WIPAG

WY Infection Prevention Orientation Manual

Section #11, Microbiology

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Objectives

At the completion of this section the Infection Preventionist (IP) will:

- Know the basic elements of microbiology
- Describe the specimen collection process for microbiological specimens
- Describe organisms, the modes of transmission, and the clinical significance of organisms.
- Visit the microbiology laboratory

Number of hours

- Key Concepts and Methods combined: 10-15 hours

Required Readings

- Wyoming Infection Prevention Orientation Manual (WY IPOM), Section #10, Laboratory
- Information contained in the Appendix
- Brooks K. *Ready Reference for Microbes. 3rd Edition.* Washington, D.C.: Association for Professionals in Infection Control and Epidemiology, Inc.; 2012
- Grota P, Allen V, Boston KM, et al, eds. *APIC Text of Infection Control & Epidemiology. 4th Edition.* Washington, D.C.: Association for Professionals in Infection Control and Epidemiology, Inc.; 2014.
    - Chapter 21, Risk Factors Facilitating Transmission of Infectious Agents, by C Fiutem
    - Chapter 22, Microbial Pathogenicity and Host Response, by E Lee
    - Chapter 24, Microbiology Basics, by M Brown
    - Chapter 25, Laboratory Testing and Diagnostics, by J Smyer
    - Chapters 70 through 99 regarding pathogens of importance in Healthcare

Overview

The IP should know basic microbiology, terminology, organisms, and techniques to prevent and control infections in the healthcare setting.

Key Concepts

Key Terms

Exercise #1: Use the required readings, and help from both the laboratory and your IP mentor to complete Table 1.

Table 1. Microbiology terms.

Term	Definition
bacteria	
virus	
mold	
fungus	
yeast	
protozoa	
helminth	
colonization	
infection	
disease	
zoonosis	
commensal organism	
normal flora	
pathogenic	
non-pathogenic	
opportunistic pathogens	

virulence	
aerobic organisms	
aerophilic organisms	
anaerobic organisms	
antibiogram	
bacterial spores (endospores)	
endotoxins	
exotoxins	
antitoxins	
flagella	
lipid	
incubation period	

Stages of illness

There are five stages of infection.

Exercise #2: Use the required readings and help from your IP mentor to complete Table 2. Match the stage of illness with the correct corresponding definition.

Table 2. Stages of illness, and corresponding definitions.

Stage of illness	Definitions
1. Invasion	a. maximum impact of illness when pathogen is proliferating rapidly – toxic by-products of microbial metabolism and immune response produce tissue damage
2. Incubation	b. pathogen replicating, no symptoms
3. Prodromal	c. pathogen acquires entry into the body mucus membranes inhalation, self inoculation
4. Acute illness	d. pathogen is contained and eliminated from body, damaged tissue is repaired and resolution of symptoms
5. Recovery	e. initial appearance of symptoms (usually mild and vague)

Bacteriology

Bacteria are very small, relatively simple, single celled organisms. They contain a single long circular molecule of double strand DNA. This "bacterial chromosome" is not surrounded by a nuclear envelope and is attached to the plasma membrane.

The cell wall of bacteria is a rigid structure that maintains the shape of the cell and prevents bursting of the cell from the high osmotic pressure inside it. Several types of cell wall structures in bacteria have been categorized according to their staining characteristics. Two major types of cell walls are Gram positive and Gram-negative. Some mycobacteria have an acid fast wall (e.g., *M. tuberculosis*) and mycoplasms have no cell wall. Refer to the Wyoming Infection Prevention Orientation Manual Section #10, Laboratory for information about Gram stain techniques.

A Gram positive cell wall is composed of a very thick protective peptidoglycan layer. Because this layer is the principle component of the Gram positive cell wall, many antibiotics prevent synthesis of peptidoglycan.

The cell wall of the Gram negative microbe is composed of two layers. The inner peptidoglycan layer is much thinner than in gram positive cell walls. Outside this peptidoglycan layer is another outer membrane that is unique to the Gram negative cell wall. The outer membrane contains proteins, phospholipids and lipopolysaccharide. This outer membrane

- Acts as a barrier to hydrophobic compounds and harmful substances
- Acts as a sieve, allowing water-soluble molecules to enter through protein-lined channels called porins
- Provides attachment sites that enhance attachment to host cells

Because of these cell wall structure differences, gram negative bacteria are less affected by antibiotics.

Shapes of bacteria (morphology)

Bacteria vary in size from 0.4-2 μm. They occur in four basic shapes:

Cocci (spherical) – usually round but may sometimes be irregularly shaped. Cocci that remain in pairs are after dividing are called diplococci and those that remain attached in a chain are called streptococci while those that remain attached in clusters or broad sheets are called staphylococci.

Bacilli (rod shaped) – most appear as single rods and are fairly uniform in shape although some are oval and look so much like cocci that they are called coccobacilli.

Spirochetes (spiral shaped) – vary in length and in number of turns.

Pleomorphic - lack a distinct shape (like jello).

Other cell attributes

Surface polymers: some pathogenic bacteria produce a covering called a "capsule" which acts as virulence factors in helping the pathogen evade phagocytosis. Slime layers are similar to capsules but are more diffuse layers surrounding the cell. They also serve to inhibit phagocytosis or in some cases to aid in adherence to host tissue or synthetic implants.

Cell Appendages: flagellum is an organ of locomotion. They are exterior protein filaments that rotate and cause bacteria to be motile. Flagella that extend from one end of the bacterium are called "polar". Flagella that occur on all sides of the bacterium are called peritirichous. Pili (also known as fimbriae) are hair like protein structures that aid in attachment to surfaces. Some (known as sex pili) are involved in bacterial conjugation and gene exchange. Proteins exist within the pili that aid in attachment and are called adhesions.

Endospores are formed by 2 genera of bacteria *Bacillus* and *Clostridium.* Endospores are dormant forms of bacteria that are resistant to heat, cold, drying and chemical agents. Spores form when there is a shortage of needed nutrients and can lie dormant for years. When the spore is exposed to a favorable nutrient rich environment, it becomes active again.

Special types of bacteria:

Mycobacteria – Mycobacteria are weakly Gram positive but stain better with an acid-fast stain. This group includes organisms that cause tuberculosis and leprosy.

Mycoplasma - Mycoplasmas are extremely small bacteria that lack cell walls and are surrounded only by an outer plasma membrane. Because they lack a rigid cell wall they are resistant to cell wall-active antibiotics (penicillins). Mycoplasms associated with human infections are *Mycoplasma pneumoniae* (atypical pneumonia), *Ureaplasma urealyticum* (UTIs) and *Mycoplasma hominis* (urogenital infections).

Exercise #3: Use the required readings, information contained in this section, and help from your laboratory to complete Table 3.

Table 3. Basic characteristics of bacteria and associated definitions.

Term	Definition
Gram stain	
Gram positive	
Gram negative	
Culture & sensitivity	
Acid fast bacilli	
WBC versus epithelial cells	
Aerobic	
Anaerobic	
Shape: • **Cocci** • **Diplococci** • **Bacilli** • **Spirochete** • **Pleomorphism**	
Coagulase test – positive or negative	

Motility	

Environmental factors influencing the growth of bacteria

Three factors influence the growth rate of bacteria: pH, temperature and gaseous composition of the atmosphere.

- Most bacteria of concern grow best at a neutral pH
- Bacteria that have adapted to humans grow best at or near 98.6^{o} Fahrenheit
- Some require oxygen (obligate aerobes), some cannot grow in the presence of oxygen (obligate anaerobes) and some can grow either with or without oxygen (facultative anaerobes).

Bacteria need sources of carbon, nitrogen, and energy, small amounts of elements such as phosphates, and a variety of metals and ions to live.

All bacteria that inhabit the body are heterotrophic. They require more complex substances for growth, such as an organic source of carbon, and they obtain energy by oxidizing or fermenting organic substances. Often the same substance (e.g., glucose) is used as both a carbon source and energy source.

Bacteria of interest

Select bacterial species are of particular concern in the healthcare environment due to transmissibility among patients and residents. These species are listed in Table 4.

Exercise #4: Use your required readings, and help from your laboratory to complete Table 4. Identify the key characteristics and diseases most commonly associated with the bacteria.

Table 4. Bacteria.

Organism	Morphology	Gram Stain (positive, negative, acid fast or n/a)	Spore former (yes, or no)	Common disease(s) caused by this organism
Acinetobacter baumannii				
Bacillus cereus				
Bacterioides fragilis				
Clostridium difficile				
Clostridium perfringens				
Escherichia coli				
Gardenerella vaginalis				
Haemophilus influenzae				

Klebsiella oxytoca				
Klebsiella pneumonia				
Listeria monocytogenes				
Micrococcus sp.				
Neisseria gonorrhoae				
Neisseria meningitidis				
Pseudomonas aruginosa				
Salmonella typhi				
Serratia marcescens				

Shigella sonnei				
Staphylococcus aureus				
Methicillin-resistant *Staphylococcus aureus* (MRSA)				
Staphylococcus capitis				
Streptococcus pneumoniae				
Alpha-hemolytic *Streptococcus sp.*				

Mycobacteria

Mycobacteria are a unique class of bacteria that cause human and animal infections. The ability to discern the various types and to make decisions regarding the care of patients with these infections is critical.

Exercise #5: Use the required readings, help from the laboratory and your IP mentor to complete Table 5.

Table 5. Mycobacterium species important in healthcare settings, the normal source of infection with these organisms, the typical manifestation of the disease in humans, and treatments available.

Mycobacterium species	Normal source	Manifestation & treatment
	Cows and unpasteurized milk	
	Frequently associated with hot tubs and spas	
M. tuberculosis	Human to human transmission	
M. xenopi		
		Causes skin lesions that require years to heal. Grows in the 9-banded armadillo.
		Causes bacteremia in patients with acquired immunodeficiency
	Infections traced to dye and marking pencils in operating rooms	
M. gordonae		

Virology

Viruses are pathogens that infect animals, humans and plants. Unlike bacteria and parasites, they are composed of a lipid/protein outer coat, and a singular type of nucleic acid (either RNA or DNA). Viruses are also obligate intracellular pathogens that can only replicate inside of a cell. They are difficult to grow in laboratory.

Viruses, originally classified according to the diseases they caused or where they were found, now are classified by the type and structure of their nucleic acids, chemical and physical characteristics, size, type of replication and host. They are ultramicroscopic particles that contain nucleic acid (either RNA or DNA) surrounded by protein and in some cases a membrane-like envelope.

Outside the host cell the virus is known as a viron. A viron is metabolically inert and does not grow or multiply. Viruses that contain only the viron are called "naked" or "non-enveloped" viruses and are relatively stable to temperature, pH and chemicals. Viruses that wrapped in a membrane are called enveloped viruses and are more fragile because anything that disrupts their envelope inactivates them.

All viruses replicate in a similar fashion and includes the following five steps:

1. **Attachment:** the viron attaches to a receptor site on the host cell.
2. **Penetration:** the viron enters the host cell
3. **Replication:** viral DNA or RNA directs the host cell to begin synthesis of viral components. Replication uses host cell energy sources and amino acids to produce these components.
4. **Maturation:** the viral components spontaneously assemble into a viral particle: new virons are formed
5. **Release:** the host cell breaks open or the virus buds through the cell wall and new virons are released. Some viruses lie dormant in the host cell for months or years; after this latent period new virons form and cause damage to host cells.

Exercise #6: Use the required readings, information from this section, help from your laboratory and IP mentor to complete Table 6.

Table 6. Basic characteristics of viruses.

Term	Definition
Obligate intracellular parasites	
Size of viruses	
Nucleic acid	
Shapes	
Enveloped vs. non-enveloped viruses	

Exercise #7: Use the required readings, and help from your laboratory to complete Table 7.

Table 7. Viruses

Virus Name	Disease(s) caused	Common source for virus	Incubation period	Is isolation required
Enterovirus				
Hepatitis A				
Hepatitis B				
Hepatitis C				
Hepatitis D				
HIV				
Influenza				
Measles				
Mumps				
Norowalk virus (a.k.a. Norovirus)				
Respiratory Synctial Virus (RSV)				

Exercise #8: Use your resources such as the required readings, the laboratory and your IP mentor to complete Table 8. Determine the differences between viruses and bacteria.

Table 8. A comparison of viruses vs. bacteria.

Characteristic	Viruses	Bacteria
Size and type of microscope to see organism		
Need a living host to multiply		
Has a cell wall and a cell membrane		
Usually tested for susceptibility to antibiotics		
Can there be beneficial types?		
Nucleic acid type		

Fungi

Fungi derive nutrients from organic matter. Most fungi are aerobes that require a moist environment and grow best at a neutral ph. Their spores and conidia are able to survive in dry conditions for long periods of time. Some fungi are well-adapted human pathogens; however, most are accidental pathogens that humans acquire through contact with decaying organic matter or in airborne spores. Typically fungi are divided into three separate groups:

- **Yeasts** – a single celled fungus similar to bacteria. Common pathogenic yeasts include *Candida spp.* which cause vaginitis, mucositis and *Cryptococcus neoformans* which causes meningitis, pneumonia in compromised individuals.
- **Molds** – fungi that grow in multicellular filaments called hyphae. Hyphae are tubular branches, and are genetically identical to one another. Hyphae are connected and form a single organism known as a colony. Common pathogenic molds are *Aspergillus spp.* which causes necrotizing pneumonia, and agents of mucormycosis such as *Rhizopus and Mucor spp.*
- **Dimorphic fungi** – grow as either a mold or a yeast depending on the environment. Common examples are *Pneumocyctis carinii* and *histoplasma capsulatum* which cause pulmonary infections.

Some fungal species are opportunistic pathogens, such as Mucorales, that can infect immunocompromised individuals. Other fungi, such as candida or thrush, can cause infections in individuals who have altered “normal flora” as a result of antibiotic therapy.

Unlike bacteria, fungi have an organized nucleus and a very different type of cell wall and life cycle. These differences are three of the reasons that infections with fungi do not respond to antibiotics. Some

fungi that are considered commensal within a human respiratory tract can be seen as an overgrowth and as such cause a new infection (e.g., thrush). Fungi are ubiquitous in the environment and are part of the normal flora of humans. Fungi have two stages in their life cycle and have two separate names, depending on the phase in which they are identified.

Most laboratories will only identify fungi that have a low index of pathogenicity. The laboratory manipulation of fungi is a complex procedure that requires special hoods, practices, and special media and incubators.

Exercise #9: Use the required readings, help from the laboratory, or your IP mentor to complete Table 9.

Table 9. Fungi of importance in healthcare.

Fungus (disease caused by)	**Usual source (environment)**	**Infection control implications including the requirement for isolation.**
Aspergillus fumigatus **(Aspergillosis)**		
Blastomyces dermatitidis **(Blastomycosis)**		
Candida albicans **(Candidiasis)**		
Coccidioides immitis **(Coccidioidomycosis; Valley Fever)**		
Cryptococcus neoformans **(Cryptococcosis)**		
Cryptococcus gattii **(Cryptococcosis)**		
Fusarium **sp. (fungal keratitis)**		

Histoplasma capsulatum **(Histoplasmosis)**		
Murcomycosis		
Pneumocystis jirovecii **(Pneumocystis pneumonia)**		
Sporothrix schenckii **(Sporothrichosis)**		
Trichophyton mentagrophytes **(dermatophytosis; Ringworm)**		

Parasites

A parasite is an organism that lives in or on another organism and takes its nourishment from the other organism. A parasite cannot live independently. Parasitic diseases include infections caused by three types of organisms:

- **Protozoa** – a single-celled organism that can only divide within its host organism, such as *Plasmodium*, which causes malaria.
- **Helminths** – worms that cause Schistosomiasis.
- **Arthropods** – Insects and arachnids (spiders, etc.), a number of which can act as vectors (carriers) of parasitic diseases.

Infections with parasites rarely require isolation or are an infection prevention emergency. Most parasites have a life-cycle that includes multiple incubation periods and different hosts. It may be the responsibility of the IP to review the case and report to the local health jurisdiction. The IP should be able to educate the staff and family of the patient.

Parasites are often divided into categories depending on their location in the human body.

Blood

The most commonly known blood parasites are those that cause malaria; *Plasmodium falciparaum, P. malariae, P. ovale and P. vivax*., Be aware of parasite infections with filarial organisms such as *Trypanosoma cruzi* (the agent of Chaga's disease) which can be transmitted by blood transfusion.

Intestine

Common intestinal parasites in Wyoming include *Giardia* sp. and *Cryptosporidium* sp. Common parasites around the world include *Entomoeba histolytica, and Ascaris lumbercoides*.

Pediatric patients may have "pinworms" or *Enterobius vermicularis*, which may require the IP to provide education to the patient and family to prevent re-infection or transmission in the home setting.

Exercise #10: Use the required reading and discussions with your laboratory contact to complete Table 10.

Table 10. Common parasitic organisms important in healthcare.

Organism	Mode of transmission to humans	Intermediate host	Treatment	Is isolation required?
Ascaris lumbercoides				
Babesia microti				
***Cryptosporidium* sp.**				
Entamoeba histolytica				
Enterobius vermicularis				
Giardia lamblia				
Nagleria fowlerii				
***Plasmodium* sp.**				

Trypanosoma cruzii				

Methods

Read the WY IPOM, Section #10 Laboratory, to learn about testing methods used for the detection and identification of bacteria, viruses, fungi, and parasites important to infection prevention.

Exercise #11: Using the resources at your disposal including the required readings, laboratory personnel, and your IP mentor, follow the case stories below and answer the questions in each box beneath the description.

CASE #1

Clinical History: A 28 year-old G2P2A0 was admitted to the obstetrics services (OB) service with a fever of 103°F, shaking chills, and hypotension. She was treated for sepsis and given ampicillin via IV

Specimen: Blood Culture
Gram Stain Multiple Gram positive rods
Microbiology: Growth in motility agar
The most likely pathogen is: _____.
The most likely source of the pathogen is: _____.

CASE #2

Clinical History: An 18 year-old high school football player was seen in the Emergency Department for a "spider bite" on the shoulder. The wound was erythematous, tender to touch, and had a central core that appeared to be white. When aspirated the following materials were identified:

Specimen: Aspiration of abscess
Gram Stain: Multiple Gram positive organisms in clusters
Microbiology: Coagulase Positive, *mecA* positive by PCR
The most likely pathogen is: _____.
The treatment of choice is: _____.

CASE #3

Clinical History: An 87 year-old female patient has been in the hospital for several days, is intubated, and has been on a ventilator for the past 120 hours. She now has a fever of 103°F, a left-shift in the white count, hypotension, and increased O2 demands (FiO2 > 20; PEEP > 30 for 48 hours). The physician orders a sputum culture, and the following laboratory report was received

Specimen: Aspirated sputum
Gram Stain: Multiple gram negative rods of varying sizes interspersed among many WBC's.
Microbiology: Pan resistant Gram Negative rod, only susceptible to the antibiotic Colistin.
Select the most likely pathogen:

Acinetobacter calcoaceticus va Baumanii

P. aeruginosa

E. coli

Achromobacter

Elizabethkingii meningiosepticum

Does this patient require isolation? (circle one) Yes No

CASE #4

Clinical History: A patient comes into the Emergency Department with complaints of a headache, fever, stiff neck, and fear of light. He undergoes a diagnostic spinal tap, and the spinal fluid is submitted for analysis. The following laboratory data are returned to you and the ordering unit.

CSF – glucose 60
CSF – protein 60
CSF – WBC 10-12
80% monocytes
Gram stain: Rare WBC, rare RBC, no organisms seen
Does this patient require isolation? (circle one) Yes No
Please indicate your rationale : _____

_____

What is your probable guess as to the cause of these finding and your rationale? _____

_____

Resources

Helpful/Related Readings

- Bennett J and Brachman P, eds. *Bennett & Brachman's Hospital Infections. 6th Edition.* Philadelphia, PA: William R Jarvis; 2014.
  - Chapter 11, The Role of the Laboratory in Prevention of Healthcare-Associated Infections, by MA Pfaller and DJ Diekema
  - Chapter 15, Multi-drug Resistant Organisms: Epidemiology an Control, by MY Lin, RA Weinstein, and MK Hayden
  - Chapter 22, Clinical Laboratory-Acquired Infections, by ML Wilson and LB Reller
  - Chapter 44, Healthcare-Associated Fungal Infections, by RM Smith, SK Fridkin and BJ Park
- Heymann D. *Control of Communicable Diseases Manual. 19th Edition.* Washington, D.C.: American Public Health Association; 2008.
- Pickering L, et al, eds. *Red Book: 2012 Report of the Committee on Infectious Diseases. 29th Edition.* Elk Grove Village, IL: American Academy of Pediatrics; 2012.
- Mandell G, et al, eds. *Mandell, Douglas and Bennett's Principles and Practice of Infectious Diseases. 7th Edition*. Philadelphia, PA: Churchill Livingstone Elsevier; 2010.
- Lautenbach E, Woeltje KF, and Malani PN, eds. SHEA Practical Healthcare Epidemiology (3rd Edition). University of Chicago Press, Chicago, IL 2010
  - Chapter 8, Twenty-First Century Microbiology Laboratory Support for Healthcare-Associated Infection Control and Prevention, by LR Peterson and MO Wright
  - Chapter 9, Molecular Typing Systems, by JHafkin, L Chandler and J Maslow
  - Chapter 19 *Clostridium difficile* Infection, by N Bagdasarian and PN Malani

Helpful Contacts (in WY or US)

- David Woodard, Contractor in healthcare environmental services, dwood1492@gmail.com,

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- Leslie Teachout MT(ASCP), CIC, Infection Prevention at Riverton (307) 857-3552 and Lander (307)335-6442 Hospitals, leslie.teachout@lpnt.net, cellphone (406)570-9321
- Emily Thorp, MS, Infectious Disease Surveillance Epidemiologist and HAI Prevention Coordinator, Wyoming Department of Health, 307-777-8634, emily.thorp@wyo.gov

Related Websites/Organizations

- Wyoming Department of Health, Infectious Disease Epidemiology Unit, Healthcare-Associated Infection Prevention: www.health.wyo.gov/phsd/epiid/HAIgeneral.html
- Centers for Disease Control and Prevention (CDC): www.cdc.gov/

My Facility/City/County Contacts in this Area

Position Title	Name	Phone number	Email address
Laboratory Director			
Microbiology Section Supervisor			
Bacteriology Staff			
Virology Staff			

Appendix: Key Information from Required Readings

Normal flora

Microorganisms are found everywhere in nature and are also naturally present in and on humans. The term used for those microorganisms that can establish populations in a host, such as the human body, without causing disease is "normal flora." The normal flora that establish permanent populations are called "resident flora" and the microorganisms with temporary or semi-permanent populations are called "transient flora."

Common Normal Flora

Body Site	Common organisms
Mouth	*Staphylococci, S. viridans, Enterococci, S. pneumoniae, Neisseriae, Corynebacteria, Haemophilus, Enterobacteriaceae, Actinomyces, Lactobacilli, Bifidobacteria, Fusobacteria, anaerobic* Gram neg. *cocci,* anaerobic Gram neg. cocci
Upper Respiratory Tract	*Staphylococci, S. viridans, S. pneumoniae, Corynebacteria, Haemophilus, Propionibacteria, Actinomyces, Bacteroides, Fusobacteria,* anaerobic Gram neg. *cocci,* anaerobic Gram neg. *cocci*
Skin	*Staphylococci, Corynebacteria, Propionibacteria,* anaerobic Gram neg. *cocci*
Conjunctiva	*Staphylococci, Corynebacteria,* anaerobic Gram neg. *cocci*
Lover Intestine	*S. viridans, Enterococci, Corynebacteria, Enterobacteriaceae, Clostridia, Lactobacilli, Bifidobacteria, Fusobacteria,* anaerobic Gram neg. *cocci*
External Genitalia	*Staphylococci, S. viridans, Enterococci, Corynebacteria, Enterobacteriaceae, Bacteroides, Fusobacteria,* anaerobic Gram neg. *cocci*
Anterior Urethra	*Staphylococci, Enterococci, Neisseriae, Corynebacteria, Bacteroides, Fusobacteria,* anaerobic Gram neg. *cocci*
Vagina	*Staphylococci, S. viridans, Enterococci, Neisseriae, Corynebacteria, Lactobacilli, Bifidobacteria, Bacteroides,* anaerobic Gram neg. *cocci*

Stages of illness

- Invasion – pathogen acquires entry into the body
  - mucous membranes, inhalation, self inoculation
- Incubation – pathogen replicating, no symptoms
- Prodromal – initial appearance of symptoms (usually mild and vague)
- Acute Illness – maximum impact of illness when pathogen is proliferating rapidly – toxic by-products of microbial metabolism and immune response produce tissue damage
- Recovery – pathogen is contained and eliminated from body, damaged tissue is repaired and resolution of symptoms

Common Infections and the Usual Organisms That Cause Them

Infection/site	Common Organisms
Bronchitis	*S. pneumoniae*, *H. influenzae*, respiratory viruses
Device-related	Coagulase-negative *staphylococci*, *Corynebacteria sp.*
Endocarditis	*S. viridans, S. aureus, Enterococci*
Gastroenteritis	*Salmonella sp., Shigella sp., Campylobacter sp., E. coli 0157:H7*, viruses
Meningitis	*H. influenzae, N. meningitides, S. pneumoniae*
Pelvic Inflammatory Infection	*C. trachomatis, N. gonorrhoeae, Bacteroides sp. Enterobacteriaceae*
Pharyngitis	*S. pyogenes*, respiratory viruses
Pneumonia (community)	*S. pneumoniae, H. influenzae, M. pneumoniae, C. pneumoniae, M. tuberculosis*
Pneumonia (healthcare)	*Pseudomonas sp. S. aureus, Enterobacteriaceae*
Septicemia	*S. aureus, S. pneumoniae, E. coli, Klebsiella sp., Salmonella sp.*
Sinusitis	*S. pneumoniae, H. influenzae, S. pyogenes, S. aureus*
Skin	*S. aureus, S. pyogenes, Candida sp.*, dermatophytes
Urinary Tract	*E. coli, Enterococci, Candida sp., Klebsiella sp., Proteus sp.*

WIPAG welcomes your comments and feedback on these sections.
For comments or inquiries, please contact:

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