NURS 143
Health Alterations II
Cardiovascular
&
Hematological Systems

Fall 2010
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Objectives

- Use the nursing process to organize the care of children and adults with stable, recuperative or chronic health states.
- Conform to legal and ethical principles in relationships with individuals and families.
- Use therapeutic techniques to facilitate communication with the health-care team, individuals and families.
- Use theory based knowledge to analyze rationales for making clinical judgments.
- Organize care by setting priorities and seeking assistance as needed.
- Select experiences that strengthen clinical performance

Chronic illness defined

- Illness lasting a long time

Identify some chronic issues related to the cardiovascular & hematological system
Chronic Illness

- Requires collaboration
- Care management
  - Patient
  - Family
  - Health Care team
- Healthcare delivery system
  - Patient-centered care individual needs, values, preferences
  - Interdisciplinary teams
  - Self-management

Managing Chronic Illnesses

- Self-regulation/care
- Care giver concern
- Stigma
- Nursing management outside the hospital
- Advocacy role of the nurse
- Ethical-legal issues

Safety: improving medication management for older adults

- BEER (gerontologist) risk-benefit appropriateness of medications
- Institute of Medicine (IOM) deaths from medical errors
- Chronic conditions compared with medications prescribed
- Financial burden & under/over medicated
- Side effects & interactions & adverse drug reactions
  - Renal function: digoxin, aminoglycosides, antibiotics, radiographic contrast media, ACEI, NSAIDS
- Hospital admissions
  - Constipation, falls, depression, immobility, confusion
Safety risk reduction

- Pre-poured pill boxes
- Voice activated instructions
- Medication list
- Once-a-day dosing
- Lab studies
- Monitor side effects
- Lower dosing

Hypertension

- Prevention, early detection,
- Management of early disease
- Prevent complications
- Interventions
- Define hypertension

What would happen if a person with hypertension is not diagnosed early?
Which risk factors are modifiable?

Why is hypertension the “silent killer”?

Joint National Committee on Prevention, Detection, Evaluation of HTN

- Normal
  - SBP <120 DBP <80
- Pre-hypertension
  - SBP 120-139
- DBP 80-89
- Hypertension
  - SBP ≥ 140 DBP ≥ 90

Stage I
- 140-159/90-99

Stages 2 & 3
- ≥ 160/≥ 100
RAAS

- Renin-Angiotension-Aldosterone System
  - Renin produced
  - Angiotensin I
    - Angiotensin II (vasoconstrictor)
  - aldosterone
  - Retain Na+H2O → BP

Vessel Changes
- Sclerosed
- Tortuous
- Narrowed
- Decreased elasticity
- Atherosclerosis

Organ Damage
- Heart
- Brain
- Eye
- Kidney
Labile hypertension

- BP fluctuates abruptly and repeatedly
  - Emotional stress
    - Headache
    - Tinnitus
      - Relaxation techniques
      - Remove stress trigger
      - Anti-anxiety medications

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<table>
<thead>
<tr>
<th>BP control</th>
<th>&lt;120/80</th>
<th>Diabetes/CKD &lt; 130/80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lipid management</td>
<td>LDL &lt; 100 mg/dl optimal</td>
<td>Omega-3 fatty acids</td>
</tr>
<tr>
<td>Smoking cessation</td>
<td>1-800-noBUTTS</td>
<td></td>
</tr>
<tr>
<td>Weight management</td>
<td>BMI 18.5-24.5</td>
<td>DASH</td>
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<tr>
<td></td>
<td>Potassium-rich foods</td>
<td>Daily aerobic exercise 30 minutes</td>
</tr>
<tr>
<td></td>
<td>Weight training</td>
<td></td>
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</tbody>
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| Waist circumference | Males < 40 " |
|                    | Females < 35 " |

| Diabetes Management | Non-diabetic Fasting blood glucose ≤ 100mg/dl |
|                     | Diabetic Fasting blood glucose ≤ 126mg/dl |
|                     | HgA1c < 7% |
Stepped-care Therapy

- Life Style Modifications
- Pharmacologic Therapy
- Hypertension Guidelines

Pharmacological Goals

- Decrease cardiac workload
- Decrease $O_2$ demand
- Decrease preload (volume)
- Decrease afterload (resistance)
- Increase contractility

Pharmacology

- Diuretics
- Angiotensin Converting Enzyme Inhibitors (ACEI)
- Beta blockers
- Calcium Channel blockers
- Angiotensin Receptor blockers
- Alpha-adrenergic blockers
Diuretics

- **Thiazides**
  - Hydro/chlor/thiazide
    - ↓ fluid volume
    - Hypotension
    - Hypokalemia (dry mouth, thirst, weakness, tachycardia, muscle weakness)
    - Hyperuricemia (gout)
    - Hyperglycemia

  What should the nurse monitor when the client is receiving this medication?

- **Loop**
  - Furosemide (Lasix)
  - Bumetanide (Bumex)
    - ↓ fluid volume rapidly
    - Hypokalemia
    - Renal failure
    - Hearing loss
    - Thrombocytopenia
    - Hyperglycemia
    - Neutopenia
    - Anemia

  What should the nurse include on the teaching plan when the client is receiving this medication?

- **Potassium sparing**
  - Spironolactone (Aldactone)
    - ↓ fluid volume sparing potassium
    - Hyperkalemia
    - Avoid high potassium foods: bananas, oranges, salt substitute, dried apricots

Angiotensin converting Enzyme Inhibitor (ACEI)

- **Captopril (Capoten)**
- **Lisinpril (Zestril)**
- **Benazepril (Lotensin)**
  - Blocks conversion angiotensin I to angiotensin II (potent vasconstrictor)
  - Diabetes - decrease nephropathy & neuropathy
  - Non-productive persistent cough
  - Neutropenia
  - Hyperkalemia
  - Angioedema

What do these names have in common?
Beta blockers

- Propranolol (Inderal)
- Atenolol (Tenormin)
- Metoprolol (Lopressor, Toprol)

  - Blocks sympathetic nervous system
    - Bradycardia
    - Fatigue
    - Heart failure
    - Mask hypoglycemic symptoms
    - Insomnia
    - Sexual dysfunction

Calcium channel blockers

- Verapamil (Calan, Isoptin)
- Diltiazem (Cardizem)
- Nisoldipine (Sular)

  - Inhibits calcium ion influx during cardiac depolarization
  - Promotes vasodilation, relaxes coronary smooth muscle
  - ↓ conduction from SA → AV node
    - Headaches
    - Hypotension
    - Tachycardia

Angiotensin Receptor blockers

ARB

- Valsartan (Diovan)
- Losartan (Cozaar)

  - Blocks vasoconstrictor & aldosterone producing effect on angiotensin II
    - Cough
    - Hypotension
    - Anorexia
    - Lithium toxicity
    - Hyperkalemia
    - Hepatitis
    - Renal failure
Alpha-adrenergic blockers

- Terazosin (hytrin)
- Doxazosin (cardura)
- Prazosin (minipress)
  - Peripheral vasodilator
  - Orthostatic hypotension
  - Palpitation
  - Fatigue, weakness
  - Diarrhea, emesis
  - Caution in elderly

Measurements

- Systolic/Diastolic
- Pulse Pressure = SBP minus DBP (<40 shock, >40 resistance) change in pressures during contraction
- Mean Arterial Pressure = 1/3 PP plus DBP (77-97) >60mm/Hg to sustain organ/tissue perfusion average pressure inside blood vessels

The Cardiac System
Blood flow

- Right Atrium
- Tricuspid Valve
- Right Ventricle
- Pulmonic Valve
- Pulmonary Arteries
- Pulmonic Veins
- Left Atrium
- Mitral Valve
- Left Ventricle
- Aortic Valve
- Aorta

Cardiac Conduction System

- SA Node
- AV Node
- Bundle of HIS
- Left Bundle Branch
- Right Bundle Branch
- Purkinje Fibers

Sinus Node
- Atrium
- Left Bundle Branch
- AV Node
- Bundle of HIS
- Right Bundle Branch
- Ventricles
Cardiac Conduction & EKG & Heart sounds

Ventricles contract
AV valves close
“lub”

Ventricles relax
P & Aortic valves close
“dub”

Normal Sinus Rhythm

QRS complex
P wave

Normal Sinus Rhythm

ECG tracing
**NSR**

- Rhythm - Regular
- Rate - 60-100
- P Wave - Visible before each QRS complex
- Signal originates from the SA node

**Normal Sinus Rhythm**

![Heart and ECG](image)

Cardiac Output = Stroke Volume x Heart Rate

- **Preload**
  - Ventricular volume at the end of diastole
  - **dependent on venous blood return to body**
  - **Position change**

- **Contractility**
  - Ability to contract in absence of changes in preload/afterload
  - **SNS influence**

- **Afterload**
  - **Resistance to ventricular ejection**
  - **Dependent on diameter of arteriolaris (narrow → ↑ afterload)**
Cardiac Output

- Cardiac Output = Stroke Volume \times Heart rate
- 4 – 8 Liters Minute
- Cardiac Index = 2.5 – 4.0 L/minute
  < than 2.5L/min./mm² = inadequate perfusion of body tissues

Cardiac Functioning in Pediatrics

- Oxygen requirements high for first 8 weeks of life (↑ metabolic rate - growth requirements, heat production, physical activity, ↑ work of breathing)
- Cardiac output depends almost completely on heart rate until the heart muscle is fully developed at age 5
- exercise, fever, anxiety →
  ↑ metabolic rate → ↑ CO → ↑O₂ → tachycardia
- Most common cause of pediatric bradycardia is Severe hypoxemia

The challenge

<table>
<thead>
<tr>
<th>The nurse takes a BP on a client POD #1. The BP is 160/92. The nurse should</th>
<th>The nurse is preparing to administer lisinopril. The nurse should</th>
</tr>
</thead>
<tbody>
<tr>
<td>The nurse is teaching a client about betablockers. The teaching plan should include</td>
<td>The nurse need to administer lovenox. The recommended dose is 1mg/kg every 24 hours. The client weighs 176.</td>
</tr>
</tbody>
</table>
### Laboratory & Diagnostic Studies

- CBC
  - WBC
  - Hgb, Hct
  - Sedimentation rate
- Lytes
- BUN & Creatinine
- Cardiac markers
  - CPK-MB
  - HDL/LDL
  - Troponin
- C-reactive protein
- Homocysteine
- Lipid panel- Cholesterol
- EKG
- Chest x-ray
- Echocardiogram
- Stress test
- TEE (transesophageal echocardiogram)
- Monitoring
  - Telemetry
  - Holter monitor
- MRI
- MUGA scan (Multiple Gated Acquisition scan) heart motion isotope study

### Diagnostic tests - Managing Care of a client pre, intra, post procedure

- Angiography
- Cardiac catheterization
Diagnostic tests - Invasive

- Angiography
- Cardiac catheterization
- Hemodynamic studies
- Thallium(cardiolyte) imaging – nuclear medicine-isotope study to determine myocardial perfusion

Heart Failure

- Inability of the heart to pump an adequate amount of blood to meet the metabolic demands of the body’s tissues.
- Statistics
  - 50% of deaths from heart disease
  - 5-year mortality rate – 50%
  - Most frequent cause for hospitalization for people > 65.
  - MI Complication
Etiology of HF

- Interference with
  - Preload
  - Afterload
  - Contractility
  - Heart rate
  - Metabolic state

- Pathology
  - Impaired ventricular emptying
  - Impaired ventricular filling

Left Heart Failure
Systolic & diastolic failure

**Adults**
- Cough (blood-tinged, frothy sputum)
- ↓ urinary output
- Orthopnea
- Tachycardia
- Palpitations
- Paroxysmal nocturnal dyspnea
- Weight gain

**Children**
- Poor feeding
- Weight loss
- Failure to thrive
Right Heart Failure

- Dependent edema/ascites
- Jugular vein distention
- Hepatosplenomegaly
- Fatigue

HF in Children

- Congenital heart defects most common cause
- Early S&S
  - Fatigue, irritability, restlessness
  - Toddler assumes squat position
  - Venous return = preload
  - SVR = afterload
- Sinus Bradycardia may be sign of Digoxin toxicity sign (< 100 in infant, < 80 older children)
  - Digoxin prescribed mg/kg

Abnormal heart sounds auscultated in Heart Failure

S3
- Vibration of the ventricular walls, resulting from the first rapid filling heard after S2.
- Commonly heard in children and young adults, older adults, elderly with heart disease

S4
- Fourth heart sound when the atriums contract before S1
- Vibration of valves, supporting structures, and the ventricular walls
- Auscultated in patient with increase resistance to ventricular filling, such as in heart failure
Nursing Management for a Client with Heart failure

- The home health nurse makes a visit to Renee, a client with stage II heart failure, receiving digoxin 0.25 mg daily, lasix 40 mg PO BID, KCL 40 mg Po daily, colace 250 mg PO daily, NTG gr 1/150 PRN chest pain. What should the nurse include in the assessment to measure that the heart failure is maintained for this client?

- When does ventricular filling occur?
- When does ventricular emptying occur?
- What role does ejection fraction play in heart failure?
- What significance does a Brain Natriuretic Peptide (BNP) and heart failure?
- Identify the core indicators for a patient with heart failure

Managing the client with Coronary Artery Disease

P provocation
Q palliation
R quality
S region
T quantity
Interview questions regarding pain

R radiation
S associated
T symptoms

P time
Interview Questions

- Health management
- Pain History
- Family History
- Activity tolerance
- Shortness of breath

Managing patients with Coronary Artery Disease

[Diagram of coronary artery with labels: intima, media, adventitia, atherosclerosis, fibrous plaque, complexed lesion, lipids, connective tissue, smooth muscle cells, dense tissue, necrosis, thrombus, lumen.]
**CAD Interventions**

- PTCA
- Balloon angioplasty
- Arterectomy
- Stents
- anticoagulation therapy
- CABG
- Medication
- Diet

**Angina - Ischemia**

- Chest discomfort or pain occurs when myocardial oxygen demands exceed supply
- Types
  - Stable – fixed lesion – pain occurs with exertion
  - Unstable - can occur at rest
  - Variant – due to vasospasm
Pharmacologic Management of Angina

- Vasodilators (NTG)
- Antiplatelet aggregates (ASA, Plavix)
- Beta-blockers
- Calcium Channel Blockers

Myocardial infarction

- Necrosis

Myocardial Infarction

- Duration: hours to days
- Severity 0 – 10
  - 0 = silent M. I.

Diagnostic

- Serial CK-MB rises in 3-6 hours, returns to normal in 3-4 days
- Troponin – remains elevated for 6-7 days (abnormal if > 0.4 ng/ml)
- Serial 12-lead EKG STEMI
Characteristics

Angina
- Squeezing, pressing aching pain radiating to left shoulder, arm, jaw, right shoulder
- Transient, gradual or sudden onset, short duration
- Apprehension
- Relieved with rest/NTG

Myocardial infarction
- Sudden, unbearable heavy, vise-like
- Shoulder & arm radiation
- Not relieved with rest/NTG
- Pain last hours/days
- Diabetics may not have pain- silent MI

Goals of Treatment for M.I.

- Myocardial Salvage
- Prevention of reinfarction
- Prevention of recurrent ischemia

Coronary Reperfusion Therapy (CRT)
- Thrombolytic therapy (clot lysis and reperfusion)
- Tissue plasminogen activator (TPA)
- Tenecteplase
- Abiopase
- Urokinase
- Reteplase
- Streptokinase

Contraindication
- Bleeding, PUD, pregnancy

What do our names have in common?

Cardiac Cripple

- Denial
- Understanding
- Adjustments
- Living again
Compensatory Mechanisms

- Release the fight-or-flight hormones, epinephrine & norepinephrine
- Stress
- Decompensation
- HF: Inability to pump adequately
- HR, force
- CO

Positive Outcomes

- Improved comfort
- Absence of complications
- Improved cardiac output
- Improved gas exchange
- Decrease in fear/anxiety
- Increase in activity tolerance
- Adaptation to changes in lifestyle

Nursing interventions

- Decrease workload of the heart
  - Bedrest
  - Pace activities
  - Oxygen administration
- Promote comfort
  - Pain relief
- Relieve anxiety
  - Explain
  - Monitor
Pharmacology

- Digoxin
  - HF
  - Improves LV Ejection fraction/contractility
  - IV push, PO
  - Administered with diuretics, ACEI
  - Serum 0.8–2.0 ng/mL
  - Side effect – bradycardia
  - digoxin toxicity (hypokalemia potentiated)
    - anorexia & nausea, visual changes, arrhythmias
    - Digibind - potent antidote binds with digoxin

- Antiarrhythmics
- Analgesics
- Anti-anxiety
- Sedatives
- Hypnotics

Managing Care of the Client with Structural Disorders

- Valvular disorders
  - Aortic stenosis/insufficiency
  - Mitral stenosis/insufficiency
  - Check for murmurs & opening snaps (A sharp, high-pitched click in early diastole, associated with the opening of the abnormal valve in cases of mitral stenosis.)
  - Replacement – requires anticoagulant therapy

Structural Disorders/Infections

- Infectious disorders
  - Bacterial endocarditis
  - Rheumatic fever Assessments

- Prevention
- Treatment – antibiotics
- Complications
  - Bacterial Endocarditis – emboli
  - Rheumatic Fever – valvular disorders
Alterations in the Hematologic System

Problems of Oxygen transport

Hematological Alterations

- How would you know that a patient has an alteration in the hematological system?
- What puts a patient at risk for a hematological alteration?
- What orders would you anticipate the physician to write?
- What nursing interventions would the nurse include on the nursing care plan?

Anemia

Assessment Findings

- Weakness
- Pale skin
- Tachycardia or irregular heartbeat
- Shortness of breath
- Chest pain
- Dizziness
- Cognitive problems
- Cold or numb extremities
- Headache
Classification of Anemias

- Due to deficiency of factors required for RBC production or RBC destruction
  - Hemolytic
    - Trauma/burns
    - Chemical agents
    - Transfusion reaction
    - Systemic diseases
  - Secondary
    - Chronic conditions
    - Cancer

Classification of Anemia's

- Hemorrhagic
  - Acute
  - Chronic
- Congenital
  - Sickle cell
  - Thalassemia

Pathophysiology of anemia

- Blood loss – acute/chronic
- Impaired production
  - Decreased hemoglobin synthesis
  - Defective DNA synthesis
  - Decreased amount of RBC precursors
- Increased destruction/Hemolysis
- Nutritional Deficiencies
- Erythrocytosis
Hematopoiesis - Nutritional Factors

- Vitamin B₁₂ (extrinsic factor)
  - formation of red blood cells and the maintenance of a healthy nervous system.
  - The protein in food binds with Vitamin B₁₂. During digestion hydrochloric acid releases vitamin B₁₂ from proteins in foods which combines with a substance called intrinsic factor (IF), a complex which is absorbed by the gastrointestinal tract.
  - fish, meat, poultry, eggs, milk, and milk products, fortified breakfast cereals

Folic Acid: RBC formation

- leafy green vegetables, fruits, dried beans, peas and nuts. Enriched breads, cereals and other grain products
- Pregnancy - prevent major brain or spine birth defects

Iron: Hemoglobin production

- Heme: red meats, fish, and poultry
- Nonheme: lentils and beans, iron-enriched and iron-fortified foods.
- Fish: cod, sardines, tuna, clams, oysters, shrimp
- Poultry: chicken, eggs, yolk
- Lean Red Meats: beef, lamb, veal, pork, liver
- Nuts and Beans Soybeans: dried beans, hazelnuts, almonds, lentils, peanuts
- Vegetables: broccoli, chard, spinach, green beans, asparagus, turnips, parsley, kale, watercress, brussel sprouts
- Beans: green, Lima, peas, chick peas, garbanzo
- Fruits/Sweets: dates, prunes, figs, apricots, apples, raisins, chocolate, coconut
- Fruits/Vegetables: citrus fruits, tomatoes, oranges, cabbages, lemons, green peppers, limes, grapefruits, tangerines, cantaloupes, tangelos
- Bread and Cereals: Enriched, fortified and whole grain breads and cereals are often high in iron (check label)
- Grains: Wild rice, corn meal, oats, soybean, wheat, bran, rye, buckwheat, popcorn, barley, wheat germ, millet
- Cereals: Farina, cream of wheat, shredded wheat
Iron Deficiency | Vitamin B₁₂ | Pernicious Anemia
---|---|---
Nutritional | Nutritional | Failure of absorption of Vit B₁₂ due to lack of intrinsic factor (*parietal gastric cell secretion)
Blood loss | Intestinal malabsorption | |
Diet | Supplemental iron | Diet
Supplemental iron | Diet Supplements | Treat cause
Treat Cause | Treat cause | |
B₁₂ = extrinsic factor | B₁₂ (cobalamin) | I.M. Iron

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Aplastic Anemia
- Bone marrow failure
  - Etiology
    - Autoimmune (hereditary/congenital)
    - Myelotoxins
  - Pancytopenia
    - RBC’s (anemia)
    - Platelets (Thrombocytopenia)
    - Leukocytes (Neutropenia)
  - Medical management
    - Bone marrow transplant
  - Focus of nursing care plan
    - Infection & bleeding complications

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Sickle Cell Anemia
- Etiology
  - Genetic
  - Ethnicity
- Pathophysiology
  - Normal Hb A replaced with 55-65% Hb S
  - Hb S molecules release O₂ & tend to cluster to form long rod-like structures - stiff & sickle shape
  - Occlusion of microcirculation
  - Hb S lifespan – 10-20 days
Sickle Cell Anemia

**Signs & symptoms**
- Occur at about 6 months of age (Hb F replaced with Hb S)
- S & S of anemia
- Crisis related to occlusion of small arteries/tissue necrosis
  - Pain in chest, back, abdomen, bones
  - Renal damage, blindness, strokes
  - Acute chest syndrome – hypoxia respiratory failure
- Prone to infections, pneumonia

**Diagnostic studies**
- Sickledex - sickle-turbidity test
- Screening for children > 6 mo.
- Hemoglobin electrophoresis (measures different types of hemoglobin)

**Continuous treatment**
- Transfusions (strokes → ↑ viscosity
- Aggressive treatment of infections

**Crisis treatment**
- Hydration
- Oxygen
- Pain control
- Bedrest

**Nursing Diagnosis**
- Altered family processes
- Risk for altered parenting
- Altered growth and development
- Impaired physical mobility
- Alteration in comfort: Pain

**Goals**
- Increase tissue perfusion
- Promote hydration
- Control pain
- Prevent infection
- Ensure adequate nutrition
- Prevent complications
- Provide emotional support
β-Thalassemia

- Inherited disorder of hemoglobin synthesis
- Ethnicity – Mediterranean descent
- Major/minor
- S&S of infant
  - Failure to thrive
  - Pallor
  - Severe anemia
  - Hepatosplenomegaly
- Goal supportive – blood transfusions

Polycythemia

- RBC’s & hemoglobin
- Pathophysiology
  - hyperviscosity
  - Hypervolemia
  - Tissue & organ congestion
- Treatment
  - Phlebotomy
  - Myelosuppressive agents
  - bone marrow radiation

Immune Thrombocytopenic Purpura

- < 40, women; Children 2-5 years-old
- Platelet deficiency < 100,000/mm^3
- Major problem
- Signs
- Treatment
  - Immunosuppressant therapy
  - Platelet transfusions
  - Splenectomy

Complications
- Stroke
- Myocardial infarction
Hemophilia - Hereditary deficiency in clotting factors

Males – affected

Females – carriers

Symptoms

- Spontaneous bleeding
- Knees, elbows, ankles, wrists, shoulders
- Arthropathy - Hemarthrosis - progressive joint damage
- Deep tissue bleeding
- Chronic synovitis, hypertrophy
- Acute joint pain/swelling
- Osteoarthritis / rheumatoid arthritis

- ↑ pain, swelling
- Warmth & tingling
- ↓ ROM
- Acute pain - interferes with normal activities
- Limb dysfunction
- Compartment syndrome

Treatment

- Clotting factor replacement
  - Hemophilia A VIII
  - Hemophilia B Christmas IX

Nursing interventions

- Teach
  - Safe environment
  - Close supervision
  - Dental care precautions
- Referrals
  - Financial assistance
  - Support groups

Nursing Diagnosis - Hematological Alterations

- Activity intolerance
- Altered nutrition
- Altered tissue perfusion
- Risk for injury
- Fatigue
- Alteration in comfort: Pain
Platelets

Folic Acid
- Improving medication management for older adult clients.
- AHA/ACC guidelines for secondary prevention for patients with coronary and other atherosclerotic vascular disease
- Diet and lifestyle recommendations for hypertension
- Chronic Care Model Audiovisual Presentation
  [link](http://www.researchchannel.org/mov/uw_chro_care_250k_qt.mov)
- The Role of Prophylaxis in Managing Hemophilia in Adult and Pediatric Populations
  [link](http://cme.medscape.com/viewarticle/705176)