsic pathway (7,8,10,5,4,2,1) (prothrombin, thrombin, fibrionogen, fibrin clot)

CF **7**a and CF **8**a should be present to have common pathway or called CF **10** -> CF 10a + CF **5**a + Ca (CF**4**) -> CF **2** (**prothrombin**) -[prothrombinase complex]> **thrombin** -> **fibrinogen** -> CF **1** -> CF 1a -> **Fibrin formation clot**

IF hemophilia **CF 8 is absent (type a)** if **type b, CF 9**

Low platelet = **thrombocytopenia**

Plasminogen -> **Plasmin (rTPA basis)**-> **dissolve the clot**

Antiplatelets -> INHIBITS **thromboxin A2, AVP, GP2a, GP3D**

Anticoagulants (PREVENTS clot NOT dissolve) -> **inhibits CF 10a**, PREVENT **thrombin**

Reticuloendothelial system (RES)

Macrophages

spleen, Liver (kuffer cells), lymph nodes, lungs

Spleen

Filters blood and induce hemolysis

With liver they can produce hematopoesis (bone marrow failure)

ASSESSMENT AND DIAGNOSTICS

Health history

Race (african-american, sickle cell)

Nutrition

Iron, B12,6,9 intake

Medication

Chemotherapeutic -> decrease blood cell production

Systemic

Acute or Gradual

Autosomal Dominant

ONLY **1 dominant Gene** (50/50)

Autosomal Recessive

2 recessive genes (both parents)

X-Linked

X chromosomes

Skin and Mucous Membrane Findings

Pallor -> anemia

Jaundice -> hemolysis

Ecchymoses & petechiae -> thrombocytopenia

Gray-tan or bronze skin -> hemochromatosis

Ruddy complexion -> polycythemia

Bleeding from lines/tubes -> coagulopathy

Oral and Lymphatic

Oral:

Petechiae

Bleeding gums

Smooth, beefy red tongue -> B12/folate deficiency

Ulceration -> **infection (tender and movable)**, leukemia (IMMOBILE)

Lymph nodes

Large, firm, **fixed** -> lymphoma, leukemia

Cardiopulmonary and renal

Murmurs, gallops -> severe anemia

Edema -> Heart failure

Respiratory

Dyspnea -> anemia

Musculoskeletal

Bone tenderness -> myeloma

Joint pain/swelling -> sickle cell

Back pain, kyphosis -> vertebral involvement

Abdominal

Splenomegaly -> leukemia, myelofibrosis

Hepatomegaly -> chronic hematologic disease

DIAGNOSTICS

Hematologic count and function

Quantitative, Qualitative, or both

CBC

RBC, WBC, platelet, hemoglobin, hematocrit, RBC indices

(**MCV**) mean corpuscular volume (**how big the rbc**)

Megaloblastic = **B12/folate deficiency**

(**MCH**) Mean corpuscular hemoglobin (**how red**)

Micrositic = iron deficiency anemia

Peripheral Blood smear

Coagulation studies

PTT (intrinsic) - 25-37 secs , heparin prolongs

PT (extrinsic) - 9.4-12.5 secs, INR of 0.9-1.1

If taking anticoagulant meds **normal range can be normal til 2.5x the base**

Bone Marrow aspiration and biopsy

Abnormal blood count, suspected malignancy, unclear anemia or pancytopenia

Posterior ilia crest (preferred), sternum

Prevent bleeding, analgesics (no **NSAIDs risk for bleeding**), no strenuous activities for 1-2 days

THERAPEUTIC

Splenectomy

Risk for infections

Therapeutic apheresis

Platelepheresis

Leukaphersia

Phasmapheresis

Hematopoeitic Stem Cell Transplant (HSCT)

Stem cells = blast

Filter the blood

POTENTIAL curative

Types: **Allogeneic (donor)**, **Autologous (self)**

Every **3 months**

Highly immunosuppressed, reverse isolation precautions

Therapeutic Phlebotomy

Controlled blood removal of **~500 mL**

Polycthemica vera (very viscous), hemochromatosis (high iron)

Blood Transfusion

200-250 mL

Aliquoted (divide to 2)

CANNOT exceed 4 hours

Factor 8/9 - hemophilia

Albumin -> vol expansion (nephrotic syndrome)

IVIG (liver cirrhosis) -> immuno deficiency, ITP

Kawasaki disease (**early identify**), COVID-19,

Heat-treated -> LOWER viral transmission

Usually 24 hrs from **time of extraction** (aliquoted)

Cross-match sheet

DONT stop **even if fever** (**nonhemolytic**)

Acute hemolytic (**wrong check**)

Acute tubular necrosis

IMMEDIATELY Urine sample

Dyspnea -> STOP -> then give antihistamine (prior can also be given) -> continue

TRALI (Transfusion related acute lung injury)

Long-term complications

Deperoxamine

Iron overload

Pharmacologic alternative to BT

Need **functioning Bone Marrow**

Erythropoietin

Epoietin alfa, Darbeopetin alfa

Granulocyte Colony-Stimulating Factors (G-CSF)

Stimulates **myeloid cell production (neutrophils)**

COMMON on chemotherapy px

Neutrophilic below 500 -> highly susceptible

Bone pain EXPECTED

Granulocyte-Macrophage Colony-Stimulating Factors (GM-CSF)

NEED **functioning bone marrow**

Sagramostin

Bone, muscle pain, fever

Thrombopoietin (TPO)

Stimulates **platelet production**

ANEMIA DISORDERS

Anemia

Tissue **hypoxia**

Asymptomatic at first -> **progressive**

It is a manifestation

Due to **increased RBC obstruction**

Hypo proliferative Anemias

Inadequate **RBC production**

Low or inappropriately **normal reticulocytes**

Hemolytic Anemia

PREMATURE RBC destructions

HIGHER reticulocyte count

Bleeding-Related Anemia

RBC **loss**

90 mL normal in menstruation

LOW Hgb/Hct

Iron deficiency (**chronic**)

Clinical Manifestations of **ANEMIA**

General: **Fatigue, Weakness, Dyspnea, Palpitations, Pallor**

Severe: **Chest pain, Syncope, Delirium, Heart Failure**

Iron deficiency Anemia

Malnutrition, Bleeding

Celiac disease - Gluten no no (Barley, Rye, Oats, Wheat)

Malabsorption syndrome

Toddler -> *physiologic anorexia and high intake milk*

Glossitis, brittle nails, angular cheilosis (singaw), pica

Ferrous sulfate, **TAKE BEFORE MEALS with vitamin C**

Constipation, hard & dark stool

Give liquid if oral is intolerated. **USE straw** in between teeth

Anemia of Inflammation

Get **serum ferritin**

Aplastic Anemia

Pancytopenia: **anemia, neutropenia thrombocytopenia**

Idiopathic, Immune-mediated T-cell destruction, benzene, chemo, radiation, viral hepatitis

Bone marrow aspiration

HSCT -> I**mmunosuppressive therapy IF CANNOT HSCT**

HSCT ONLY below 60 years old

Complete cure but **donor is issue**

Aplastic Immunosuppressive therapy (ATG)

Antithymocyte (AG)

Chill T-cell

STOP radiation, BT

HIGH RISK for due to **severe neutropenia**

Folic acid & Vitamin B12 Deficiency

Poor diet, alcoholism, **hemolytic anemia**

Treated with folic acid 1 mg/day

Vit B12

Vegan diet, **Pernicious anemia (low intrinsic factor)**, Metformins and PPI, **neurologic deficits (unique to this)**

Pernicious Anemia

LIFE TIME REPLACEMENT of intrinsic factor

HIGH RISK gastric cancer

Beefy red tongue

Gait balance problem, cognitive impairment, memory problems

High Iron = High folate

Spinabifida

IM for intrinsic factor

HEMOLYTIC DISORDERS

INCREASED blood count

Sickle Cell disease

HgS -> polymerizes in hypoxia

Genetic

HgS if dehydrated -> clumping (vaso-occlusion) + hemolysis

Thalassemias

REDUCED alpha and beta globin chain

NOT RED due to less binding to oxygen

RBC **prone to rupture due to rigidity**

Alpha-thalassemia

African decent

Beta-thalassemia

Southeast asian decent

Severe anemia and profound hemolysis

Regular Blood transfusion -> Increased Iron -> toxicity -> nepheroxatin

Hypocalcemia in massive BT (since Ca is a clotting factor)

G-6-PD Deficiency

X-linked enzyme -> RBC instability

Shorter RBC lifespan

Hemolysis causing substance from infection, fever, **-sulfa drugs**, **anti-malaria medications**

Newborn screening (24-48 hrs of life)

Normal NS: **free, 6 congenital errors (G-6-PD)**

Expanded NS

Avoid triggers

Immune Hemolytic Anemias

antibody-mediated RBC destruction

common in **CLL**

Taking drugs or viral infection

Cortiocosteriod to manage immune system

IVIG

Splenomegaly

Hemochromatosis

GI absorbing **too much Iron** -> goes to liver -> Iron deposits -> Liver cirrhosis

It can stick to skin (**Grey-tan or bron skin**)

Symptoms of diabetes

Remove Iron -> **deferoxamine** **(iron removal therapy)** -> **therapeutic phlebotomy (500 mL)**

Meat, green-leafy vegetable, and limit vitamin C, protect liver

Monitor cardiac and endocrine system, even family members

Polycythemia

INCREASED RBC production

PRIMARY polycythemia vira - increase from **bone marrow**

SECONDARY polycythemia - increase **erythropoietin from kidney (hypoxemic)**

EXTREMELY viscous blood

Therapeutic phlebotomy

Neutropenia

<2000/mm2; severe < or equal to 500/mm2

High infection risk

G-CSF, offending agents, urgent antibiotics

Lymphopenia

<1500/mm2

AIDS (helper T cells, CT4)

Steroid users -> DECREASED lymphocytes