Slide 1

Microbial Diseases: Nervous System

Lecture 24

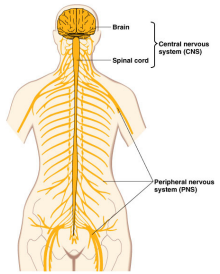
Slide 2

Learning Outcomes

- Nervous System
- Meningitis
- Encephalitis
- Exotoxins of *Clostridium sp*
- Leprosy
- Rabies
- Polio
- Arboviruses

Slide 3

Nervous System



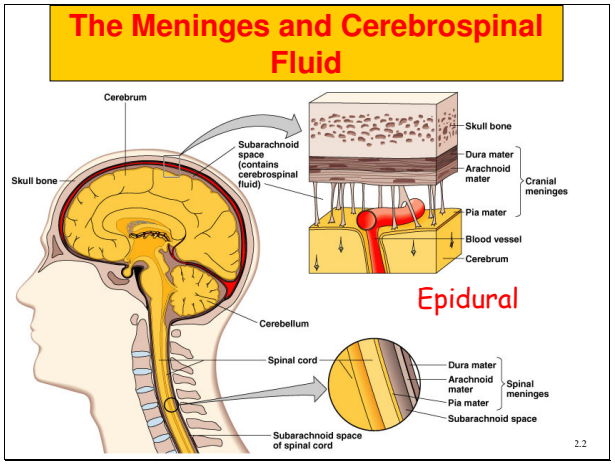
- No normal microbial flora
- Entry of Microbes to CNS:-
  - Skull or backbone fractures
  - Medical procedures
  - Along peripheral nerves
  - via blood or lymph

Slide 4

Microbial Diseases of the Nervous System

- Microbes can grow in the cerebrospinal fluid in the subarachnoid space of the CNS
- The blood brain barrier (capillaries) prevents passage of some materials (such as antimicrobial drugs) into the CNS
- Meningitis
  - Inflammation of meninges
- Encephalitis
  - Inflammation of the brain

Slide 5



Slide 6

Meningitis

- Viral – most common
- Fungi – *Cryptococcus neoformans*
- Protozoa – *Naegleria fowleri*
- Bacteria - several
- Symptoms
  - Prodromal symptoms mild, cold-like
  - Fever, headache, stiff neck
  - Followed by nausea and vomiting
  - May progress to convulsions and coma
- Diagnosis by Gram stain of CSF
- Treated with cephalosporins

Bacterial Meningitis

Bacterium	Percentage of Cases	Fatality Rate
Streptococcus pneumoniae	30–50	19–46
Neisseria meningitidis	15–40	3–17
Haemophilus influenzae	2–7*	3–11

Other bacteria causing meningitis account for 6–8% of cases.

**Before introduction of Hib vaccine, H. influenzae accounted for about 45% of cases of bacterial meningitis; about 70% of these cases occurred in children under age 5.*
SOURCE: Adapted from E.J. Phillips and A.E. Simor, "Bacterial Meningitis in Children and Adults," Postgraduate Medicine 103 (3):104 (1998).

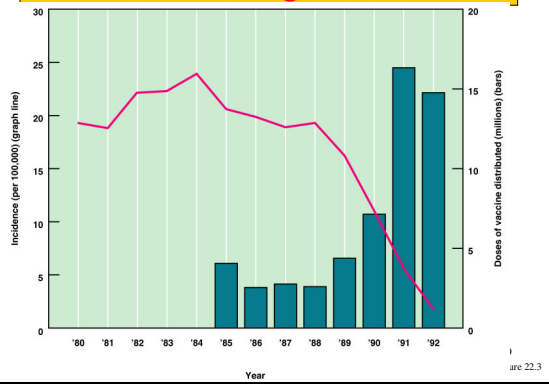
Table 22.1

Haemophilus influenzae Meningitis

- Occurs mostly in children (6 months to 4 years)
- Gram-negative aerobic rod, normal throat microbiota
  - Capsule antigen type b
  - T-independent antigen
  - Does not stimulate strong immune response in infants
- Prevented by Hib (conjugate) vaccine

Slide 9

Haemophilus influenzae Meningitis



are 22.3

Slide 10

Meningococcal Meningitis

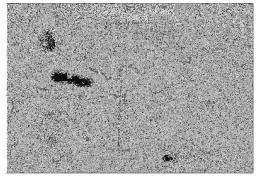
- *Neisseria meningitis*
- Aerobic, Gram -, encapsulated cocci
- Present in 10% of noses
- Induces Tumor Necrosis Factor
- Increases permeability of Blood-Brain barrier
- Symptoms caused by endotoxin
- Rash
  - Does not fade when pressed
  - Blood leaked out of capillaries
- Students
- Untreated mortality rate 85%

Pneumococcal Meningitis

- *Streptococcus pneumoniae*
- Gram-positive diplococci
- encapsulated
- 70% of people are healthy nasopharyngeal carriers
- Most common (1 month to 4 years)
- Mortality: 30% in children, 80% in elderly
- pneumococcal conjugate vaccine (PCV) children < 5 years
- pneumococcal polysaccharide vaccine adults > 65

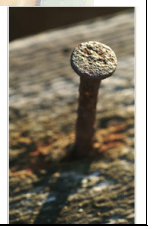
Listeria Meningitis

- *Listeria monocytogenes*
- Gram-positive aerobic rod
- Reproduce in phagocytes
- Usually foodborne, can be transmitted to fetus during pregnancy or labor
- Infection appears 2-3 days after birth
- Death rate 30%



Tetanus

- *Clostridium tetani*
- Gram-positive, endospore-forming, obligate anaerobe
- Grows in deep wounds
  - Anaerobic conditions
- Exotoxin Tetanospasmin
  - A-B toxin
  - binds to motor neurons inhibiting release of glycine and (gamma-aminobutyric acid)
  - Prevents relaxation of antagonistic muscles
- vaccination with tetanus toxoid (DTP) and booster (dT)
- Post –exposure treatment for immunized person = toxoid
- Unimmunized person tetanus immuno globulin (antibodies)



Biol 240 S06

Botulism

- *Clostridium botulinum*
- Gram-positive, endospore-forming, obligate anaerobe
- Intoxication due to ingesting botulinum toxin
- Infant botulism due to ingestion of endospores
- Botulinal toxin blocks release of acetylcholine neurotransmitter causing flaccid paralysis
- Prevention: Proper canning
  - Nitrites prevent endospore germination in sausages
- Treatment: antitoxin
  - No vaccine – under development

Biol 240 S06 14

Slide 15

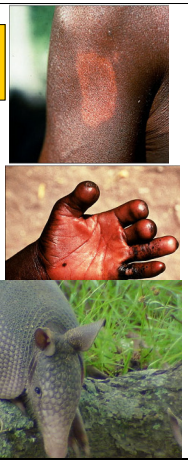
Leprosy

- *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
- Nasal secretions

Slide 16

Leprosy

- Tuberculoid (neural) form: Loss of sensation in skin areas; positive lepromin test
  - Sensitized T cells
- Lepromatous (progressive) form: Disfiguring nodules over body; negative lepromin test
- Immune system no longer responsive

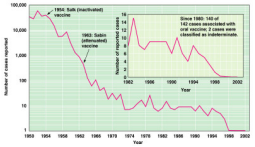


Poliomyelitis

- Poliovirus (Picornaviridae)
- Transmitted by fecal-oral route
  - 90% asymptomatic
- Initial symptoms: sore throat and nausea
- Viremia may occur; if persistent, virus can enter the CNS;
  - destruction of motor cells and flaccid paralysis occurs in <1% of cases
- Mostly affected children and adolescents
- Summer epidemics swept USA 1910

Poliomyelitis

- Prevention is by vaccination (enhanced-inactivated polio vaccine)
  - Modern sanitation
- Salk 1954
- Killed - inactivated
- Sabin 1963
- Attenuated oral polio vaccine
- Only affects humans (and chimpanzees)
- Eradication efforts



Not Polio?

- FDR
- 1921 diagnosed with Polio BUT
  - Too old - 39
  - Paralysis symmetrical
- Polio often asymmetrical
- 2003 Study
- Guillain-Barre Syndrome
  - acute ascending polyneuritis
- autoimmune -- immune system mistakenly host tissue
- Damages motor AND sensory neurons
- Paralysis parallel

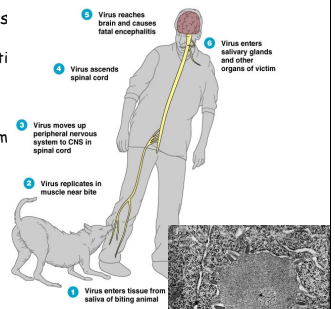
Eradication of Polio

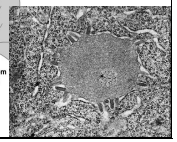
- Endemic Polio 4 countries 2004)
  - Nigeria, India, Afghanistan, Pakistan
- (11 in 2007)
- DRC, Sudan, Niger, Chad, Myanmar
- Epidemics
- Introduced from endemic countries by travelers
- Education
- Cultural Barriers

Slide 21

Rabies

- Rhabdovirus
- Transmitted by animal bite
  - zoonosis
- Virus multiplies in skeletal muscles
- Enters peripheral nerves travels to CNS
  - → brain cells causing encephaliti
  - Negri bodies in cytoplasm of infected nerve cells
- Furious rabies
  - Virus replicates in limbic system
  - Restlessness, anxiety, irritability,
  - Headache, Muscle spasms, salivation and hydrophobia
- Paralytic rabies
  - Virus replicates in cerebral cortex
  - Depression, lethargy, coma





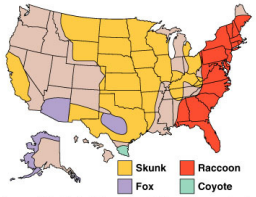
Slide 22

Rabies

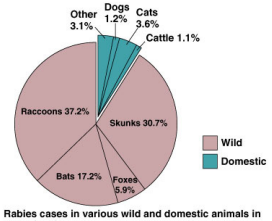
- Preexposure prophylaxis:
  - Rabies vaccine
- Postexposure treatment:
- Vaccine + immune globulin
- Quarantine Restrictions in rabies free nations: UK, New Zealand
- Immunization of wildlife

Slide 23

Rabies virus (Rhabdovirus)



Areas of the United States in which rabies predominates in certain wildlife species. Rabies-infected bats were reported in 47 of the 48 contiguous states. In eastern states in which raccoons are the predominant rabies-infected animal, many cases were also reported in foxes and skunks.



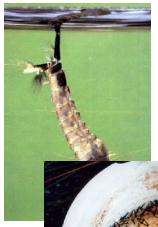
Rabies cases in various wild and domestic animals in the U.S.A. in 2002.

Figure 22.12

Slide 24

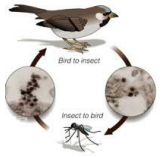
Arboviral Encephalitis

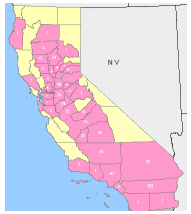
- Arboviruses are arthropod-borne viruses that belong to several families.
- Prevention is by controlling mosquitoes
- Treatment options limited
- St Louis Encephalitis
- Japanese B Encephalitis
- Eastern Equine Encephalitis



West Nile Virus

- Mosquito = vector
- Birds = reservoir
- Epidemiology
- Introduced into US 1999 NY
- 377 Human cases Ca 2007
- Kern Co 137
- Los Angeles 37

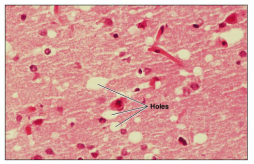




http://westnile.ca.gov/

Transmissible Spongiform Encephalopathies

- Caused by prions
  - Sheep scrapie
  - Creutzfeldt-Jakob disease
  - Kuru
  - Bovine spongiform encephalopathy
  - Elk wasting disease
  - Familial insomnia
- Transmitted by ingestion or transplant or inherited
- Chronic, fatal



(a) Brain tissue showing spongiform lesions