

# PHARMACOLOGY NOTES

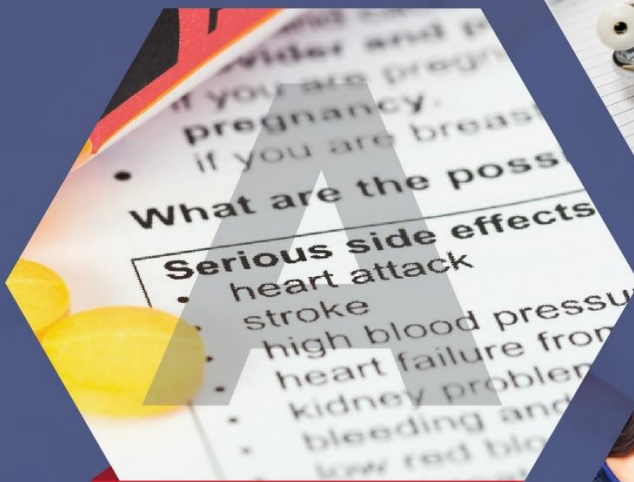
NURSING IMPLICATIONS FOR  
CLINICAL PRACTICE



Administration



Therapeutic Effects



Adverse Effects



Teaching

GLORIA VELARDE

# PHARMACOLOGY NOTES

## NURSING IMPLICATIONS FOR CLINICAL PRACTICE

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### Overview

**There are currently nine (9) units comprising this *Pharmacology Notes* resource. Units are broken down by body system and published individually for ease of retrieval:**

Unit A: Autonomic Nervous System (ANS)

Unit B: Cardiovascular (CV) System

Unit C: Hematological System

Unit D: Central Nervous System (CNS)

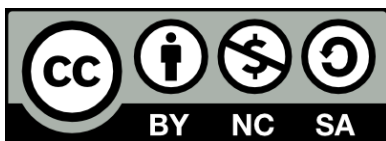
Unit E: Skeletal System: Bone and Joints

Unit F: Immune System

Unit G: Digestive System

Unit H: Endocrine Pharmacology

Unit I: Respiratory System



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# UNIT C

## HEMATOLOGICAL SYSTEM PHARMACOLOGY

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Drugs Affecting Blood Cells

Drug Classes: A-T-A-T

|   |
|---|
| (MC) Major Class or Therapeutic Class<br>(SC) Subclass or Pharmacologic Class<br>(SSC) Selective Subclass – more<br>specific action within Subclass |
|---|

(MC) Antiplatelets

(MC) Anticoagulants

(MC) Thrombolytics

(MC) Other Hemostatics

(MC) Hematopoietics

(SC) RBC Agents

(SC) WBC Agents

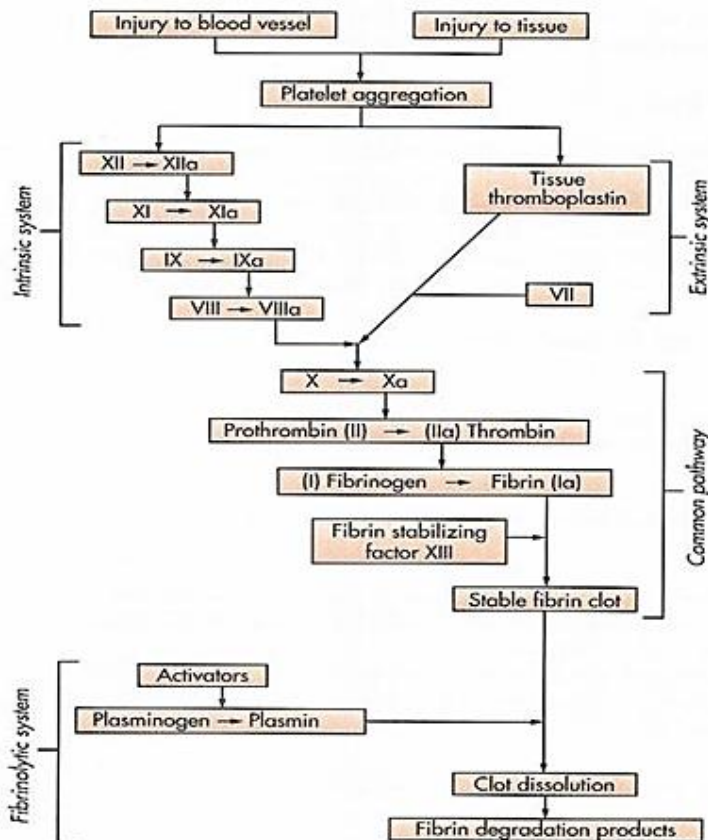
(SC) Platelet Agents

# Hematological System Pharmacology

## I. ANATOMY AND PHYSIOLOGY/PATHOPHYSIOLOGY REVIEW

### A. Hemostasis and Fibrinolysis

#### 1. Coagulation Cascade:



- Intrinsic pathway – involves circulating coagulation factors in blood; begins when injury occurs to vessel
  - Extrinsic pathway – involves tissue factors (and tissue phospholipids) outside of blood vessels; begins when injury occurs to tissues
- Common Pathway: The Final 3 Steps in the Clotting Process:
    - Thromboplastin formation – Platelets rupture on a roughened surface and thereby yield thromboplastin.

Rough Surface + Platelets Rupture = Thromboplastin

- Thrombin formation – Thromboplastin (formed in the first step) reacts with calcium and prothrombin, which is a plasma protein formed in the liver.  $\text{Ca}^{++}$  and prothrombin are both "on call" in bloodstream *waiting* for some thromboplastin to combine with forming thrombin.

$\text{Ca}^{++} + \text{Prothrombin} + \text{Thromboplastin} = \text{Thrombin}$

- c. Fibrin formation – Thrombin (formed in the second step) causes a chemical reaction which converts fibrinogen (a plasma protein) to fibrin. Fibrin is an insoluble substance made up of fine filaments which form a mesh to trap blood cells and thus a clot is formed.

Thrombin + Fibrinogen = Fibrin (CLOT)

## **B. Virchow's Triad – Describes Three Broad Categories of Factors that Contribute to Thrombosis**

1. Venous stasis (e.g. circulatory problems, edema, immobility)
2. Endothelial damage (e.g. trauma, surgery, invasive procedures)
3. Hypercoagulability (e.g. hematologic disorders, adverse effects of other medications)

## **C. Blood Cell Functions**

1. Erythrocytes (red blood cells or RBCs) – oxygen-carrying to cells and removal of carbon dioxide (gas exchange):
  - a. Measured by complete blood count (CBC): hematocrit (Hct), hemoglobin (Hgb) and RBC count
  - b. The lifespan of a RBC is 120 days; the process of erythropoiesis takes 3-5 days
  - c. Factors affecting RBC production/RBC counts:
    - 1) diet/GI function (intrinsic factor) – deficiencies of iron, folic acid, B<sub>12</sub>
    - 2) bone marrow function
    - 3) growth factors (hormones) = erythropoietin
    - 4) blood loss
    - 5) ↑ RBC destruction
    - 6) adverse drug effects
2. Leukocytes (white blood cells or WBCs) – immune system – the body's line of defense against infection:
  - a. Two classifications of WBCs:
    - 1) granulocytes: neutrophils, eosinophils, and basophils
    - 2) agranulocytes: lymphocytes and monocytes
  - b. Measured by CBC: WBC count and WBC differential (measures the percentage of the 5 types of WBCs)
  - c. Factors affecting WBC production/WBC counts:
    - 1) bone marrow function
    - 2) cancers
    - 3) adverse drug effects
  - d. The lifespan of granulocytes – circulate 5-8 hours, then, migrate to tissues; live another 4-5 days

3. Thrombocytes (platelets) – play an important role in hemostasis (clotting) by the formation of a platelet plug:
  - a. Measured by CBC: platelet count; and by assessing effect through bleeding times
  - b. Factors affecting platelet production/platelet counts:
    - 1) bone marrow function
    - 2) growth factors (hormones) = thrombopoietin
    - 3) ↑ platelet destruction
    - 4) pooling of blood
    - 5) adverse drug effects
  - c. The lifespan of thrombocytes – 7 days

## II. PHARMACOLOGY

### A. Pharmacologic Connections for Hematologic Agents

1. Drugs Affecting Coagulation:
  - a. Most drug affecting coagulation, produce an ***inhibitory*** effect, meaning they ***prolong*** the time to form a clot
  - b. Agents are more often given to ***prevent*** thrombosis for high risk conditions (refer to Virchow's triad)
  - c. Several drugs that affect coagulation, often exert their effect (MOA) within the last three (3) steps of the coagulation cascade (***common pathway***)
  - d. Antidotes are also called hemostatics, which are agents that promote clotting
2. Drugs Affecting Blood Cells:
  - a. Most hematopoietic agents enhance or promote blood cell production by replacing with:
    - 1) natural hormones or growth factors
    - 2) recombinant DNA or synthetic versions
    - 3) dietary supplements (vitamins and minerals)
  - b. Effects are determined by:
    - 1) improvement in CBC values specific to blood component
    - 2) improvement in or maintenance of the blood cell's normal function(s)

## Nursing Implications: Hematological Pharmacology: Drugs Affecting Coagulation

| Major Class    | MOA   | Prototype – generic   | Prototype – trade   | A – Admin   | T – √ Therapeutic Effects – General (MC)   | A – √ Adverse Effects – Common  | T – Teaching – General  | T – Teaching – Specific  |
|----------------|---|---|---|---|--|---|---|--|
| antiplatelets  | Interferes w/ normal platelet function – platelet activation, adhesion, aggregation, or procoagulant activity | aspirin<br><br>clopidogrel<br><br>ticlopidine<br><br>ticagrelor | acetylsalicylic acid, ASA<br><br>Plavix<br><br>Ticlid<br><br>Brilinta | Route: Oral<br><br>Contraindications: pregnancy, bleeding, tendencies, recent/ history of head/ spinal injuries, recent GI/GU bleeding, surgery-post-op   | <ul style="list-style-type: none"> <li>Prevent thrombi formation (DVT) – <b>Ø s/sx DVT</b></li> <li>Prevent MI/stroke – <b>Ø s/sx MI/ ACS/ stroke</b></li> <li>Prevent recurring clots (s/p MI, ACS, stents, PAD)</li> </ul> | <ul style="list-style-type: none"> <li>GI: N/V/ dyspepsia, gastric bleeding</li> <li>Heme: prolonged bleeding time; thrombocytopenia</li> </ul> <p>Specific to ASA:</p> <ul style="list-style-type: none"> <li>ENT: tinnitus, hearing loss</li> <li>Reye's syndrome in children or adolescents</li> </ul> | <ul style="list-style-type: none"> <li>Safety – injury/ bleeding prevention</li> <li>AVOID: other NSAIDs, anticoagulants, thrombolytics</li> <li>Stop as directed prior to invasive tests or surgeries</li> </ul> | <ul style="list-style-type: none"> <li>ASA: no children/ teens for viral infection</li> <li>Check labs as indicated</li> </ul>   |
| anticoagulants | ↑ effects of antithrombin III → inactivates <b>thrombin</b>   | heparin   | Heplock   | Route: Parenteral: IV/SC<br><br>*SC considerations: <ul style="list-style-type: none"> <li>Ø alcohol to site or allow to dry completely</li> <li>Ø aspiration</li> <li>Apply light pressure w/ gauze</li> <li>Ø massage site</li> </ul> | <b>As above +</b><br><br>Treats existing thrombus, embolus – <b>↓ s/sx of DVT or PE</b><br><br><b>Lab tests for heparin:</b> PTT   | <b>+ bleeding tendencies:</b> <ul style="list-style-type: none"> <li>skin – bruising</li> <li>mucous membranes: bleeding gums; nose bleeds</li> <li>stools + guaiac</li> <li>urine + hematuria</li> <li>neuro Δ LOC</li> </ul>  |   | <b>Antidote:</b> <ul style="list-style-type: none"> <li>protamine sulfate</li> </ul> <b>Labs:</b> <ul style="list-style-type: none"> <li>✓ PTT</li> </ul>                        |
|                | Low-molecular weight heparin – similar to heparin; specific to factor X                                       | enoxaparin  | Lovenox   |   | <b>As above +</b><br><br>Ø labs necessary for enoxaparin   | <p>Specific to heparin:</p> <ul style="list-style-type: none"> <li>Heme: HIT</li> </ul>   |   | <b>Antidote:</b> <ul style="list-style-type: none"> <li>protamine sulfate</li> </ul> <p>For HIT (adjunctive tx):</p> <ul style="list-style-type: none"> <li>lepirudin</li> </ul> |



| Major Class   | MOA   | Prototype – generic          | Prototype – trade  | A – Admin                        | T – √ Therapeutic Effects – General (MC)  | A – √ Adverse Effects – Common  | T – Teaching – General  | T – Teaching – Specific   |
|---|---|------------------------------|--|----------------------------------|---|---|---|---|
|   | Blocks hepatic production of coagulation factors (Vit. K) → interferes w/ the transfer to: <b>prothrombin</b> | warfarin                     | Coumadin   | Route: Oral<br><br>Timing: @ HS  | <b>As above +</b><br><br><b>Lab tests for warfarin:</b> PT, INR   | <b>+ bleeding tendencies:</b> <ul style="list-style-type: none"><li>• skin – bruising</li><li>• mucous membranes: bleeding gums; nose bleeds</li><li>• stools + guaiac</li><li>• urine + hematuria</li><li>• Neuro Δ LOC</li></ul>                | (See previous page)   | <b>Antidote:</b> <ul style="list-style-type: none"><li>• Vitamin K</li></ul><br><b>Labs:</b> <ul style="list-style-type: none"><li>• ✓ PT, INR</li><li>• ✓ bleeding times</li></ul> |
| <i>New oral anticoagulants (NOACs)</i>              | Activated factor X (Xa) inhibitor   | apixaban                     | Eliquis  | Route: Oral                      | As previous + Lab tests: aPTT, PTT  |   |   | <b>Labs:</b> <ul style="list-style-type: none"><li>• ✓ aPTT/PTT</li></ul>   |
|   | Direct thrombin inhibitor → prevents fibrin clot  | rivaroxban<br>dabigatran     | Xarelto<br>Pradaxa   | Route: Oral (also IV)            |   |   |   |   |
| thrombolytics or tissue plasminogen activator (tPA) | ↑ conversion of plasminogen to plasma → breaks down fibrin  | alteplase<br>urokinase (uPA) | Activase<br>Abbokinase   | Route: Parenteral: IV            | <b>As above +</b><br><br><b>Dissolves</b> existing thrombus or embolus  | <b>As above + more bleeding tendencies</b>  |   | <b>Antidote:</b> <ul style="list-style-type: none"><li>• aminocaproic acid (Amicar)</li></ul>   |
| Other hemostatics                                   | Replace clotting factor(s) deficient in hereditary bleeding disorders (i.e. hemophilias)                      | Factor XIII (hemophilia A)   | Recombinate (1 <sup>st</sup> generation)<br><br>Helixate (2 <sup>nd</sup> generation)<br><br>Advate (3 <sup>rd</sup> generation)<br><br>Nuwiq (4 <sup>th</sup> generation) | Route: Parenteral: IV, injection | <b>↓ s/sx hemophilia:</b> <ul style="list-style-type: none"><li>• ↓ bleeding episodes</li><li>• ↓ joint pain/disease</li><li>• Ø hematuria GI bleed, intracranial bleed</li></ul> | <ul style="list-style-type: none"><li>• HA</li><li>• GI: N/V</li><li>• Skin: facial flushing</li><li>• Hypersensitivity</li><li>• Flu-like sx</li><li>• Pain/swelling at injection site</li><li>• Resistance (+ antibodies against AHF)</li></ul> | <ul style="list-style-type: none"><li>• Contact MD re: sx of allergic reaction</li><li>• Report s/sx DVT</li><li>• ✓ antihemophilic factor (AHF) levels</li><li>• Teach re: safety to minimize complications of disease</li></ul> |   |
|   |   | Factor IX (Hemophilia B)     | AlproLIX<br>BeneFIX  | Route: Parenteral: IV            |   |   |   |   |



## Nursing Implications: Hematological Pharmacology: Hematopoietics

| Subclass           | MOA   | Prototype – generic                  | Prototype – trade              | A – Admin   | T - ✓ Therapeutic Effects – General (MC)   | A - ✓ Adverse Effects – Specific (SC)  | T – Teaching – General   | T – Teaching – Specific  |
|--------------------|---|--------------------------------------|--------------------------------|---|--|--|--|--|
| <b>RBCs Agents</b> | Gives dietary element B <sub>12</sub> necessary for RBC synthesis   | cyanocobalamin, Vit. B <sub>12</sub> | Crystamine, Calomist, Nascobal | Route: <u>SC/IM/PO</u> /intranasal spray – Maintenance: monthly<br>• If given for pernicious anemia – must be injection due to lack of intrinsic factor | Treatment of <b>erythrocytopenia or anemia</b> :<br>• ↑ RBCs<br>• ↑ Hct<br>• ↑ Hgb<br><br>↓ <b>s/sx of anemia</b> :<br>• ↓ SOB<br>• ↓ paleness, pallor<br>• ↓ fatigue, weakness<br>• ↓ dizziness<br>• ↑ energy | • Uncommon; rash, diarrhea, hypokalemia  | • Eat well-balanced diet<br>• F/U labs<br>• Instruction re: proper injection technique if needed | • If given for pernicious anemia – supplement must be given <b>parenterally</b> monthly<br>• Neuro sx could be permanent if tx stopped   |
|                    | Increases hormone erythropoietin which stimulates bone marrow to produce RBCs; erythropoietic growth factor | epoetin alfa                         | Epogen, Procrit                | Route/freq: <u>SC/IV</u> – 3x/wk  |  | • CV: edema, HTN, headache<br>• GI: N/V/D  |  | • Monitor BP & weight regularly  |
|                    | Gives dietary element, iron necessary for RBC synthesis   | ferrous sulfate                      | Feosol                         | Route/freq: PO – daily  |  | • GI: N/V/C, dark stools<br>• Liquid oral form – teeth staining<br>• Iron toxicity in children |  | Oral iron prep:<br>• take w/ food for GI upset<br>• drink liquids via straw<br>• expect dark stools<br>• add fiber in diet<br>• take w/ Vit. C to enhance absorption<br>• avoid antacids – take at least 2 hrs apart |
|                    | Gives dietary element, folic acid necessary for RBC synthesis   | folic acid                           |                                | Route/freq: <u>PO/IM</u> /SQ/IV – daily   |  | • Minimal  |  | • No special teaching  |

| Subclass               | MOA  | Prototype – generic             | Prototype – trade        | A – Admin  | T - ✓ Therapeutic Effects – General (MC)   | A - ✓ Adverse Effects – Specific (SC)   | T – Teaching – General  | T – Teaching – Specific   |
|------------------------|--|---------------------------------|--------------------------|--|--|---|---|---|
| <b>WBCs Agents</b>     | Stimulates bone marrow to produce WBCs; <i>a granulocyte colony-stimulating factor (G-CSF) analog used to stimulate the proliferation &amp; differentiation of granulocytes</i>  | filgrastim<br><br>pegfilgrastim | Neulasta<br><br>Neupogen | Route: <u>SC/IV</u><br><br>Timing: avoid 24 hrs before or after chemotherapy | Treatment of <b>leukopenia or neutropenia</b> :<br><ul style="list-style-type: none"> <li>• ↑ WBCs</li> <li>• ↑ neutrophils</li> </ul><br><b>↓ s/sx of leukopenia or neutropenia</b> :<br><ul style="list-style-type: none"> <li>• ↓ incidence of infection</li> <li>• resolution of existing infection</li> </ul> | <ul style="list-style-type: none"> <li>• Flu-like sx</li> <li>• Bone pain</li> <li>• Rare: CV – dysrhythmias, tachycardia</li> </ul>                        | <ul style="list-style-type: none"> <li>• Infection control measures – handwashing</li> <li>• Avoid persons w/ infection</li> </ul>  | <ul style="list-style-type: none"> <li>• Bone pain can be managed w/ Tylenol or NSAIDs, if not contraindicated</li> </ul>     |
| <b>Platelet Agents</b> | Stimulates bone marrow to produce platelets; <i>a thrombopoietic growth factor that directly stimulates the proliferation of hematopoietic stem cells &amp; megakaryocyte progenitor cells &amp; induces megakaryocyte maturation resulting in increased platelet production</i> | oprelvekin                      | Interleukin 11, Neumega  | Route: <u>SC</u><br><br>Timing: avoid 24 hrs before or after chemotherapy    | Treatment of <b>thrombocytopenia</b> :<br><ul style="list-style-type: none"> <li>• ↑ platelets</li> <li>• ↓ bleeding times</li> </ul><br><b>↓ s/sx of thrombocytopenia</b> :<br><ul style="list-style-type: none"> <li>• ↓ bleeding tendencies</li> </ul>  | <ul style="list-style-type: none"> <li>• Fluid retention – edema, dyspnea</li> <li>• CV – dysrhythmias, tachycardia</li> <li>• Rare: fever, rash</li> </ul> | <ul style="list-style-type: none"> <li>• Safety measures – avoid activities that could cause bleeding</li> <li>• Report s/sx of bleeding tendencies: ↑ bruising, + blood in urine or stool</li> </ul> | <ul style="list-style-type: none"> <li>• Weigh self to monitor for acute increases (weight gain → fluid retention)</li> </ul> |