Chapter 5

Immunity Inflammation and Infection

Learning Objectives

* Describe physical and chemical barriers.
* Describe how inflammatory changes act as bodily defense mechanisms.
* Identify the signs and symptoms of inflammation.
* Discuss the process of repair and healing.
* Differentiate infection from inflammation.
* Discuss the actions of commonly found infectious agents.
* Describe the ways in which infections are transmitted.
* Identify the signs and symptoms of infection.
* Compare community-acquired and nosocomial infections.

Learning Objectives cont'd

* discuss the nursing care of patients with infections.
* Describe the Centers for Disease Control and Prevention (CDC) Standard Precautions guidelines for infection control.
* Describe the CDC isolation guidelines for Airborne, Droplet, and Contact (Transmission-Based) Precautions.
* Describe the immune response.
* Identify the organs involved in immunity.
* Compare natural and acquired immunity.
* Differentiate between Humoral (antibody-mediated) and cell-mediated immunity.
* Describe the nursing care of patients with immunodeficiency and of patients with allergies.
* Describe the process of autoimmunity.

* Allergen
* Antibodies
* Antigen
* HAI
* Immunodeficiency
* Medical asepsis
* Surgical asepsis

* The body defends itself by:
  * Sounding an alarm
  * Signaling for help to fight the attacker (the infection)
  * It quarantines the infection
  * Then cleaning up after itself before it gets back to normal again
* This all happens at the cellular level
* If the lines of defense or barriers are not working at the most basic level,
  * The body will activate other processes to protect itself

Pg 56 Physical and Chemical Barriers

- **First line of defense:**
  - intact skin and mucous membranes
    - Protective covering
    - Secrete substances that inhibit the growth of microorganisms
    - Sweat glands: lysozyme
    - Sebaceous glands: sebum (antimicrobial & antifungal)
    - Acidic secretions: skin, GI and GU mucosa
      - Normally should be acid ph

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Physical and Chemical Barriers

* Immunoglobulin A:
  * Secreted by Mammary glands, resp. and GI tracts
* Skin and mucous membranes Also have normal flora
* Resp. tract has cilia
* GI has motility
* Skin sloughing

Physical and Chemical Barriers

- **Second line of defense:** Phagocytosis and Inflammation
  - Phagocytosis: rid the body of invading microorganisms/debri
    - WBCs (leukocytes) ingest bacteria (5 types of leukocytes)
      - Neutrophils: fight bacterial infections
      - Monocytes: become macrophages, ingest foreign antigens
      - Eosinophils: fight parasitic infections/ elevated during allergic reactions
      - Basophils: initiate the inflammatory response/ release histamine
      - Measuring the amt of leukocytes gives an estimate of severity of infxn
      - Lymphocytes: (lympho ct gives an idea of the body's immune function)
        - B – produce antibodies
        - T – increase the immune response

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Immunity

* Provides the body with resistance to invading organisms
* Enables it to fight off invaders once they have gained access
* Constantly exposed to micro-organisms
* If your immune system is healthy, you should be able to ward off infections

Factors compromising Your Immune System

1. Diseases states
2. Congenital defects
3. Aging
4. Stress
5. Therapeutic interventions (drugs, radiation)

Antigens

* Antigen: any substance capable of stimulating a response from the immune system
* The body recognizes it as not of itself or foreign
    - Microorganisms
    - Abnormal/mutated body cells
    - Transplanted cells (blood transfusions)
    - Non-infectious substances (pollen, insect venom, food)
    - Foreign molecules (drugs)
* Once recognized as foreign, the body will respond by destroying it and getting rid of it.

Antibodies

* Antibodies/immunoglobulin's:
  * proteins that are created in response to specific antigens

Immunity

* Innate/natural: present at birth
  * Not dependent on immune response or previous contact with infectious agent
  * Specific to a race or an individual
  * Can be influenced by Nutritional status, stress and environment
  * Defense mechanisms help natural immunity: ie
    * Physical and chemical barriers to infection
    * Phagocytosis
    * Inflammatory process

Immunity

* Acquired immunity:
  * develops after birth
  * as a result of the body's natural immune response to antigens
  * You must have proper development of functioning B & T lymphocytes

  * Active acquired immunity:
    * Is developed after direct contact with an antigen
    * Thru illness or vaccination

Vaccines

1. Vaccines are prepared from:
    1. Dead organisms that can no longer cause disease (DPT)
    2. Destroyed bacterial toxins that act as antigens (Tet - Tox)
    3. Altering the structure of live organisms so they are unable to cause disease, yet maintain antigenic properties (measles, polio)
2. Once exposed to the antigen:
    1. Body will memorize the antigen
    2. If exposed to the antigen later, will react quickly to fight infection in the early stages.

Passive Acquired Immunity

* Passive acquired immunity:
* Antiserum/Immune Globulin:
  * Made from human or animal blood that contains antibodies to a specific antigen
  * Emergency treatments: snakebites, rabies, hepatitis

* **IS TEMPORARY:**
* New - born's receive this type of immunity from mom :
  * Through placenta
  * or breast milk

CELLS AND ORGANS INVOLVED IN IMMUNITY

* Leukocytes: active in fighting infection:
  * Granulocytes : neutrophils, Eosinophils, Basophils
  * Non granulocytes (a-granulocytes) Monocytes and lymphocytes
* Thymus –form and help mature leukocytes
* Bone-marrow – same as above
* Lymph nodes –attack antigens in interstitial fluid , (gate keepers)
    * Produce and circulate lymphocytes
* Spleen – acts as a filter to remove dead cells and debris
* Liver – filters the blood, produces immunoglobulin's/other chemicals

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Nonspecific Defenses

1. Physical, chemical barriers
2. Inflammation
3. Phagocytosis
4. Complement:
    1. series of proteins that enhance the inflammatory process;
    2. stimulates chemotaxis (movement towards the antigen), Phagocytosis, and antibody response

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Nonspecific Defenses

5. Pyrogen: released in inflammation and causes increase in body temperature

- supposed to stop pathogen growth, slow infection process

6 Interferon:

produced in viral infections;

- inhibits the replication of viruses
- Can be synthetically produced /used in cancer treatment

SPECIFIC DEFENSES AGAINST INFECTION- IMMUNE RESPONSE

* Immune response involves:
  * Antigens – foreign
  * Recognized by the body
  * Antigen antibody reaction
  * And the antigen is destroyed
* Two types of immune responses
* Antibody mediated – immediate
* Cell mediated - delayed

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Specific Defenses

1. Antibody-Mediated (Immediate) Immunity

   AKA- Humoral immune response

2. Involves B lymphocytes & the production of antibodies in response to antigens.
   1. Antigen-antibody reaction specific to the antigen
   2. The antibody produced sticks to the antigen and destroys it
   3. Antibodies are:
      * IgG: most abundant (crosses placental barrier→ newborn passive immunity)
      * IgM
      * IgA
      * IgE: is important for allergic reactions, parasitic infections
      * IgD

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Specific Defenses

1. Cell-mediated (Delayed) Immunity
    1. AKA – cellular immunity
2. Delayed response to injury or infection. Requires time to:
    1. migrate T cells
    2. Production of material to help immune response/destroy antigens
    * Helper – strengthen Humoral immunity
    * suppressor – stop the Humoral response
    * killer T cells – destroy antigens
    * Fights most viral or bacterial infections
    * May attack transplanted tissues/organs
    * In AIDS – suppressor cells are hi
    * - T cells are low (suppressor cells are suppressing the immune response)

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Inflammatory Process

Inflammation: “the fire within”

1. Rubor (redness)
2. Calor (heat)
3. Tumor (swelling)
4. Dolor (pain)
5. Loss of function

Causes:

trauma

chemical stimuli

biological agents

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Inflammatory Process

* Cardiovascular: hemodynamic changes
  * Dilation – increased blood flow
* Increased permeability: leukocytes begin "pavementing" line the walls of the blood vessels
  * Neutrophils and Monocytes
  * Increased fluid causes the swelling
* Chemical mediators: cause cellular changes
  * Prostaglandins, histamines, leukotrines
  * Induce a brief period of the inflammation

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Inflammatory Process

* Once the infection is controlled
  * Anti-inflammation: cortisol
  * Stops the inflammatory process

* Order: Zofran 8 mg p.o. t.i.d. Available: Zofran in a 100 mL bottle labeled 4 mg/tsp. How many mL will the nurse administer for each dose?
*
* 3. Order: Morphine 2mg Available: Morphine 10 mg/mL How many mL will the nurse give?
*

Signs & Symptoms

* Local:
  * heat,
  * swelling,
  * redness,
  * pain,
  * loss of function
* Systemic:
  * fever, headache,
  * muscle aches, chills,
  * sweating,
  * increase in WBCs

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Wound Healing

- Repair/regeneration start right away
- Age, general health, may delay overall process
- Slower repair: decreased tissue elasticity, decreased blood supply, vitamin deficiencies
- May require I & D several times
- Delayed primary closure: sutured closed after infection resolves

Infection

* Invasion of body tissues by microorganisms, multiplication of organisms, and damage to tissue
* Infection results in inflammation
* Infection causes tissue injury
* Inflammation can precedes infection

* Infection is the end-result of
  * Pathogenic invasion

Infection

INFECTIOUS AGENTS

* BACTERIA
* VIRUSES
* FUNGUS
* PROTOZOA
* RICKETTSIAE
* HELMINTHS

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Bacteria

* One-celled microorganisms
* Rapidly multiply
* Classified by:

1. Shape (round or rod)
2. Cluster pattern
3. Need oxygen
4. Ability to retain stains (gram+ or gram-)
5. Ability to grow with oxygen (anaerobic)
6. Acid fast (mycobacterium tuberculosis)
7. These characteristics are used in the design of the drug to fight it.

Viruses

* Very small microorganisms
* Cause significant disease:
  * Cold, measles, chickenpox, hepatitis, HIV
* DNA or RNA viruses
* No cell wall :
  * PCN attacks cell walls
* Difficult to kill without harming the host

* Prevention: hand hygiene, immunizations

Fungi

* Vegetable-like organisms, some of which produce disease in humans
* Suppressed immune system increases risks
* "Mycoses"
* HIV pts. Or immunosuppressed pts
* Considered an opportunistic infxn
* Spore forming

* May be difficult to treat

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Protozoa

* One-celled organisms

* Anyone immuno-compromisedSpread through foo with feces
* Malaria, dysentery
* HIV/Aids patients are vulnerable

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Rickettsiae

* Microorganisms (between bacteria and viruses in size)
* Live on rodents
* Transmitted through flea/tick bites
* Prevalent in poor sanitation, rodent infested areas
* Rocky mountain spotted fever, typhus

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HELMINTHS

- Worms
- Parasites from soil and water
- Transmitted hand to mouth
- GI tract
- Pinworms, tapeworms
- Wt loss, abd pain , bloating
  - Anemia, resp s/s
- Hook worms- enter via feet
- Live in the heart/lungs

Prions

* Misfolded protein
* Not actually alive
* Hijacks the living cell
* Very long incubation period
* Advance rapidly once active
* Invades brain tissue
* Degenerates nervous tissue
* “mad cow disease”

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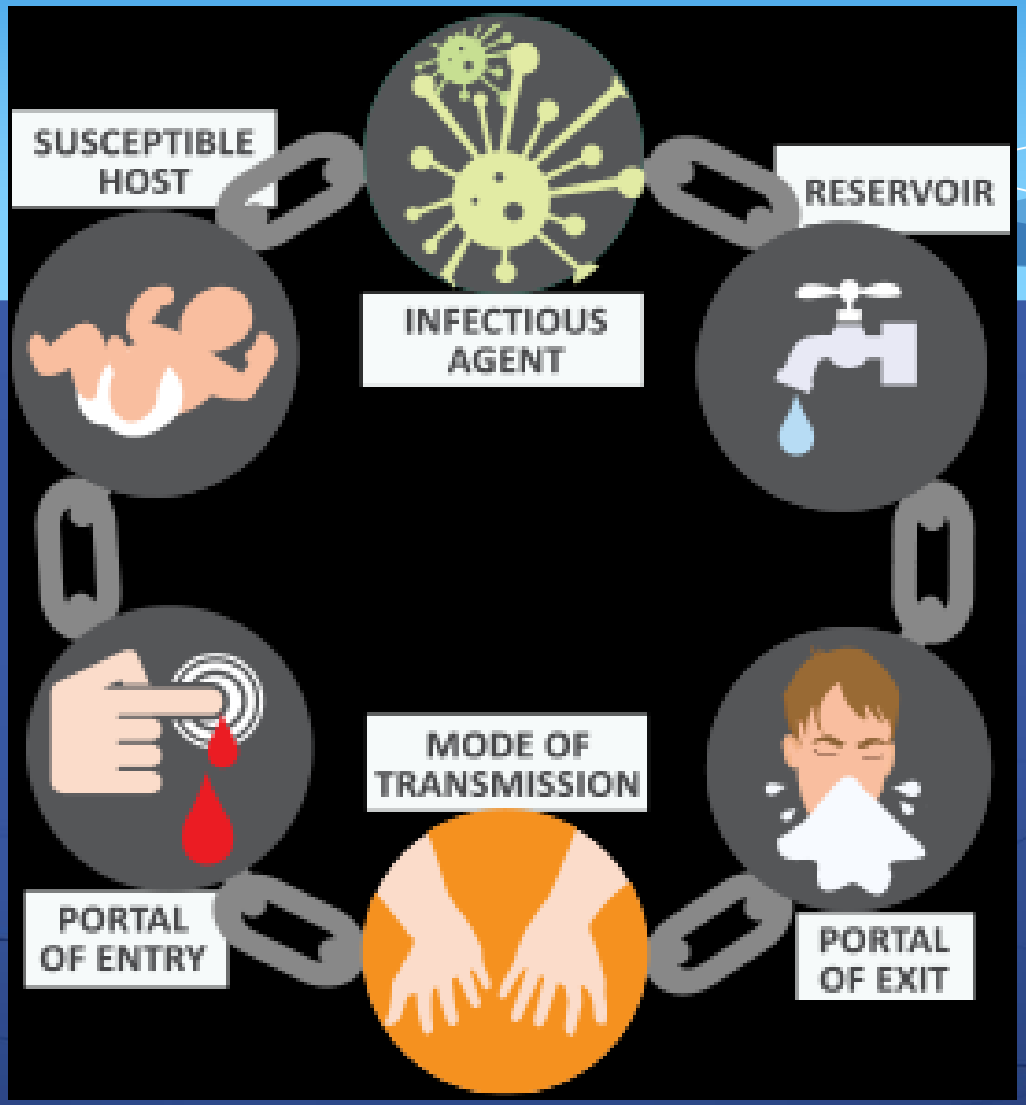
Chain of Infection



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Signs and Symptoms

* Incubation period: (period of subclinical infection)
  * More contagious than those with s/s
    * Measles and cold viruses
    * HIV
    * TB

* Localized: redness, pain, warmth, swelling, pus
* Generalized: pain (maybe),
* large organ swelling, (dull pain)
* warmth/fever, malaise, anorexia,
* prostration, swelling of lymph nodes

TYPES OF INFECTIONS

* COMMUNITY ACQUIRED
* HEALTH CARE ASSOCIATED INFECTIONS

Community-Acquired

* Day-to-day contact with the public
* Poverty, low immunized communities, overcrowding, unsanitary conditions
* Foodborne illness
* STDs
* Multiple ABX have to be used
* **See page 176 for diseases that must be reported to the CDC**

Disease control /disease patterns

Prevention and Control

* Immunizations
* Education
* Screening/early treatment
* Isolation
* Prompt treatment
* Sanitation
* Proper hygiene
* Personal barriers
* Public spraying
* Strep throat

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Healthcare Associated

- Previously called Nosocomial infections
- Increased morbidity
- Prolonged hospitalization
- Higher healthcare costs
- More resistant → more serious
- Immunocompromised
- Reimbursements ☹
- Bacteria in hospital is more deadly
- Insurance companies are not reimbursing for any HAI's

Healthcare Associated

1.7 million people per year get an infection during a hospital stay

98,987 people in the U.S. die annually from HAIs

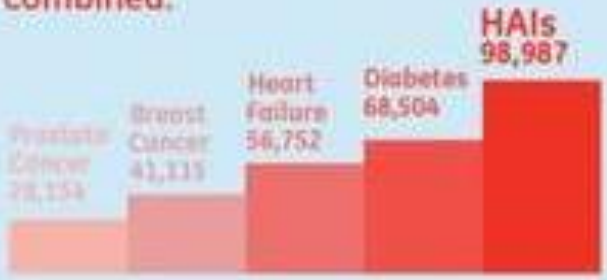
System $35 Billion/yr

Patient $1,100 per admission

9.4% of total inpatient costs are HAI-related

More than ⅔ of HAIs affect people with Medicare or Medicaid

HAIs kill more people each year than Breast Cancer and Prostate Cancer combined.



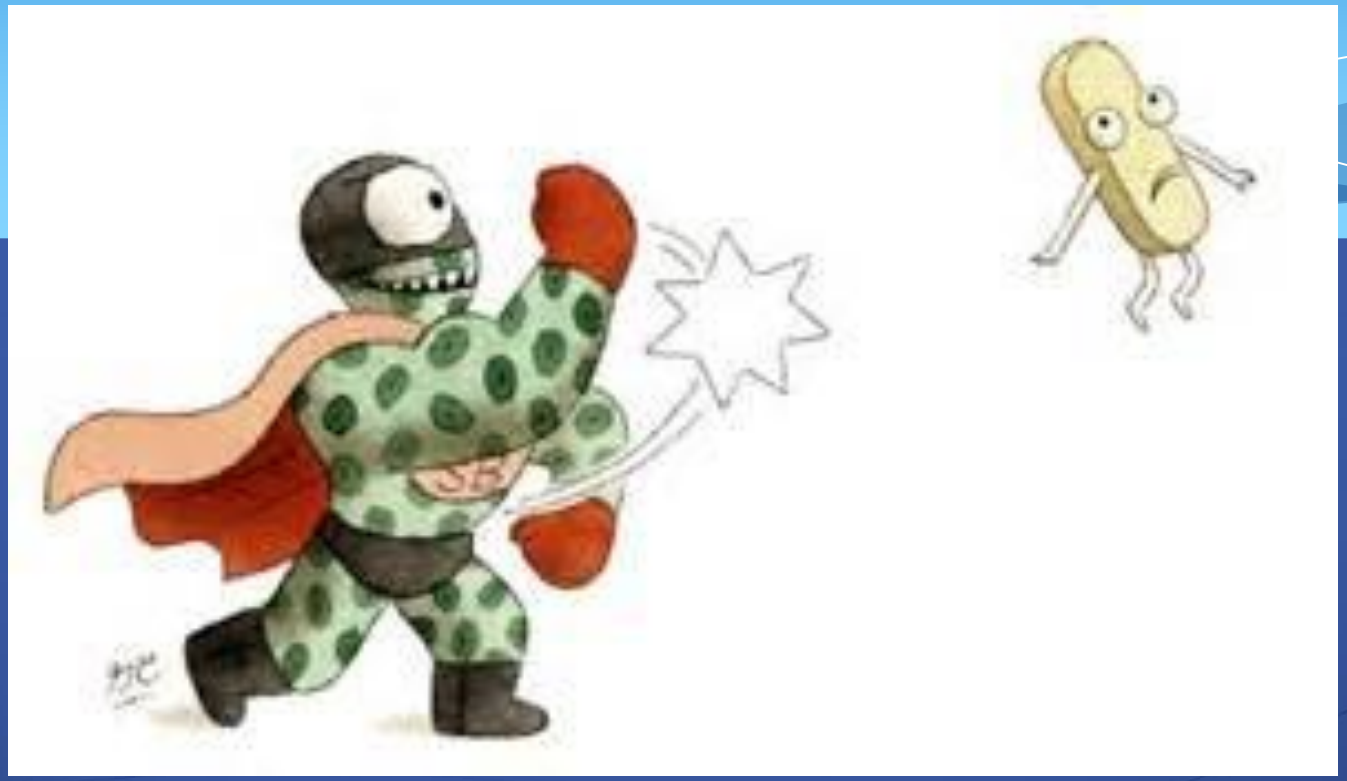
Resistance

* Vancomycin Resistant Enterococcus
* Multidrug-resistant Organisms (MDROs)
* Methicillin-resistant Staphylococcus a
* C-Diff
* Microbes in hospitals are resistant
* Iatrogenic infections

Prevention and Control

- Vaccinations
- Appropriate use of antimicrobials
- Culture & sensitivity testing
- Proper techniques
  - Proper hand hygiene
  - See table 13-1 page 177 (steps to prevent ABX resistance)
  - More susceptible: AIDS, Immunocompromised, chemotherapy
  - Common sites: surgical wounds, urinary tract, respiratory tract

SUPERINFECTION



- Antimicrobial therapy for one microorganism allows a second one to overgrow
- common with broad-spectrum antimicrobials (wipes out normal flora)
- C. diff (severe colitis and bloody diarrhea)

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Care of Patients with Infection

* **Medical asepsis: limiting** the spread of microorganisms
  * **"Clean technique"**
* **Surgical asepsis: elimination** of microorganisms from any object in contact with the patient
  * **"Sterile technique"**

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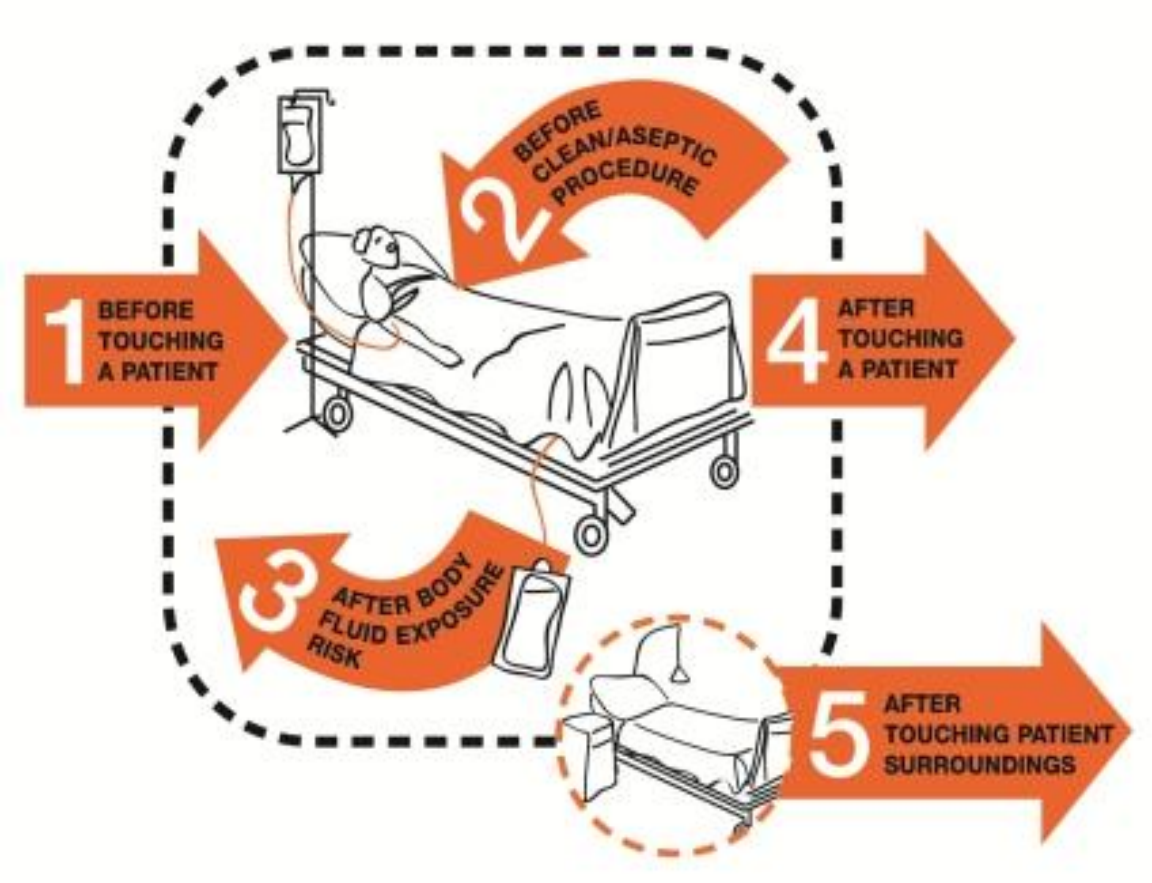
Hand Hygiene



Hand Washing versus Alcohol Rub

* Hand washing must be done
  -when hands are visibly soiled
  -if Clostridium difficile (C.diff) is suspected or diagnosed

* Alcohol rubs can be used
  -if hands are not visibly soiled

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See box.13-3

Standard Precautions

- Wear gloves when touching body fluids
- Wash hands immediately after touching body fluids
- Wash hands between tasks and procedures to avoid cross contamination
- Change gloves after each patient contact
- Wear eye protection, masks , face shields if appropriate
- Wear gowns when appropriate
- Handle equipment and clothing soiled with body fluids so as to prevent transfer of microorganisms
- Place needles and sharps in appropriate container
- Use mouthpiece or cover when performing CPR

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Standard Precautions

Use gloves whenever you may come into contact with:

-blood

-potentially infectious materials

-mucous membranes

-non-intact skin

Always remove gloves and dispose of them between patient contact!

Always decontaminate your hands after removing gloves.

Use masks, face shields, or eye protection if there is a chance of spraying or splashes

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Airborne Precautions

Apply to patients known or suspected to be infected with a pathogen that can be transmitted by airborne route; these include, but are not limited to:

* Tuberculosis
* Measles
* Chickenpox (until lesions are crusted over)
* Localized (in Immunocompromised patient) or disseminated herpes zoster (until lesions are crusted over)

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Airborne Precautions

PPE Use:

* Respiratory protection (N95)
* Private room (door closed)
* Ventilation system
* Goggles, gloves, gown

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Droplet Precautions

Apply to patients known or suspected to be infected with a pathogen that can be transmitted by droplet route; these include, but are not limited to:

* Respiratory viruses (e.g., influenza, para-influenza virus, adenovirus, respiratory syncytial virus, human metapneumovirus)
* Bordetella pertussis

* PPE use:
  * Surgical mask
  * 3 foot rule

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Contact Precautions

Applies to patients with any of the following conditions and/or disease:

- Presence of stool incontinence (may include patients with norovirus, rotavirus, or Clostridium difficile), draining wounds, uncontrolled secretions, pressure ulcers, or presence of ostomy tubes and/or bags draining body fluids
- Presence of generalized rash or exanthems

PPE use:

- Wear gloves when touching the patient and the patient's immediate environment or belongings
- Wear a gown if substantial contact with the patient or their environment is anticipated

* Review box 5.4 AND 5.5 use of transmission-based precautions

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PPE

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PE (Protective Environment)

Reduce fungal spore count, reduce risk of environmental fungal infections

1. Ventilation (Hepa-filter) (positive airflow)
2. Easily cleaned
3. No live plants/No flowers

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Bioterrorism

* Intentional use of microorganisms to cause death/disease
* Powders, aerosols, contaminated food/water
* Anthrax, botulism, plague, smallpox, tularemia, Ebola
* Be aware of your institutions emergency plan.

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Immunocompromised Patients

* Are at high risk for opportunistic infections
  * Chemo, Immunocompromised, transplant patients, HIV, aplastic anemia
* Dehydrate easy:
  * Fever/anorexia
* Maintain Hydration fluid is needed as transport medium
* average person needs 2L per day
* Nutrition-high protein, high vitamin C for wound healing
* Isolation may lead to depression
* Education- medications. Therapy, sharps disposal, bandages

Forced seclusion ☹

SIDE EFFECTS OF CORTICOSTEROID MEDS

* **Side effects of oral corticosteroids used on a long-term basis (longer than three months) include:**
* osteoporosis (fragile bones),
* hypertension (high blood pressure),
* diabetes,
* weight gain,

SIDE EFFECTS OF CORTICOSTEROID MEDS

* increased vulnerability to infection,
* cataracts and glaucoma (eye disorders),
* thinning of the skin,
* bruising easily, and.
* More items...

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Immunocompromised Patients

* Labs to screen for infection:
  * CBC with diff
  * ESR
  * Iron level
  * Cultures/sensitivity (pan cultures)
  * Pt may be discharged with ABX to be continued at home
  * ABX are to be continued until completed
  * Treatment may include Hyperbarics
    * Monitor for O_2 Tox:
      * Resp problems, SZ's , bradycardia
  * May be discharged to HH care – read pt teaching on page 185

* Nursing care of a patient with an infection
  * Pts easily dehydrate
    * 2 liters per day of fluids
    * Hi protein
    * Hi vitamin diet
    * Vitamin Cs
* Isolation may be required:
  * Caution for depression

* CDC now recommends both droplet and airborne precautions for chickenpox

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NANDAs

(North American Nursing Diagnosis Association)

1. Risk for Infection
2. Risk for Injury
3. Impaired Tissue Integrity
4. Social Isolation
5. Disturbed Body Image
6. Ineffective Self-Help Management

GOALS:

1. Recover from infection
2. Prevent spread of infection

Immunodeficiency

- When the body's self-defenses against foreign invasion fail to function normally
  - Immunocompromised, immunosuppressed
  - Great risk for infection
- Can be:
  - Congenital (immune system fails to develop properly)
  - Acquired :
    - infections, malignancies, autoimmune diseases, (lupus)
    - chronic diseases, drugs, stress, aging, malnutrition

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Nursing Care

1. Primary responsibility: PREVENT INFECTION
    1. Education
    2. Clean or Sterile technique
    3. No Flowers/plants /no produce in the diet
2. Vital Signs
    1. Fever
3. Nutritional intake
4. Assessment
5. s/s may be atypical, masked or absent
6. No rectal temperatures
7. Protective isolation may be needed
8. No visitors with suspected illness

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Hypersensitivity/Allergy

* Inherited
* Allergen: antigen that causes a hypersensitive reaction that normally is not offensive (pollen, house dust, molds, foods etc)
* Starts with Sensitization to allergen:
  * small amount of antibody production
  * Larger defenses, more antibodies
  * Eventually Triggers allergic response (can be severe)
* S/S's:
* Urticaria, pruritus, conjunctivitis, rhinitis,
* laryngeal edema, bronchospasm,
* dysrhythmia, gastrointestinal cramps,
* malabsorption, angioedema

Allergic Reactions

1. Allergic rhinitis, asthma are most common
2. Urticaria: hives
3. Pruritis: itching
4. Conjunctivitis: eye swelling, red, gooey
5. Rhinitis: nasal swelling
6. Laryngeal edema: throat swelling
7. Bronchospasm: tightening of chest
8. Dysrythmia: changes in heart rhythm
9. GI cramps
10. Malabsorption
11. Angioedema

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Treatment

* Antihistamines-May cause confusion in the elderly
  * Dry mouth, nausea, blurred vision, dizziness, drowsiness
* Bronchodilators
* Corticosteroids
* Oxygen
* Breathing Treatment
* Desensitization-small amount of allergen injected ,
* eventually tolerance to allergen occurs
* Decreasing the severity of the allergic response

Nursing Care

* **DOCUMENT ALL ALLERGIES**

  the reactions they cause
  * any treatment currently used
  * If allergic to shellfish may be allergic to Iodine
  * Ask about latex allergies (kiwi)
  * Any one allergic to stings (needs a sting kit with epi)
* NEVER ADMINISTER ANY DRUG THE PATIENT REPORTS A
* Notify Pharmacy and Dietary
* Notify PCP
* Continue allergy medications (as ordered)
* Patient education

Anaphylaxis

* **Life-threatening situation**
  * Shock, coma, death
* Histamine released causes bronchospasm,
* vasodilation, increased permeability
* water enters tissues, person becomes hypovolemic

Anaphylaxis

* **Life-threatening situation**
  * Shock, coma, death
* Anxiety, wheezing, difficulty breathing,
* cyanosis, hives, facial edema, arthralgia, hypotension
* Most common cause of anaphylaxis is ABX (PCN), bees, wasps, contrast.

THIS IS AN EMERGENCY

What is the main priority?

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Medical Treatment

* *Oxygen: 100% NRB*
* *IV epinephrine*
* *Dopamine/volume expander*
* *Nebulized bronchodilator (Albuterol)*
* *Diphenhydramine : Benadryl IV*
* *Corticosteroids: solumedrol , prednisone*

* *angioedema*

Nursing Care

- *Obtain a thorough history*
- *Prompt recognition*
- *Follow protocol (if available)*
- *Administer prescribed drugs*
- *Monitor fluids and vitals*

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Autoimmune Diseases

* *The body cannot determine self from oneself*
* *The system reacts against and destroys its own tissues*
* *Genetics*
* *Drug-induced*
* *Results as a complication of infection*
* *Can involve any tissue or organ system*

* Treatment: depends on the disease and tissues affects
* Corticosteroids, NSAID's, immunosuppressive therapies

Auto-immune diseases

1. Hyperthyroidism, Type 1 diabetes, Addison disease
2. Multiple sclerosis, myasthenia gravis
3. Rheumatic fever, cardiomyopathy
4. Ulcerative colitis, Crohn's disease
5. Rheumatoid arthritis, Lupus
6. Idiopathic lymphopenia or neutropenia, autoimmune idiopathic thrombocytopenia
7. Psoriasis

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Nursing Care

* *Risks for Activity Intolerance*
* *Anxiety*
* *Impaired Skin Integrity*
* *Ineffective Breathing Pattern*
* *Impaired Gas Exchange*
* *Deficient Knowledge*
* *Fear*
* *Fatigue*
* *Ineffective Coping*
* *Risk for Infection*
* *Imbalanced Nutrition*

Questions?