

Metabolic Disturbances of Bone

Control of bone metabolism:

Factors affecting bone metabolism

PTH

Calcitonin is released in response to increased CA in blood and causes inhibition of bone breakdown (decreases bone reabsorption) and promotes CA deposition in the bone. Its antagonist is PTH.

Vitamin D transports CA and phosphorous from the intestines into blood and aids in deposition of CA into bone matrix.

Vitamin C helps in the synthesis of collagen matrix which contains the amino acid hydroxyproline. Vitamin A for growth of skeletal tissue and soft tissue.

Protein for the bone matrix.

Other, including estrogen, somatotrophin.

Many factors can metabolically alter bone as lack of vitamins, rapid cell destruction, kidney diseases where CA is wasted, abnormal metabolic diseases etc.

Diagnostic Studies: Serum calcium increases as calcium is reabsorbed from bone as with hyperparathyroidism, prolonged bed rest, use of thiazide diuretics decreases as with removal of parathyroid gland, various malabsorptive diseases, use of steroids and with decrease in vitamin D as in rickets and Osteomalacia.

Urinary calcium involves 24 hour collection and requires test of renal function to determine body's ability to excrete calcium.

Serum phosphates evaluated in relationship to CA.

Serum alkaline phosphatase reflects increased osteoblasts associated with increased enzyme alkaline phosphatase and rises in proportion to new bone cell production from osteoblasts and the deposition of CA in bone. Levels increase with liver disease, bone disease, Paget's bone cancer, hyperparathyroidism. Levels may decrease with malnutrition scurvy, and pernicious anemia.

Urinary hydroxyproline is associated with rapid bone breakdown.

Serum urates aid in diagnosing gout as it reflects faulty purine metabolism.

Also scans x-ray, biopsy, single-photon densimeter for osteoporosis.

Gout

<http://easyweb.easynet.co.uk/~pgardiner/Gout.htm>

<http://arthritisnet.com/diseaseindex/gout.htm>

<http://www.medicinenet.com/Script/Main/Art.asp?li=MNI&ArticleKey=724>

<http://www.healthanswers.com/centers/body/overview.asp?id=bone+muscle+joint&filename=000422.htm> (great reference on acute gout plus pictures!)

<http://www.healthanswers.com/centers/body/overview.asp?id=bone+muscle+joint&filename=000424.htm> (good information on chronic gouty arthritis)

Definition: Hereditary condition of *disturbed uric acid metabolism* whereby sodium urates are deposited in articular, periarticular and subcutaneous tissues.

Uric acid is the end product of protein metabolism and is also synthesized in the liver and from ingested foods and the breakdown of body proteins.

Hyperuremia from overproduction of uric acid and/or inability to excrete uric acid at sufficient

Classification: Primary as the result of genetic defect of purine metabolism

Secondary results from increased cell turnover

Pathophysiology: Uric acid has low solubility so it precipitates at sites where blood flow is least active including cartilaginous tissue; get masses of sodium urate crystals in or near joints and cartilage.

Renal lithiasis is the most common serious complication.

Assessment: There is heredity predisposition, history of pain, dietary intake with high purine foods.

Diagnostic tests: Must differentiate from other forms of arthritis.

Have serum uric acid level above 8 mg/dl, elevated urinary uric acid levels in secondary gout: albuminuria; leukocytosis; and increased

X-ray changes are late with *punched-out* appearance of bone as urate acids replace bony structure.

Special studies include needle biopsy of synovial fluid to detect intracellular crystals sodium crystals. Also increased heat per thermography.

Nursing diagnosis: Pain, alteration in tissue integrity, alteration in urinary elimination

Interventions:

Acute phase efforts focus on alleviation of pain, inflammation, fever, swelling primarily achieved by bedrest, joint immobilization, avoidance of weight bearing.

Medications : ASA, tylenol and NSAID (indomethicin, naproxyn, sulindac, butazolidin). **Colchicine** may be required and can be given orally or IV Q 1-2 hours for no more then 4-8 MG within 24 hours. Must stop the drug if GI symptoms develop or if the pain stops; use prophylactically, before and after surgery. May inhibit migration of granulocytes to area of inflammation and to decrease lactic acid production associated with phagocytosis and also interrupts cycle of urate crystal deposition.

For long term management

1. Uricosuric agents inhibit *resorption* of uric acid; thus yield increased excretion of uric acid and will decrease serum urate levels.

a. Probenecid (benemid) this drug also inhibits renal secretion of weak organic acids as penicillins and cephalosporins. ASA has an antagonist effect and would promote urate retention if taken together. Acetaminophen alright. Initially increase the number of attacks within the first 6-12 months so may need to give colchicine prophylactically. Side effects *hemolytic anemia and gastric distress*.

Should have high fluid intake as it might cause precipitation in renal tubules. Monitor kidney function. Alkalinize the urine to *prevent renal colic*. Give with food, milk to decrease gastric distress. Avoid purine foods.

b. Sulfipyrazone (Anturane). Block renal tubular resorption of uric acid and increase its excretion. Also inhibits platelet aggegation. Side effects agranulocytosis.

2. Xanthine-oxidase inhibitors indicated if gout caused by *overproduction* of uric acid

a. Allopurinol (zyloprim) which decreases uric acid production by *inhibiting* the biochemical reactions that permit its formation. Side effects *agranulocytosis, anemia, rash*. Discontinue at first sign especially if patient of diuretics. May use in conjunction with uricosuric agents.

Must monitor intake and output, consume at least 2 liters of fluid daily, and keep the urine alkaline. Frequent checks of CBC, take with food. May cause drowsiness.

Nursing Interventions: Comfort measures include bed rest, don't touch, use foot cradle, hot/cold packs, and perform frequent neurovascular assessments. Protect the skin, very dry.

Keep fluids to 2-3 liters daily.

Manage knowledge deficit, include food to avoid (alcohol, purine rich foods as spinach, peas, meats, shellfish). Explain what precipitates attack including fasting, overindulgence, medications as ASA and diuretics and stress.

Osteoporosis

<http://www-medlib.med.utah.edu/WebPath/TUTORIAL/OSTEO/OSTEOPOR.html>

Characteristics: Reflects a decrease in total bone mass and loss of bone exceeds bone formation. Bones fracture under everyday stress. Usually evident by 60-65 years. Eight times more common in women due to lower calcium intake; less bone mass; reabsorption begins at earlier age and increases with menopause; pregnancy and lactation; and longevity.

By age 70 lose 30% skeletal mass.

Predisposing Factors:

Include family history, northern European, increased caffeine, alcohol, sodium and protein. Also early menopause, lactose intolerance, small bones, anorexia and bulimia, cigarettes and lack of exercise. Various medications can promote including aluminum hydroxide, corticosteroids, tetracycline, heparin, INH, lasix, thyroxin, anticonvulsants.

Some diseases also promote including hyperthyroidism, hyperparathyroidism, Cushings, alcoholism, liver cirrhosis and diabetes.

Assessment: Back pain, spontaneous fractures mostly in the forearm, spine, thighs and hips. Gradual loss of height and Dowager's hump.

Diagnosis: Lab studies are normal. Bone mass measurements are decreased. X-ray shows generalized bone demineralization. X-ray cannot detect until 25-40% of calcium is lost.

Prevention: Administration of 1000 mg/CA daily for premenopausal and 1500 mg daily for postmenopausal. CA carbonate is good supplement. Avoid salt as it leads to excretion of CA. Increase sunlight exposure. Avoid alcohol. Also estrogen therapy. Exercise.

Lots of research in this area. In one study daily injection of parathyroid hormone was administered with oral doses of activated vitamin D to increase the amount of calcium absorbed from the diet. Significant increase in bone density of vertebra was found. Texas study reported that use of sodium fluoride also increased bone mass.

If fracture occurs, follow appropriate protocol.

Osteomalacia

<http://www.skiagram.com/p4-571.html>

Characteristics: Vitamin D deficiency inhibits absorption of calcium from the intestines yielding insufficient calcification of bone. Same as rickets in children.

Predisposing factors: Due to lack of exposure to UV light, GI malabsorption, pregnancy, kidney disease, acidosis as the kidneys uses CA to combat acidosis.

Assessment: Persistent skeletal pain, muscular weakness, weight, weight loss, kyphosis and deformities of the extremities. Bones are soft, develop bowing of legs, knock-kneed.

Diagnosis: Lab shows decreased serum calcium. X-rays shows generalized bone demineralization. There is also increased serum alkaline phosphatase and increased urinary hydroxyproline loss.

Nursing Diagnosis: See previous handout

Treatment: Treat underlying cause. Vitamin D and normal diet. Ultraviolet irradiation and increase exercise.

Paget's Disease

<http://www.osteo.org/pdisbone.html>

Characteristics: Deformities of the bone caused by unexplained abnormal regeneration and reabsorption of bone, fibrotic changes, and remodeling with structurally uneven bone. Commonly affects pelvis, long bones, spine and cranium. Have bone breakdown then osteoblastic activity.

Predisposing factors: White male over 50.

Assessment: **Insidious** onset, small hat syndrome. Pathological fractures, and pain in bones, skin temperature affected. Impaired hearing, spine bent forward, rigid, thorax compressed, immobile, ape-like, CHF. Pathological fractures may lead into osteosarcoma, chondrosarcoma or fibrosarcoma.

Diagnosis: Increase in serum alkaline phosphatase. X-ray shows bone curved, thickened bone cortex ESP at weight bearing and cranium

Nursing Diagnosis:

Treatment:None specific, supportive. calcitonin. EHDP (etidronate disodium which reduces the rapid turnover of bone, decreased serum ALK Phos and urinary hydroxyproline. May need to use mithramycin which is cytotoxic, but provides dramatic relief. General measures include keep client active, supervise exercise, firm mattress. May need corset, brace. Learn how to lift and move properly. Need balanced diet with Vitamin D, calcium and protein.

Bone Cancer

<http://www.healthanswers.com/centers/body/overview.asp?id=bone+muscle+joint&filename=001230.htm>

<http://www.healthanswers.com/centers/disease/overview.asp?id=cancer&filename=001302.htm>

1,900 get bone cancer each year. Most common in children and young adults.

Recall definitions of primary (only 1% bone tumors are primary) and secondary (most often comes from cancer of breast or lung or liver).

Multiple myeloma is most frequently occurring primary tumor that arises in bone: affects plasma cells; cover with hematology.

Osteogenic sarcoma: Primary neoplasm, highly malignant; occurs in 10-12 years. Dx by serum alkaline phosphatase and calcium levels, and x-ray findings.