Infection Control Workshop #4

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Review from Workshop #3

- Infection Control Strategies
- Epidemiological Strategies
- Outbreak Investigation/Management/Control

Infection Control Strategies

- Surveillance
- Social distancing
- Activity Restriction
- "Chain of infection"

Epidemiology Strategies

- Line List
- Concentric Circles
- Isolation
- Consumer

Outbreak Investigation

- Outbreak
- Contact Tracing
- Use of prophylaxis
- Secondary prevention

Outbreak Management/Control

- Suggested Procedures (respiratory disease outbreak) :
  1) Confirmed cases on droplet precautions-
     Confined to room(s) or unit restriction until the person is afebrile for at least 24 hours without antipyretic medicaton
  2) Notify NYSDOH Regional Epidemiology Program
  3) Fill out line list
  4) Monitor staff for illness

Outbreak Management/Control

- Suggested Procedures continued-
- Implement control measures
  - restrict consumer's activity
  - Minimize float staff
  - Provide staff education for infection control
  - Clean staff/consumer areas more than usual
  - Ensure supplies of hand hygiene/mask

Outbreak Management/Control

- Suggested Procedures continued-
- Notify any other facilities
- restrict use of respite\
- restrict visitors to extent possible

Workshop #4

- The learner will be able to:
  - Distinguish various microbiological and laboratory tests used in identification of infectious agents.
  - Describe CBC with differential blood testing.
  - Differentiate components of blood testing.
  - Differentiate shifts in blood titers.
  - Describe differences in Immunoglobulins.
  - Describe components in Culture & Sensitivity studies.
  - Define Quantiferon Gold.
  - Describe use of Gram Stains testing.
  - Describe use of Western Blot/ELISA/PCR testing.
  - Describe other blood tests as needed.

Microbiological & Laboratory Tests

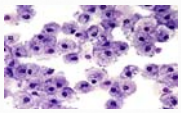
- Microbiological and laboratory tests:
  - Assists in determining causitive agent
  - Assists is determining stage of disease
  - Increase evidence to discern course of disease
  - Provide assessment of individual's health.
  - Guide the plan and interventions
  - Increases evidence to show progression of treatment.

Complete Blood Count (CBC)

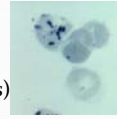
- CBC is basic blood screening-most widely ordered lab test.
- CBC looks at elements of blood.
- CBC provides diagnostic information regarding the overall health of the individual.
- CBC provides diagnostic information related to the individual's response to disease and/or treatment.

Complete Blood Count (CBC)

- Red Blood Cell (RBC) count- whole blood
- Hemoglobin (Hgb)
- Hematocrit (Hct)
- Platelets
- White Blood Cell (WBC) count-
- WBC Differential blood count-

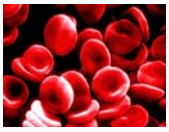


RBC (erythrocytes)



- Produced in bone marrow (hematopotiesis)
- Immature when released (reticulocytes)
- Reticulocytes mature into erythocytes within a few days
- Erythocytes live ~120 days
- Aged and damaged RBCs ehgulfed by macrophages of liver, spleen and bone marrow
- Liver recovers hemoglobin to use in new blood cells

Red Blood Cell Count



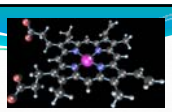
- RBC -whole blood
  - Male 4.5-6.2 million/mm
  - Female 4.2-5.4 million/mm
  - Children 4.6-4.8 million/mm
  - RBC/Hemoglobin/Hematocrit testing- best determinant for anemia polycythemia.

RBC/Hemoglobin/Hematocrit- increase together.
RBC/Hemoglobin/Hematocrit-decrease together.

RBCs

Erythrocytopenia (⇩RBCs)	Erythrocytosis/Polycythemia (⇧ RBCs)
Chronic renal failure	Chronic pulmonary disease
Bone marrow damage	Cardiovascular disease
Vit B12 or folic acid deficiency	High altitude
Hemolysis	
Hemorrhage	
Anemia of chronic disease (systemic lupus, rheumatoid arthritis, infection, bacterial endocarditis, TB, AIDS, Crohn's)	

Hemoglobin



- Main cell that carries O_2 and removes CO_2.
- Heme portion affinity for O_2
- Shift to RIGHT = decrease affinity for O_2
  - Increased body temperature/CO_2 concentration
  - Decreased pH.
- Shift to LEFT = increase affinity for O_2
  - Decreased body temperature/CO_2 concentration
  - Increased pH.

Hemoglobin

Increased

- Burns
- Congestive Heart Failure
- Chronic Obstructive Pulmonary Disease
- Dehydration
- High Altitudes
- Polycythemia vera

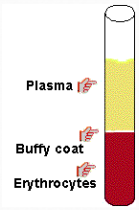
Decreased

- Anemias
- Carcinoma
- Fluid retention
- Hemolytic disorders
- Hemorrhage
- Hodgkin's Disease
- IV overload
- Nutritional deficit

Hematocrit (Hct)

- Packed cell volume = hematocrit
- Part of CBC

- Male 43-49%
- Female 38-44%



Hematocrit

Increased

- Burns
- CHF
- COPD
- Dehydration
- High Altitudes
- Shock
- Polycythemia

Decreased

- Anemia
- Blood Loss
- Hemolytic disorders
- Fluid retention
- Nutritional deficit
- Hemorrhage
- Pregnancy

Platelets

- Platelets 150-450 x 10000/cubic mm. OR (150,000-450,000/cubic mm).

Platelet activity is necessary for blood clotting, vascular integrity and vasoconstriction.

Platelets

Thrombocytosis (⇧)

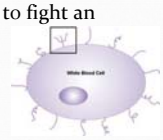
- Acute infections
- After exercise
- Anemias
- Chronic heart disease
- Cirrhosis
- Leukemias
- Malignancies
- Trauma
- Tuberculosis

Thrombocytopenia (⇩)

- Certain drugs such as depakote, H_2 blockers and Proton-pump inhibitors, heparin
- Vit B12 and/or folic acid deficiency
- Leukemia
- Sepsis
- Alcohol toxicity
- Drug toxicity
- Iron deficiency anemia
- Congenital states
- Before menstration

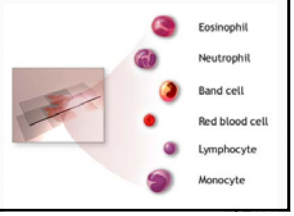
White Blood Cells (WBC)

- WBC produced by bone marrow.
- Total WBC indicates degree of response to pathogen
- Percentage of each type indicates type and severity of infection
- shift to left: the presence of immature WBC because the bone marrow is releasing prematurely to fight an acute infection
- Degenerative shift to the left: WBC count decreasing but the percentag of band cells increase
- shift to right is the presence of large percentage of older, more mature WBCs



WBC

- Expressed as the number of leukocytes/cc of blood
- Total count: 4.5-11.0
- Count Includes (expressed in percentage of total):
  - Neutrophils
  - Eosinophils
  - Basophyls
  - Monocytes
  - Lymphocytes



Neutrophils

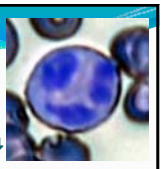
- Neutrophils 2.7-6.5 Absolute count OR 54-65 % of total WBC

  - First in line of defense against pathogens, esp. bacteria
  - Part of phagocytosis (killing pathogens)
    - Kills bacteria
    - Destroys bacteria's ability to reproduce
    - Destroys bacteria's ability to produce endotoxins

Neutrophils

- Short lived (4-10 hours)
- plentiful and responsible for the bulk of an immune response
- fast acting, arriving at the site of infection within an hour
- Release neutrophil extracellular trap (NET), which serves to trap and kill microbes outside of the cell
- the main component of pus and responsible for its whitish color
- release superoxide, which becomes converted into hypochlorous acid, or chlorine bleach

Neutrophils



Increased

- Acute infection
- Drugs such as corticosteroids
- Hemorrhage
- Extremes in temperature
- Infectious diseases
- Inflammatory conditions
- Malignancies
- Metabolic disorders
- Physiological stress
- Tissue necrosis

Neutropenia⇩

- Apalstic anemia
- Acromegaly
- Addison's Disease
- Anaphylaxis
- Anorexia
- Bone Marrow depression
- Viral infections
- Vitamin B12 or Folate deficiency

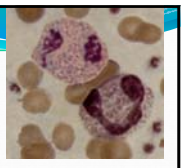
Eosinophils

- Eosinophils .05-0.5 absolute count OR 2.7% of WBC.

Often found outside of the blood vessels, particularly in the GI tract

- Part of the antigen-antibody complex.
- Found in later stages of inflammatory process.
- Migrate to inflammatory sites.

Eosinophils



Increased

- Allergies
- Asthma
- Drug Reactions
- Hay fever
- Parasitic Infections
- Rhinitis
- Tuberculosis
- Autoimmune diseases
- Drugs: sulfonamide antibiotics, erythromycin NSAIDS

Decreased

- Aplastic anemia
- Infections (shift to LEFT r/t neutrophil production)
- Stress
- Drugs: ASA, amphotericin B, glucocorticoids,hydrocortisone, inteferon, niacin, predisone

Basophils

- Basophils 15-100/cubic mm [absolute count] OR 0.01%-0.3% total WBC
  - appear in many specific kinds of inflammatory reactions, particularly those that cause allergic symptoms
  - Increase during healing process
  - Contain heparin and histamine
  - found in unusually high numbers at sites of ectoparasite infection, e.g., ticks
  - important source of the cytokine, interleukin-4 perhaps more important than T cells

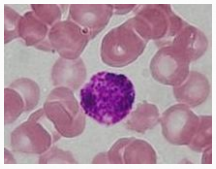
Basophils

Increased

- Inflammation (allergy/sinusitis)
- Ectoparasitic infections
- Viral Infections (e.g. varicella)
- Inflammatory bowel disease
- Hypothyroidism
- Chronic sinusitis
- After ionizing radiation

Decreased

- Acute phase of infection
- Hyperthyroidism
- Stress reactions
- After long steroid therapy



Monocytes

- Monocytes 100-500/cubic mm. OR 3-7% total WBC
  - Circulate for 1-3 days and then migrate to tissues
  - "garbage truck" ingests cellular debris at area of infection or inflammation
  - move slowly 5-7 days to elevate
  - Largest cells in normal blood
  - Second line of defense against infection.
  - Produce antiviral agent of interferon.

Monocytes

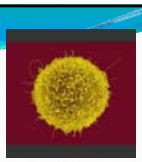
Monocytosis

- Acute inflammation
- Autoimmune disorders
- Infectious mononucleosis
- Bacterial infections
- Parasitic or rickettsial dx
- Surgical trauma
- Ulcerative colitis/celiac dx
- Lupus

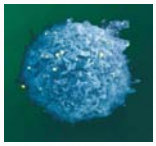
Monocytopenia

- Predisone treatment
- Chemotherapy
- Overwhelming infection
- HIV

Lymphocytes



- Lymphocytes 1500-4000 cells/cubic mm OR 25-40% of total WBC
- Long-lived 100-300 days
- Part of innate (non-specific) immune system



Lymphocytes

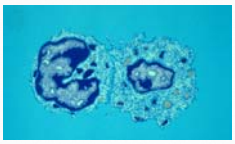
- T-cells
  - "T" stand for "thymus"
    - principal organ responsible for the T cell's maturation
  - Central role in cell-mediated immunity
  - presence of a special receptor on their cell surface called *T cell receptors*
  - Five types of Tcells – each with a distinct function

Helper T cells

- assist other white blood cells in immunologic processes,
- Assists in maturation of B cells into plasma cells and activation of cytotoxic T cells and macrophages
- Also known as CD4+ T cells because they express the CD4 protein on their surface.
- become activated when presented with peptide antigens
- Once activated, they divide rapidly and secrete small proteins called cytokines that regulate or assist in the active immune response.

Cytotoxic T-Cell

- destroy virally infected cells and tumor cells,
- are implicated in transplant rejection
- also known as CD8+ T cells since they express the CD8 glycoprotein at their surface
- recognize targets by binding to antigen associated with MHC class I



Memory T Cells

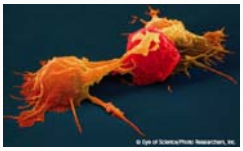
- a subset of antigen-specific T cells
- persist long-term after an infection has resolved
- quickly expand to large numbers of effector T cells upon re-exposure to their cognate antigen,
- provide the immune system with "memory" against past infections

Regulatory T cells (Treg cells),

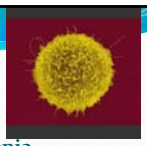
- crucial for the maintenance of immunological tolerance
- major role is to shut down T cell-mediated immunity toward the end of an immune reaction
- suppresses auto-reactive T cells that escaped the process of negat selection in the thymus.

Natural killer T cells (NKT cells)

- special kind of lymphocyte that bridges the adaptive immune system with the innate immune system
- NKT cells recognize glycolipid antigen presented by a molecule called CD1d.
- Once activated, these cells
  - Produce cytokine
  - release of cytolytic/cell killing molecules
- recognize and eliminate some tumor cells and cells infected with herpes viruses



Lymphocytes



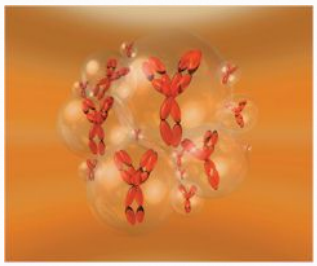
Lymphocytosis

- Lymphoma
- Mononucleosis
- Pertussis
- Viral diseases (e.g. measles, influenza, mumps, varicella, monomucleosis, firal hepatitis)
- Protozoal infections, such as toxoplasmosis
- Tuberculosis
- Crohn's Disease

Lymphcytopenia

- Common cold
- Chemotherapy
- After steroid treatment
- Malnutrition
- Severe stress
- HIV/AIDS
- CHF

IMMUNOGLOBULINS



Immunoglobulins

- Otherwise known as antibodies
- protein molecules that contain antibody activity,
- produced by the terminal cells of B-cell differentiation known as plasma cells
- made in response to bacteria, viruses, fungus, animal dander, or cancer cells
- attach to the foreign substances so the immune system can destroy them
- specific to each type of foreign substance

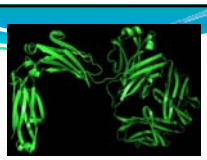
IgA

- A protein produced by plasma cells and lymphocytes
- produced predominantly against ingested antigens and those in the respiratory tract
- found in body secretions such as
  - saliva,
  - sweat,
  - tears, and
  - Breast milk
- prevents attachment of viruses and bacteria to epithelial surfaces

IgA deficiency

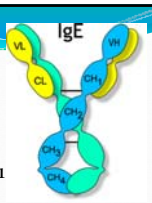
- the most common of the primary antibody deficiencies
- Can be total or partial
- Often asymptomatic
- symptomatic immunodeficiency predominantly sinopulmonary or gastrointestinal infections
- Primary deficiency most common
- Secondary deficiency associated with drugs or viral infections may be transient
- associated with celiac disease

IgD

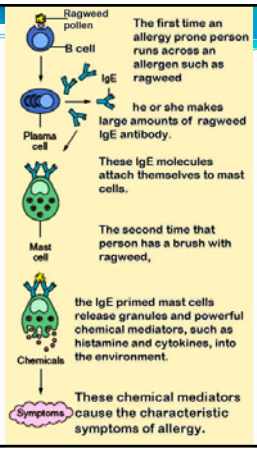


- found only on the surface of B cells
- initiate differentiation of B cells into plasma cells
- binds to basophils and mast cells and activate these cells to produce antimicrobial factors to participate in respiratory immune defense in human
- Other function(s) poorly understood

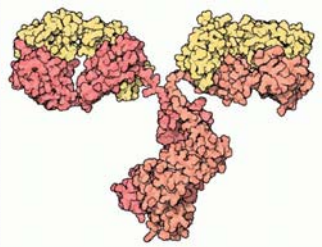
IgE



- Associated with allergies and true type 1 hypersensitivity
- Important against parasitic worms and protozoan parasites
- Atopic individuals can have up to 10 times the normal level of IgE in their blood
- specifically recognizes an "allergen"



Immunoglobulin G



Drawing of an IgG antibody - the two heavy chains are seen in red, the two light chains are yellow.

IgG

- Smallest of all immunoglobulins
- Most common (75-85%)
- Found in all body fluids
- Synthesized and secreted by plasma B cells
- important in secondary antibody responses (immune memory)
- presence of specific IgG generally corresponds to maturation of the antibody response
- Associated with Type II and Type III hypersensitivity

IgG

- Most versatile of the immunoglobulins as it can carry out all of the functions of immunoglbulin molecules
- Binds to bacteria, viruses and fungi
- Exclusive antitoxin class
- Work by
  - Agglutination
  - Immobilization
  - Complement activation
  - Opsonization for phagocytosis
  - Neutralization of toxins
- Important role in antibody-dependent cell-mediated cytotoxicity

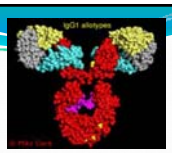
IgG subclasses

- Four subclasses
- All contain antibodies but somewhat different anti-infective functions
- inability to produce antibodies of a specific subclass may render an individual susceptible to certain kinds of infections but not others
- IgG1 (66%) and IgG3 (7%) best against diptheria, tetanus and virus proteins [Often deficient in adults]
- IgG2 (23%) predominately against influenza and pneumococcus [most common subclass deficiency]
- IgG4 (4%) associated with improvement of symptoms in IgE-mediated allergy probably due to its anti-inflammatory characteristics [deficient in up to 20 % of adualts and children]

IgG in infants

- only isotype that can pass through the human placenta
- High concentration in colostrum
- Protects fetus in utero and neonate until own immune system develops

Elevate IgG level



- Response to immunizations
  - Indicates positive response to immunizations
  - Increasing levels in response to subsequent injections of vaccines
  - May remain high for months or years
  - Maintains "memory" immunity
- Infections of all types
- Parasitic disease
- Chronic granulomatous infections
- Malnutrition (severe)
- Dysproteinemia
- Disease associated with hypersensitivity granulomas, dermatologic disorders, and IgG myeloma
- Rheumatoid arthritis
- Inflammation
- Multiple myeloma
- Liver disease
- Autoimmune disease

Decreased level of IgG

- Intense exercise or excessive physical stress
- Smoking
- Nonsteroidal drugs and immunosuppressive medications
- radiation therapy
- Thymoma
- May contribute to febrile seizures in children

IgG subclass deficiency

- diagnostic category *specific* or *selective IgG antibody deficiency*
- both recurrent infections and impaired functional antibody responses
- may exist in the presence of total IgG levels that are technically within the normal range or in some cases, even elevated total IgG levels

IgM

basic antibody that is present on B cells

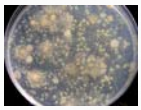
- Largest immunoglobulin primarily found in serum
- found to bind to specific antigens
- produced after exposure to an antigen for an extended time or
- exposure to an antigen for the second time
- demonstrating IgM antibodies in a person's serum indicates recent infection
- mainly responsible for the clumping (agglutination of red blood cells if the recipient of a blood transfusion receives blood that is not compatible with their blood type

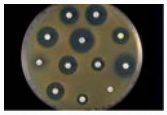
Antibody Titers

- measurement of how much antibody an organism has produced that recognizes a particular antigen
- Expressed as the most dilation that still has a positive result. E.g. a titer of 1:16 means the person's serum gives a positive response at one part serum to 15 parts solvent.
- used to determine:
  - the strength of an immune response to the body's own tissue in diseases such as systemic lupus erythematosus and other autoimmune diseases
  - response to vaccination
  - need for a booster immunization
  - Presence of , or recent infection such as mononucleosis or viral hepatitis

Culture & Sensitivity Studies

- Culture- Laboratory tests that grow microorganisms on selected media for identification of the agent responsible for acute/chronic infections.
- Sensitivity –Laboratory tests that isolate specific organisms' response to antibiotics, so appropriate treatment is implemented.





Culture & Sensitivity (C&S) Studies

- Preliminary report usually after 24 hours
- Colony count – how virulent the organism is
- Type of organism

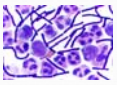
Sensitivity Report

QuantiFERON Gold

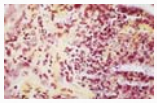
- QuantiFERON –TB (QFT-G) laboratory test
  - Approved by FDA 2005
  - Used in any application as TB skin test.
  - Two step procedure:
  - Whole Blood with T-Lymphocytes
  - Mycobacterium TB incubated
  - Eliminates False + skin tests
  - Results in 24hours.

Gram Stains

- All pathogens can be identified based upon staining characteristics: positive or negative.
- Diagnostic procedure used with C&S to identify pathogens.



- Gram + bacteria retain gentian/crystal violet
  - Purple-blue color
- Gram – bacteria do not retain stain
  - Pink color



Acid-Fast Stain(AFB)

- Stain used to identify Mycobacterium.
- most commonly used to detect presence of m. tuverculosis in sputum
- Cells that resist de-colorization by acid alcohol is called acid-fast.
- Acid-fast bacteria will appear red; non-acid-fast will appear blue.
- Can be negative 50% of the time. Check 3-8 weeks later. PCR 24-72 h.
- Good client history needed.

Enzyme-Linked Immunosorbent Assay (ELISA) Testing

- Blood test -sensitive not specific test
- performed to evaluate either the presence of antigen or of antibody in a sample
- useful tool for determining serum antibody concentrations (such as with the HIV test or west nile virus
- False positives occur.
- Inexpensive ($6).
- High sensitivity for HIV status identification.
- Also used for-hepatitis, Lyme Dx, mono, parvovirus Legionnaire's Dx and rubella.

Western Blot Testing

- used to detect specific proteins in a given sample of tissue homogenate or extract
- More specific blood test for HIV antibody
- Test performed after 2 positive ELISA tests to confirm HIV+ status.
- More expensive ($24)
- Gel Electrophoresis of antigen subspecies (separates the known pathogen components).
- Detects antibodies of specific mobility.
- is also used as the definitive test for Bovine spongiform encephalopathy (BSE, commonly referred to as 'mad cow disease').
- Some forms of Lyme disease testing employ Western blotting.
- Western blot can also be used as a confirmatory test for Hepatitis B infection.

Other Blood Tests?

- Polymerase Chain Reaction (PCR)
  - Amplifies low levels of specific DNA sequences
  - Doubles specific DNA sequences
  - Good for Chlamydia and many genetic disorders.
  - Used in NCIS/ CSI -Forensic Labs
- CMP

Questions?!?