Chapter 22

Microbial Diseases of the Nervous System

The Nervous System

- Define central nervous system and blood–brain barrier.
- Differentiate meningitis from encephalitis.

The Nervous System

- Meninges protect brain and spinal cord
  - Dura mater: outermost layer
  - Arachnoid mater: middle layer
    - Subarachnoid space contains cerebrospinal fluid (CSF)
  - Pia mater: innermost layer
- Blood–brain barrier

Meningitis: inflammation of meninges
Encephalitis: inflammation of the brain
Meningoencephalitis: inflammation of both

Why can the antibiotic chloramphenicol readily cross the blood–brain barrier, whereas most other antibiotics cannot? 22-1
Encephalitis is an inflammation of what organ or organ structure? 22-2

Bacterial Diseases of the Nervous System

- Discuss the epidemiology of meningitis caused by Haemophilus influenzae, Neisseria menigitidis, Streptococcus pneumoniae, and Listeria monocytogenes.
- Explain how bacterial meningitis is diagnosed and treated.

Bacterial Meningitis

- Initial symptoms of fever, headache, and stiff neck
- Followed by nausea and vomiting
- May progress to convulsions and coma
- Diagnosis by Gram stain and latex agglutination of CSF

Haemophilus influenzae Meningitis

- Occurs mostly in children (6 months to 4 years)
• Gram-negative aerobic bacteria, normal throat microbiota
• Capsule antigen type b
• Prevented by Hib vaccine

13 Neisseria Meningitis
• Also called meningococcal meningitis
• Caused by N. meningitidis
  • Gram-negative, aerobic cocci with a capsule
• 10% of people are healthy nasopharyngeal carriers
• Begins as throat infection, rash
• Serotypes B, C, Y, W-135
• Serotype B & C in United States
• Serotype A in Africa
• Vaccination (A, C, Y, W-135 capsule) recommended for college students

15 Streptococcus pneumoniae Meningitis
• Also called pneumococcal meningitis
• Caused by S. pneumoniae (a gram-positive diplococcus)
• 70% of people are healthy nasopharyngeal carriers
• Most common in children (1 month to 4 years)
• Mortality: 30% in children, 80% in elderly
• Prevented by vaccination

16 Listeriosis
• Caused by Listeria monocytogenes
• Gram-negative aerobic rod
• Usually foodborne; it can be transmitted to fetus
• Reproduce in phagocytes
• Spread phagocyte-to-phagocyte

18 Diseases in Focus:
  Meningitis and Encephalitis
• A worker in a day-care center in eastern North Dakota becomes ill with fever, rash, headache, and abdominal pain. The patient has a precipitous clinical decline and dies on the first day of hospitalization. Diagnosis is confirmed by Gram staining of cerebrospinal fluid.
• Can you identify infections that could cause these symptoms?
• Why is meningitis caused by the pathogen Listeria monocytogenes frequently associated with ingestion of refrigerated foods? 22-3
• What body fluid is sampled to diagnose bacterial meningitis? 22-4

21 Bacterial Diseases of the Nervous System
• 22-5 Discuss the epidemiology of tetanus, including mode of transmission, etiology, disease symptoms, and preventive measures.
• 22-6 State the causative agent, symptoms, suspect foods, and treatment for botulism.
• 22-7 Discuss the epidemiology of leprosy, including mode of transmission, etiology, disease symptoms, and preventive measures.

22 Tetanus
• Caused by Clostridium tetani
• Gram-positive, endospore-forming, obligate anaerobe
• Grows in deep wounds
• Tetanospasmin released from dead cells blocks relaxation pathway in muscles
• Prevention by vaccination with tetanus toxoid (DTaP) and booster (Td)
• Treatment with tetanus immune globulin (TIG)

23 Botulism
• Caused by Clostridium botulinum
• Gram-positive, endospore-forming, obligate anaerobe
• Intoxication comes from ingesting botulinal toxin
• Botulinal toxin blocks release of neurotransmitter, causing flaccid paralysis
• Prevention
  • Proper canning
  • Nitrites prevent endospore germination in sausages

25 Botulism
• Treatment: supportive care and antitoxin
• Infant botulism results from C. botulinum growing in intestines
• Wound botulism results from growth of C. botulinum in wounds

26 Botulinal Types
• Type A toxin
  • 60–70% fatality
  • Found in CA, WA, CO, OR, NM
• Type B toxin
  • 25% fatality
  • Europe and eastern United States
• Type E toxin
  • Found in marine and lake sediments
  • Pacific Northwest, Alaska, Great Lakes area

27

28 Leprosy
  • Also called Hansen’s disease
  • Caused by Mycobacterium leprae
  • Acid-fast rod that grows best at 30°C
  • Grows in peripheral nerves and skin cells
  • Transmission requires prolonged contact with an infected person

29 Leprosy
  • Tuberculoid (neural) form: loss of sensation in skin areas; positive lepromin test
  • Lepromatous (progressive) form: disfiguring nodules over body; negative lepromin test

30

31

• Is the tetanus vaccine directed at the bacterium or the toxin produced by the bacterium? 22-5
• The very name botulism is derived from the fact that sausage was the most common food causing the disease. Why is sausage now rarely a cause of botulism? 22-6
• Why are nude mice and armadillos important in the study of leprosy? 22-7

32 Diseases in Focus: Diseases with Neurological Symptoms or Paralysis
  • After eating canned chili, two children experience cranial nerve paralysis followed by descending paralysis. The children are on mechanical ventilation. Leftover canned chili is tested by mouse bioassay.
  • Can you identify infections that could cause these symptoms?

33

34 Viral Diseases of the Nervous System
  • 22-8 Discuss the epidemiology of poliomyelitis, rabies, and arboviral encephalitis, including mode of transmission, etiology, and disease symptoms.
  • 22-9 Compare the Salk and Sabin polio vaccines.
• 22-10 Compare the preexposure and postexposure treatments for rabies.
• 22-11 Explain how arboviral encephalitis can be prevented.

35 Poliomyelitis (Polio)
- Poliovirus
- Transmitted by ingestion
- Initial symptoms: sore throat and nausea
- Viremia may occur; if persistent, virus can enter the CNS
- Destruction of motor cells and paralysis occurs in <1% of cases
- Prevention: vaccination (enhanced-inactivated polio vaccine)

36

37 Rabies
- Caused by the rabies virus
- Transmitted by animal bite
- Furious rabies: animals are restless, then highly excitable
- Paralytic rabies: animals seem unaware of surroundings

38

39

40

41

42 Rabies Virus
- Virus multiplies in skeletal muscles and then brain cells, causing encephalitis
- Initial symptoms may include muscle spasms of the mouth and pharynx and hydrophobia

43 Prevention of Rabies
- Preexposure prophylaxis: injection of human diploid cells vaccine (HDCV)
- Postexposure treatment: vaccine plus rabies immune globulin (RIG)

44 Arboviral Encephalitis
- Arboviruses
- Arthropod-borne viruses that belong to several families
- Prevention: controlling mosquitoes

45

46 Arboviral Encephalitis

47 Arboviral Encephalitis
Diseases in Focus:
Types of Arboviral Encephalitis

- An 8-year-old girl in rural Wisconsin has chills, headache, and fever and reports having been bitten by mosquitoes.
- Which type of encephalitis is most likely?

Why is paralytic polio more likely to occur than a mild or asymptomatic infection in areas with high standards of sanitation? 22-8

Why is the Sabin oral polio vaccine more effective than the injected Salk polio vaccine? 22-9

Why is postexposure vaccination for rabies a practical option? 22-10

When there are serious local outbreaks of arboviral encephalitis, what is the usual response to minimize its transmission? 22-11

Fungal Diseases of the Nervous System

- 22-12 Identify the causative agent, reservoir, symptoms, and treatment for cryptococcosis.

Cryptococcus neoformans Meningitis

- Also called cryptococcosis
- Soil fungus associated with pigeon and chicken droppings
- Transmitted by the respiratory route; spreads through blood to the CNS
- Mortality up to 30%
- Treatment: amphotericin B and flucytosine

What is the most common source of airborne cryptococcal infections? 22-12

Protozoan Diseases of the Nervous System

- 22-13 Identify the causative agent, vector, symptoms, and treatment for African trypanosomiasis and amebic meningoencephalitis.

African Trypanosomiasis

- Trypanosoma brucei gambiense
• Chronic (2 to 4 years)
• T. b. rhodesiense infection
  • Acute (few months)
• Transmitted from animals to humans by tsetse fly

57 **African Trypanosomiasis**
• Prevention: elimination of the vector
• Treatment: eflornithine blocks an enzyme necessary for the parasite
• Parasite evades the antibodies through antigenic variation

58

59 **Naegleria fowleri**
• Protozoan infects nasal mucosa from swimming water
• Ameboid-flagellate-cyst

60

61

62

• What insect is the vector for African trypanosomiasis? 22-13

63 **Prion Diseases of the Nervous System**
• 22-14 List the characteristics of diseases caused by prions.
  •
  •

64

65 **Transmissible Spongiform Encephalopathies**
• Caused by prions
• Typical diseases
  • Sheep scrapie
  • Creutzfeldt-Jakob disease
  • Kuru
  • Bovine spongiform encephalopathy
• Chronic and fatal

66

67 **Prion Diseases of the Nervous System**
• Acquired by
  • Ingestion
  • Inheritance
  • Transplant
• Difficult to destroy
69 Preventing Prion Diseases
- Sterilization of surgical instruments by NaOH with extended autoclaving at 134°C

70
- What are the recommendations for sterilizing reusable surgical instruments when prion contamination might be a factor? 22-14

71 Disease Caused by Unidentified Agents
- 22-15 List some possible causes of chronic fatigue syndrome.
  - 
  - 

72 Chronic Fatigue Syndrome
- Also called myalgic encephalomyelitis (ME)
- Unexplained fatigue that lasts at least 6 months, plus four of these symptoms:
  - Sore throat
  - Tender lymph nodes
  - Muscle pain
  - Pain in multiple joints
  - Headaches
  - Unrefreshing sleep
  - Malaise after exercise
  - Impaired short-term memory or concentration

73 Chronic Fatigue Syndrome
- Experimental treatment promotes antiviral interferons

74
- Name one common disease that may be associated with chronic fatigue syndrome. 22-15