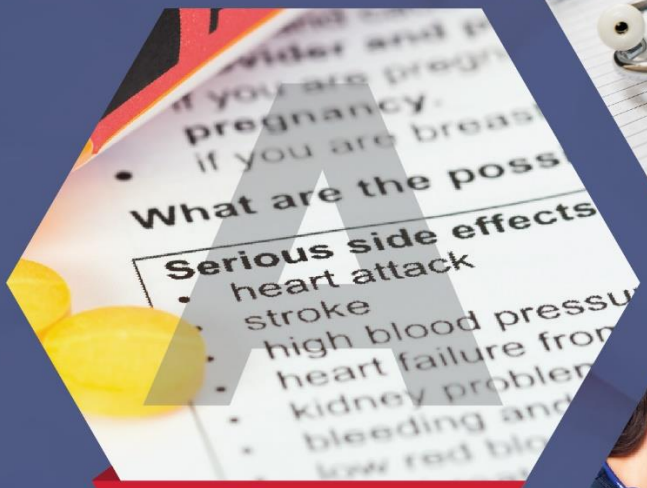
PHARMACOLOGY NOTES

NURSING IMPLICATIONS FOR CLINICAL PRACTICE

Administration

Therapeutic Effects



Adverse Effects

Teaching

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PHARMACOLOGY NOTES

NURSING IMPLICATIONS FOR CLINICAL PRACTICE

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) Pharmacology

Unit B: Cardiovascular (CV) System Pharmacology

Unit C: Hematological System Pharmacology

Unit D: Central Nervous System (CNS) Pharmacology

Unit E: Skeletal System: Bone and Joint Pharmacology

Unit F: Immune System Pharmacology

Unit G: Digestive System Pharmacology

Unit H: Endocrine System Pharmacology

Unit I: Respiratory System Pharmacology

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UNIT E

SKELETAL SYSTEM: BONE AND JOINT PHARMACOLOGY

Table of Contents

Bone and Joint Pharmacology

I. ANATOMY AND PHYSIOLOGY/PATHOPHYSIOLOGY REVIEW

A. Bone Terminology

1. Osteoblasts: bone-forming cells → ossification
2. Osteoclasts: bone cells that dissolve old or unhealthy bone → resorption
3. Bone remodeling: the process of destroying old bone (resorption) and depositing new bone (ossification)

B. Normal Functions of Calcium

1. Bone and teeth formation
2. Maintains muscle tone
3. Nerve transmission and contraction of skeletal and cardiac muscle
4. BP regulation by maintaining cardiac contractility
5. Blood coagulation

C. Regulatory Mechanisms of Calcium

1. Parathyroid hormone (PTH) – ↑PTH → ↑ bone resorption ⇒ ↑ serum Ca^{++}
2. Calcitonin → blocks bone resorption and ↑ renal excretion ⇒ ↓ serum Ca^{++}
3. Vitamin D – ↑ Vitamin D → ↑ Ca++ absorption from intestine → ↑ bone resorption and ↓ renal excretion ⇒ ↑ serum Ca++ levels:
   a. Vitamin D relies on adequate diet and sunlight
   b. Vitamin D activation relies on adequate renal function

D. Calcium Imbalances

1. Hypocalcemia:
   a. S/sx of ↑ neuromuscular irritability:
      1) *tetany*: facial twitching, paresthesia, muscle spasms, seizures (+Chvostek's sign. +Trousseau's sign)
   b. Consequence: (chronic): bone breakdown
2. Hypercalcemia:
   a. S/sx of ↓ neuromuscular irritability:
      1) CNS depression, drowsiness, lethargy, weak reflexes, headache
      2) GI/GU: N/V/A, thirst, increased urination
   b. Consequences: dysrhythmias, renal calculi

E. Common Bone Disorders

1. Osteomalacia – softening of bones; "rickets" in children:
   a. Cause: ***lack of adequate Vitamin D and calcium***
   b. Risk factors: breast-feeding (vs. Vit. D-fortified formula), ↑use of sunscreens, ↑ carbonated beverages
   c. S/sx: ***hypocalcemia***, muscle weakness, muscle spasms, diffuse bone pain (hip); child: fontanel on baby's head is slow to close, bony neck line, curved bones, enlarged joints, bowed legs
2. Osteoporosis – common metabolic bone disease; responsible for 1.5 million fractures per year:
   a. Cause: bone resorption outpaces bone deposition; disrupted bone homeostasis
   b. Risk factors: menopause – ↓ estrogen levels → uncontrolled osteoclast activity, testosterone deficiency, ↑ alcohol/caffeine/tobacco use, physical inactivity, diet – lack of Vitamin D and calcium, other dugs – corticosteroids
   c. S/sx: pain; height loss; pathological fx

F. Joint Classifications

1. Fixed/immobile = Fibrous joints
2. Semi-movable = cartilaginous joints *
3. Freely movable = synovial joints *

G. Common Joint Disorders

1. Osteoarthritis (OA) – often called degenerative joint disease (DJD)
   a. Cause: characterized by wearing a way of cartilage of weight-bearing joints (hips, knees, spine) ⇒ articular cartilage softens, thins, and degenerates
   b. Risk factors: age, obesity, prior injury, gender (women), heredity, muscle weakness, curvatures of spine, birth defects (congenital hip dysplasia or congenital dislocation)
2. Rheumatoid Arthritis (RA) – systemic autoimmune disorder
   a. Cause: autoantibodies (rheumatoid factors) activate inflammatory response in joints ⇒ degeneration of articular cartilage and thickening/calcification of synovial membrane
   b. Risk factors: age, family history, environment (toxic chemical, infection), gender (women), stress, obesity, smoking, diet
3. Gout:
   a. Cause: characterized by excess uric acid in blood triggered by diet, injury dehydration or stress ⇒ formation of uric acid crystals in joints resulting in inflammation
   b. Risk factors: primary gout inherited (Pacific islanders), secondary gout due to drugs, diabetic ketoacidosis or kidney disease, triggered by diet, injury, dehydration, or other stress

4. Consequences of Joint Disorders:
    a. When articular cartilage softens and degenerates, or
        b. When acute inflammation degenerates and thickens the synovial membranes ⇒:
        1) pain
        2) stiffness or ↓ range of motion (ROM)

II. PHARMACOLOGY

A. Pharmacological Connections for Bone Drugs

1. Since 98% of all calcium is stored in bones, when bones are affected → calcium levels are likely to be affected
2. When treating a bone disorder, often, agents are given to maintain or attain normal serum calcium levels
3. Therefore, the observed effects (therapeutic or adverse) will be related to signs and symptoms of calcium imbalances
4. Other agents given are intended to reduce bone resorption to maintain bone mineral density

B. Pharmacological Connections for Joint Drugs

1. When treating joint disorders, often agents are given to treat its cause (e.g. autoimmune, hyperuricemia) and/or its effects (i.e. pain)
2. Initial treatment of joint disorders can include:
    a. Analgesics – NSAIDS and other non-opioids (refer to CNS Pharmacology)
    b. Corticosteroids (refer to Endocrine Pharmacology)
3. The goals of drug therapy:
    a. Reduce or manage pain and discomfort
    b. Restore or improve joint ROM
    c. Minimize or delay joint degeneration/deterioration (related to managing underlying causes)

Nursing Implications: Bone Pharmacology – **relate drug effects on serum calcium

Major Class	MOA	Prototype – generic	Prototype – trade	A – Admin	T –✓ Therapeutic Effects – General (MC)	A– ✓ Adverse Effects – Specific (SC)	T – Teaching – General (MC)	T – Teaching – Specific (SC)
calcium supplement	• Replace Ca^{++}	calcium citrate calcium carbonate	Citracal Tums, Rolaids	Route: PO Timing: give w/ meals Contraindicated: renal calculi, digoxin toxicity	• ↑serum Ca^{++} • ↓s/sx tetany (-Chvostek & Trousseau's signs)	• Hypercalcemia → ↓N-M irritability	• Take as directed • Diet: well balanced • Adequate hydration • Avoid elements that ↓ Ca^{++} absorption: ○ zinc-rich ○ alcohol ○ caffeine ○ carbonated drinks • Safety – fall precautions • Exercise • ✓labs: electrolytes	• Watch for complications of hypercalcemia (renal calculi) • Dietary sources of calcium
vitamin D supplements	• ↑ absorption of Ca^{++} from intestine • ↓ bone resorption	calcitriol	Calcijex, Rocaltrol	Route: PO Timing: give w/meals Contraindicated: liver disease	• ↑serum Ca^{++} • ↓s/sx tetany (-Chvostek & Trousseau's signs)	• Hypercalcemia →↓N-M irritability • Hepatotoxicity: jaundice		• Watch for complications of hypercalcemia (renal calculi) • +sunlight ~20 mins. per day • Dietary sources of Vit. D • Avoid alcohol, other hepatotoxic agents
bisphosphonates	• ↓ bone resorption by: ○ inhibiting osteoclast activity ○ enzyme associated w/ bone turnover	alendronate sodium	Fosamax	Route: PO Timing: take on empty stomach; do not take before bedtime	• ↑bone density • ↓serum Ca^{++} • ↓s/sx hypercalcemia	• Hypocalcemia →↑N-M irritability; s/sx of tetany • GI: esophageal irritation • MS: arthralgia, myalgia, osteonecrosis of jaw		• Sit upright or ambulate after taking for ~30 mins • Drink w/ full glass of water • Do <u>not</u> take w/ Ca^{++} or Vit. D • F/U dental exams • Report: GI sx, muscle or bone pain

Major Class	MOA	Prototype – generic	Prototype – trade	A – Admin	T –✓ Therapeutic Effects – General (MC)	A– ✓ Adverse Effects – Specific (SC)	T – Teaching – General (MC)	T – Teaching – Specific (SC)
selective estrogen receptor modulator	• Mimics effects of estrogen on bone • ↓ bone resorption	raloxifene bazedoxifene	Evista Duavee	Route: PO Contraindica-tions: pregnancy; H/O DVT	• ↑bone density	• No direct effect on serum Ca^{++} levels • Repro s/sx: hot flashes, endometrial disorder breast pain, vaginal bleeding, migraines • **Black Box warning!** VTE: DVT, PE	**(See previous page)**	• Observe/reports s/sx of DVT or PE • Report menstrual problems • Contraception
calcium antagonist/ hormones	• Mimics effects of calcitonin →↓ bone resorption	calcitonin salmon	Fortical, Miacalcin	Route: Intranasal spray; IM/SQ Contraindica-tions: pregnancy, children, kidney disease, allergies to fish protein	• ↓serum Ca^{++} levels	• Hypocalcemia →↑N-M irritability; s/sx of tetany • Relate to route of admin.: ○ IN: nasal dryness, irritation ○ IM: inflam-mation at inj. site • GI: nausea		• Teach re: use of intranasal spray • Rotate injection sites

Nursing Implications: Joint Pharmacology: Antirheumatics (Disease-Modifying Antirheumatics – DMARDs)

Subclass	MOA	Prototype – generic	Prototype – trade	A – ADMIN	T – ✓ Therapeutic Effects – General (MC)	A – ✓ Adverse Effects – Specific (SC)	T – Teaching – General	T – Teaching – Specific
Group 1 – major non-biologics	Relieves severe inflammation, slows progression of RA (mechanism unknown)	hydroxychloroquine sulfate	Plaquenil	***Usually given w/ NSAIDs & corticosteroids*** Route/Freq: PO – daily	• ↓ s/sx of RA: joint inflammation & pain, • ↑ ROM • ↓ progression of RA	• Eye: retinal damage • GI: N/V/A • Other: HA, mood/mental △'s	• Take as directed • Take w/ food to ↓ GI upset; Ø antacids • Therapeutic effects may take several months to achieve	• Follow-up tests: eye exams • Report: Visual △'s, GI upset
	Immunosup-pression – reduces activity of B & T lymphocytes	methotrexate	Rheumatrex, Trexall	Route/Freq: PO/ parenteral – weekly Contraindications: pregnancy		• GI: N/V, hepatotoxicity • Heme: blood dyscrasias/BMD • Birth defects		• Follow-up tests: CBC, liver enzyme tests • AVOID alcohol & other hepatotoxic drugs • Report: s/sx infection, bleeding, GI upset, jaundice • Contraception
	anti-inflammatory & immunomodulatory actions	sulfasalazine	Azulfidine	Route/Freq: PO – 2-3x/day		• GI: N/V/D/A, abd. pain • Skin: hypersen-sitivity – pruritis, rash, etc. • Rare: BMD; hepatitis		• Follow-up tests: CBC, liver enzyme tests • AVOID alcohol & other hepatotoxic drugs • Report: s/sx infection, bleeding, GI upset, jaundice
Group 2 – major biologics	Tumor necrosis factor antagonists (TNF thought to be significant immune mediator of joint injury in RA)	etanercept	Enbrel	Route/Freq: SQ – 2x/wk		• Heme: blood dycrasias/BMD • Heart failure • Severe skin reaction • Local efforts at injection sites: redness, swelling, pain, itching		• Follow-up tests: CBC, liver enzyme tests • AVOID alcohol & other hepatotoxic drugs • Report: s/sx infection, bleeding, rash, resp. △'s
		adalimumab	Humira	Route/Freq: SQ – every other wk				
		infliximab	Remicade	Route/Freq: IV – at wks 0, 2, 6, then every 8 wks				
	B-lymphocyte-depleting agent	rituximab	Rituxan	Route/Freq: IV – every 2 wks				
	T-cell activation inhibitors	abatacept	Orencia	Route/Freq: IV – at wks 0, 2, 4 then every 4 wks				

Subclass	MOA	Prototype – generic	Prototype – trade	A – ADMIN	T – ✓ Therapeutic Effects – General (MC)	A – ✓ Adverse Effects – Specific (SC)	T – Teaching – General	T – Teaching – Specific
Group 3 – minor biologic/ non-biologic	Unknown MOA	gold salts – aurothioglucose	Solganal	Route: PO/INJ	**(See previous page)**	• GI: N/D/A • Skin: discoloration (chrysiasis), itching • Oral mucous membranes: ulceration • Nephrotoxicity	**(See previous page)**	• Follow-up tests: CBC, liver enzyme tests • AVOID alcohol & other hepatotoxic drugs • Report: s/sx infection, bleeding, rash, resp. △'s • Report: skin △'s oral ulcerations • Follow-up tests: renal function tests • Takes 3-6 mos for sx to improve

Nursing Implications: Joint Pharmacology: Antigout

Subclass	MOA	Prototype – generic	Prototype – trade	A – Admin	T – ✓ Therapeutic Effects – General (MC)	A – ✓ Adverse Effects – General	A – ✓Adverse Effects – Specific	T – Teaching – General
Antiinflammatory	Inhibits synthesis of microtubules, subcellular structures responsible for helping WBCs infiltrate joint area →↓ inflammation	colchicine	Colgout, Colcrys	Route: PO Baseline labs: uric acid, CBC, hepatic & renal function tests	↓s/sx of gout: red swollen tissue – often great toe, ankles, wrists, knees, elbows →↓ pain & ↑ ROM • ↓ uric acid levels • Termination of acute attacks • Prevention of future attacks	• GI: N/V/D (beginning of tx) • Hepatotoxicity	• Nutrition: B_{12} deficiency (colchicine interferes w/ absorption) • Bone marrow depression	• Take as directed – start when sx appear • Follow-up tests: CBC, uric acid levels; liver & renal function tests • AVOID alcohol & other hepatotoxic drugs • Diet: ↓ intake of purine-containing foods; ↑: fluid intake • Report: ↑ joint pain, ↑ adverse effects
Uric acid inhibitors	Blocks xanthine oxidase →↓ uric acid formation → blocks accumula-tion of uric acid in blood & uric acid crystals in joints	allopurinol	Zyloprim, Lopurin	Route: PO/IV Baseline labs: uric acid, CBC, hepatic & renal function tests			• Hypersensitivity • Bone marrow depression • Nephrotoxicity	
	Blocks reabsorption of uric acid by renal tubules → promotes excretion to ↓ hyperuricemia	probenecid	Probalan	Route: PO			• Facial flushing • HA	
Miscellaneous OA agent	Replaces synovial fluid that surrounds joints	sodium hyaluronate	Hyalgan	Route: INJ Given when other OA meds are not successful Contraindica-tions: H/D PAD, DVT	• ↓ pain • ↑ ROM		• Injection site: warmth, pain, swelling, numbness, tingling • Local itching or skin irritation • GI: N	• Report: o allergic reactions o severe pain or swelling at injection site • Avoid 48 hrs: jogging, strenuous activity, high impact sports, standing for longer than one hour at a time