

## The Usual Suspects: Common microorganisms causing infections in the nervous system

### Bacteria

#### Gram-positive

*Clostridium botulinum*

*Clostridium tetani*

*Listeria monocytogenes*

*Streptococcus pneumoniae*

#### Gram-negative

*Haemophilus influenzae*

*Mycobacterium leprae*

*Neisseria meningitidis*

*Treponema pallidum*

### Fungi

*Cryptococcus neoformans*

### Viruses

Measles virus

Poliovirus

Rabies virus

Varicella-Zoster virus

West Nile virus

Arboviruses (western equine encephalitis, eastern equine encephalitis, St. Louis encephalitis, etc.)

### Protozoa

*Naegleria fowleri*

*Toxoplasma gondii*

*Trypanosoma species*

## Case 2.1

A mother brings her baby daughter in to your office for her 12-month set of vaccinations. The baby is scheduled to receive, among others, the **MMR** and the polio immunizations. After the nurse shows the mother, the baby, and the baby's 3-year-old brother to the examining room, she tells the mother to undress the baby except for her diaper. She hands her a blue booklet about the polio vaccine and additional forms about the other vaccines and asks her to read them all.

The baby cries as the mother undresses her. The 3-year-old starts to climb up a chair and reaches for the needle-disposal container, mounted on the wall. The young mother is frazzled; she keeps one hand on the baby lying on the table and tries to scoop up her son with the other. The 3-year old slips out of her grip and bumps. His knee on the corner of the table as he skids to the floor. Now he is crying, too.

The mother never manages to read the vaccination information but she does sign the forms where she is supposed to. When the physician arrives, she checks for the signatures, then performs a thorough examination. On her way out she tells the mother that the nurse will be in to administer the vaccinations.

1. What type of information is contained in all vaccine brochures? Why should they be read before the vaccines are administered?
2. What particular facts are critical for parents to know about the polio vaccine?
3. What other vaccines besides the MMR and polio are appropriate for 1-year-old child?
4. Two forms of the **polio** vaccine are available, the live attenuated version (called the OPV, or oral polio vaccine), and the **killed or inactivated version** (called the IPV, or injectable polio vaccine). Why is the OPV the preferred version for this age?

## Case 2.2.

You are doing a rotation in the hospital's clinical laboratory. A sample of cloudy cerebrospinal fluid (CSF) from a suspected meningitis case arrives and you are told to Gram stain it, and then to plate it on blood agar and **chocolate agar**. In the Gram stain you find gram-negative rods of varying size and shape. You also find a lot of bacteria inside phagocytic cells. They are not diplococci. Colonies grow on both of the plates you inoculated.

Later, the charge nurse tells you that the patient, a 3-year-old girl, has not received any childhood vaccinations.

1. What is the most likely causative organism? Why?
2. Why was the child's unvaccinated status helpful in diagnosis?
3. What is causing the cloudiness in the CSF?
4. What other types of infections can this organism cause in children?

### Case 2.3

You are working in the emergency department of a regional hospital in rural Kentucky. A patient is brought in by emergency medical technicians (EMTs). Their initial report is suspected meningitis because the patient has a headache and stiff neck. The EMTs add that the patient's meningitis symptoms appear rather mild—he still has neck movement, and the headaches are not severe. The patient's overall condition is poor, however. He is very thin, has dark spots on his face and upper body, and open bloody-looking eruptions on his lips. His fever is 104°F and his blood pressure is low. He also has severe diarrhea.

1. What is the first step in determining if the patient has meningitis?
2. This test reveals the presence of very large cells that appear to be eukaryotic, surrounded by a large capsule. What is the probable diagnosis?. Name some other eukaryotic organisms that can cause meningitis symptoms.
3. What groups of people are at risk for this infection?
4. How is it acquired?
5. What anatomical sites are most often infected with this fungus?
6. Let's say your initial suspicion (your answer to question 2) was correct. What other diagnostic test should be performed on this patient?

### Case 2.4

You are an emergency medical technician and are called to the home of Kevin, a 13-week-old boy who has become listless and is having trouble breathing. The parents report that Kevin used to smile, but lately he has not smiled, nor has he had other noticeable facial expressions in the last two days. Kevin's eyes are open when you arrive, but he does not seem to be focusing. You place your out-stretched finger under his fingers and he fails to grasp it. You lift his foot and it drops back to the mattress. The parents report that he has not had a bowel movement in three to four days.

1. What is your suspicion, based on what seem to be nervous system symptoms?
2. If this is indeed the case, do you start treatment here at Kevin's home, or should you transport him to the local hospital?
3. What should be administered to Kevin at the earliest opportunity!
4. How do babies acquire this condition?
5. Although the diagnosis should be confirmed with laboratory tests, the tests should probably not be performed in the hospital lab. Why not?

### Case 2.5

In the winter of 1993, five students from one middle school in Seattle were diagnosed with meningococcal disease. The incidence of the disease had been climbing for two years in that area of Washington State, as well as in the rest of the country, and has continued to climb since then. In the Seattle outbreak, health officials identified one strain of the causative organism that was responsible for the increased incidence.

1. What type of organism would you look for in a Gram stain of blood or cerebrospinal fluid in these cases?
2. What is the organism's **portal of entry** to the host?
3. Could you swab the portal of entry (see question 2) to detect the presence of the organism? Why or why not?
4. What types of symptoms are associated with meningococcal disease?
5. A total of 900 students attend the affected middle school. What measures should have been taken to protect the remaining 895 students from acquiring meningococcal disease?

### Case 2.6

In late July of 2000 the most famous park in the United States, Central Park in New York City, was closed to the public so that it could be sprayed with insecticide to prevent the spread of the West Nile virus. Parks department workers handed out pamphlets titled *Public Health Alert*.

West Nile virus had first been noticed in New York the previous summer and fall. Seven people were killed in that early outbreak, and 55 cases of the illness were confirmed. It had not been seen previously in the United States. As its name suggests, it is normally found in Africa, the Middle East, and western Asia, as well as in parts of Europe.

1. How is West Nile virus transmitted?
2. The virus had another vertebrate host besides humans when it showed up in New York. What was it?
3. Can you list some possible mechanisms for how the virus was introduced into the United States?
4. Most infections result in no noticeable symptoms. Some of those infected may develop a skin rash. A fraction of people infected develop life-threatening encephalitis. What is encephalitis and who do you suppose is most likely to experience this symptom?
5. A sudden increase in a particular disease within a population of humans is called an **epidemic**. What is a large outbreak among animals called?

6. If you lived near Central Park and wanted to go jogging there, what would be the best time of day to avoid the park to minimize your chances of being infected with West Nile virus?

### Case 2.7

In the late 1980s there was an **epidemic** among livestock in Great Britain. Approximately 180,000 cattle were found to have "mad cow disease," so named because the condition attacks the central nervous system, which leads to bizarre behavioral symptoms and often death. The disease seems to be caused by an "unconventional transmissible agent," meaning it is unlike most microorganisms. No genetic material from this organism has ever been detected in infected tissues, although foreign protein fibers accumulate in large concentrations in the brain. Infected cows were still turning up in the late 1990s.

There was great alarm in the late 1990s when dozens of humans starting turning up with symptoms similar to those seen in the cows in the late 1980s. More than 50 people have been diagnosed with the human variant of mad cow disease. This is consistent with the approximately 10-year incubation period of this unconventional transmissible agent. In 1996 scientists confirmed that the same agent was present in affected human and cow brains.

1. What is the name for a transmissible agent that contains only protein and has no genetic material?
2. What is the formal name for mad cow disease? Explain the name.
3. The human form of the disease is called something else. What is it?
4. Scientists suspect that the humans infected during this outbreak acquired the disease from eating meat from diseased animals. Even when meat is well cooked, it transmits the infection. What does this say about the infectious agent?
5. These cases in Britain were not the first cases of the disease; it occurs at a low constant rate in other countries, including the United States. Although some of these sporadic cases can be traced to transplants of infected tissues, such as corneas or brain tissues, most are idiopathic. What does *idiopathic* mean?
6. Livestock control measures have been in place in Britain for several years now. Can we expect more human cases with links to the British cattle epidemic, or is it behind us? Defend your answer.

## Case 2.8

Immediately after you finished the physician's assistant program you took a job at a free clinic in the heart of the City. You always wanted to help society, especially those in the direst of life's circumstances. During your first week, you met Dwight, a 53-year-old overweight white man with several obvious problems. Dwight's feet are cracked and blistered and he has three infected toenails. (He tells you he has been homeless for various periods during the last 10 years). There are seeping sores in the folds of his wrists and under his arms. His gums are bleeding. Dwight is here because he has been greatly confused over the past eight months and it seems to be getting worse. He has episodes of ranting and raving. He reports "feeling crazy" and being very scared. His friends brought him to the clinic and are waiting outside.

The supervising physician quickly joins you in the examining room. Together you examine Dwight thoroughly and make a plan for addressing his pressing needs for wound care. The physician starts asking him about his health history. Dwight reveals very little, saying his memory is very bad. But he talks a lot about his past sexual exploits.

1. The doctor speaks with you in the hallway. He tells you that mental illness is very common among the homeless population. Dwight needs a thorough psychiatric evaluation. The doctor is fairly sure that some of Dwight's neural symptoms are caused by a sexually transmitted infection. Which one? Caused by which microorganism?
2. If the blood test comes back positive, does it mean that Dwight can transmit the disease to others? Explain.
3. Should Dwight be treated with antibiotics to remedy his neural symptoms? Why or why not?
4. The patient's blood test came back positive. For what other infectious disease should he now be tested?
5. The doctor tells you to expect to see more of these cases in the future. But a coworker, who graduated from nursing school 10 years ago, tells you that this disease (especially its later forms) is relatively rare and is decreasing in incidence. Who is right?