McCance: Pathophysiology, 6th Edition

Chapter 09: Infection

Key Points – Print

SUMMARY REVIEW

Introduction to Infection

1. Death caused by infection rose by 58% between 1980 and 1992 and is now the third leading cause of death in the United States and the leading cause of death worldwide.
2. It was previously believed that infectious disease was being controlled, no longer because of the reemergence of old infections thought to be controlled, emergence of previously unknown infections, and infections resistant to multiple antibiotics.
3. The current rate of emergence of previously unknown infections may be unprecedented. More than 40 unknown infections have arisen within one generation.
4. Although most infections are controlled, some uncontrolled infections have high mortality rates including SARS, Ebola virus, Marburg virus, "mad cow disease," Nipah virus, and AIDS.
5. Many common and reemerging infections have become antibiotic and drug resistant. At least 25% of *S. pneumoniae* are penicillin resistant and some are resistant to multiple antibiotics.
6. Resistant forms of *S. aureus*, a primary cause of infections of wounds, surgical incisions, and catheters, are endemic in some hospitals.
7. Antimicrobial resistance is routinely observed in tuberculosis, diarrheal diseases, hospital-acquired infections, malaria, meningitis, respiratory tract infections, STIs, and HIV.

Microorganisms and Humans: A Dynamic Relationship

1. The human body is a hospitable site for microorganisms to grow and flourish. These microorganisms make up the *normal flora* of the body.
2. The beneficial homeostasis between humans and microorganisms is maintained through the physical integrity of the gut and other mechanisms that sequester these microorganisms on the mucosal surface.

Microorganisms and Infections

1. The symbiotic relationship with the normal flora can be altered by injury, compromising protective barriers.
2. Cuts in the skin and compromised immunity can increase infections.
3. Damage to the intestinal track releases intestinal bacteria into the bloodstream, potentially leading to sepsis, shock, and death.

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4. When an individual's immune system is deficient, the person can become infected with opportunistic infections.
5. Unlike opportunistic infectious agents, true pathogens can circumvent an individual's defenses and directly cause infection. Successful infection with these agents usually requires adequate numbers of microorganisms rather than compromised immune defenses.
6. The process of infection includes colonization, invasion, multiplication, and spread.
7. Infectious microorganisms usually exist in reservoirs (e.g., contaminated soil, contaminated water, breast milk), animals, or another human.
8. As part of colonization, the microorganism stabilizes the adherence to tissue through surface receptors. Once colonization occurs, the infectious agent can invade surrounding tissue.
9. Because tissue is warm and nutrient rich, most microorganisms undergo *rapid* multiplication. Viral pathogens replicate within infected cells and some bacteria are intracellular pathogens and replicate in macrophages and other cells.
10. Many pathogens produce only localized infections. Others are, however, highly invasive.
11. Successful spreading requires a variety of virulence factors, including adhesion molecules, toxins, and the ability to evade immunity.
12. Clinical infectious disease occurs in four distinct stages: (1) incubation period, (2) prodromal state, (3) invasion period, and (4) convalescence.
13. The hallmark of most infectious diseases is fever. Body temperature is regulated at a higher than normal level.
14. A large number of agents (pyrogens) can produce fever. Current classifications include endogenous (e.g., cytokines) and exogenous agents. However, the evidence for exogenous agents is limited and they indirectly affect the hypothalamus through endogenous pyrogens.
15. Several factors influence the capacity of a pathogen to cause disease, including communicability, immunogenicity, infectivity, mechanisms of action, pathogenicity, entry portal, toxigenicity, and virulence.
16. Infectious diseases also are classified by their prevalence and spread as endemic, epidemic, and pandemic.
17. Classes of infectious microorganisms include bacterial, fungal, parasitic, protozoal, and viral.
18. Bacteria are divided into several groups: "true bacteria," filamentous, spirochetes, mycoplasma, rickettsia, and chlamydia.
19. Stable colonization of bacteria requires adhesion. Many bacteria attach through pili, also called fimbriae.
20. Invasion by bacteria results in direct confrontation with an individual's defense mechanisms, including complement, antibodies, and phagocytes (neutrophils, macrophages). Evasion of these defenses can result in bacteremia and sepsis.
21. Efficient pathogens can produce a variety of toxic molecules that may kill the individual's cells, disrupt tissue, and protect themselves against inflammation. Exotoxins are released by

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bacteria during bacterial growth and can damage cell membranes, activate second messengers, and inhibit protein synthesis.

22. Endotoxins are contained in the cell walls of gram-negative bacteria and released during lysis of the bacteria. Bacteria that produce endotoxins are called *pyrogenic bacteria* because they activate inflammation and produce fever.
23. Bacteria can protect against phagocytosis by producing toxins and extracellular enzymes that destroy phagocytic cells.
24. Some bacteria can coat the Fc portion of an individual's antibody, preventing complement activation or phagocytosis.
25. Antigenic variation allows the pathogen to alter surface molecules that express antigens that are the targets of protective immune responses. The pathogen thus becomes resistant.
26. Other self-protective mechanisms for bacteria and other pathogens include degrading immune molecules, neutralization of immune molecules, complement evasion, and immune suppression.
27. Tissue damage from bacterial infections is either directly by bacterial products or indirectly from infection.
28. *S. aureus* has become a major cause of hospital-acquired (nosocomial) infections. Antibiotic resistance also has become a major problem with *S. aureus*.
29. Fungal infection is called mycosis. Most pathologic fungi are from the environment and transmitted by inhalation or contamination of wounds.
30. In 2006, the opportunistic pathogen *P. carinii* was reclassified as a fungus and the specific variant that infects humans was renamed *P. jiroveci*.
31. *C. albicans* is the most common cause of fungal infections in humans. It resides in the skin, gastrointestinal tract, mouth, and vagina. Local defense mechanisms, including members of the bacterial flora, produce antifungal agents. The infection remains localized in individuals with an intact immune system.
32. Parasitic organisms establish a symbiosis with another species, whereby the parasite benefits. They range from unicellular protozoa to large worms. Although less common in the United States, parasites and protozoa are common causes of infection worldwide.
33. Parasitic and protozoal infections are rarely transmitted from human to human. Infection mainly spreads through vectors and includes malaria by mosquito bites, trypanosomes by the tsetse fly, and *Leishmania* spp. by sand fleas. Others are found in contaminated water or food (e.g., *G. lamblia*).
34. Malaria is one of the most common infections worldwide. It is transmitted through the bite of an infected *Anopheles* mosquito. The infectious form can enter the bloodstream, exits in the liver, and invades parenchyma cells. After several rounds of division, the liver cell ruptures and thousands of parasites enter the blood, infecting red blood cells.
35. Viruses are classified by the format of nucleic acid in the virion (RNA or DNA), either single stranded (ss) or double stranded (ds), and whether it uses the enzyme RT for replication.

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36. Viral diseases are the most common affliction of humans and include the common cold, the "coldsore," hepatitis, HIV, and several types of cancer.
37. Viruses are intracellular parasites. The viral life cycle is completely intracellular and involves several stages: attachment, penetration, uncoating, replication, assembly, and release. New virions are released from the cell for transmission of the viral infection to neighboring, uninfected cells.
38. The primary defense mechanisms against viruses include antibody and cellular immunity. Nonspecific defenses include α- and β-interferons that block intracellular replication.
39. Successful viruses use a variety of mechanisms for bypassing immune rejection, including rapid division, intracellular survival, coat with self proteins, antigenic variation, neutralization, complement evasion, and immune suppression.
40. Viruses inside the infected cell have several harmful effects, including inhibition of DNA, RNA, or protein synthesis; disruption of lysosomal membranes result in lytic enzyme release; promotion of cell apoptosis; fusion of adjacent cells (i.e., giant cells); transformation into a neoplastic cell; and alteration of antigenic properties (i.e., decreasing immune effectiveness).

Acquired Immunodeficiency Syndrome, AIDS

1. AIDS is a viral disease caused by HIV.
2. HIV infects and depletes a portion of the immune system (Th cells) making individuals susceptible to life-threatening infections and malignancies.
3. HIV/AIDS remains a major cause of death worldwide.
4. Aggressive antiretroviral therapy and public health campaigns have stabilized the number of new cases and deaths in the United States from HIV/AIDS, but the cases and deaths continue to increase rapidly worldwide.
5. In 2006, 50% of newly diagnosed cases were attributed to male-to-male sexual contact, 33% to high-risk heterosexual contact, and 13% to injected drug abuse. About 26% of newly diagnosed cases were female, with about 74% contracted through high-risk heterosexual contact.
6. The epicenter of the AIDS pandemic is Sub-Saharan Africa. Women have the highest risk of infection. The life expectancy with AIDS has dropped from 64 years to 54 years.
7. HIV is a blood-borne pathogen present in body fluids (e.g., blood, vaginal fluid, semen, breast milk) with typical routes of transmission: blood or blood products, intravenous drug abuse, heterosexual and homosexual activity, and maternal-child transmission before or during birth.
8. At the end of 2006, an estimated 8508 children in the United States developed AIDS after contracting HIV infection from their mothers (e.g., across the placenta, through contact with infected blood during delivery, or breast milk)
9. Healthcare providers are at increased risk of contracting infections from another person's blood. However, as of January 2007, only 57 cases of confirmed HIV/AIDS and 140 possible cases were contracted by occupational exposure.

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10. HIV is a member of the *retrovirus* family, which carries genetic information in the form of two copies of RNA. An enzyme, RT, converts RNA into a double-stranded DNA. Another enzyme, an *integrase*, inserts the new DNA into the infected cell's genetic material. On activation, translation of the viral information may be initiated, forming new virions, resulting in lysis and death of the infected cell, and shedding infectious HIV particles.
11. The primary surface receptor on HIV is the envelope glycoprotein gp120, which binds to the CD4 molecule found mostly on the surface of helper T cells. Several other important co-receptors have been identified.
12. The major immunologic finding in AIDS is the striking decrease in the number of CD4 Th cells.
13. The presence of circulating antibody against HIV indicates infection by the virus, although many individuals are asymptomatic.
14. The current treatment for HIV infection is a combination of drugs called HAART.

Countermeasures Against Pathogens

1. Effective means of countering infectious microorganisms is rigorous use of environmental infection control measures, including insect control, modern sanitation facilities, and clean water and food. Prophylactic or interventive procedures include vaccines and antimicrobials.
2. With antibiotic-resistant pathogens, a greater emphasis is placed on the development of new vaccines.

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