Disease Detectives

Part 1: What is wrong with Mike?

Yesterday, Mike Wright developed a severe headache, a high fever, and a stiff neck. Then, he became nauseated and began vomiting. He just wanted medicine to make him feel better and a dark quiet room so that he could sleep. Today, Mike's parents noticed that he was so sleepy that it was difficult to get him to wake up and he seemed confused. They took Mike to the hospital emergency room because they are worried that he is very sick.

1. Read the description of Mike's illness. Complete the "Mike's Symptoms" column in the chart below by putting an "x" in the appropriate boxes to indicate Mike's symptoms.

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Mike's Symptoms</th>
<th>Viral Meningitis</th>
<th>Bacterial Meningitis</th>
<th>Influenza</th>
<th>West Nile Encephalitis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fever</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Headache</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cough</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stiff neck</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nausea and vomiting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light sensitivity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Muscle aches</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confusion</td>
<td></td>
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</tr>
</tbody>
</table>

2. Use the information on the Possible Diseases sheet on the last page of this lab to complete the other four columns in the chart. Note: You may tear this page off to make it easier to complete the chart.

3. Why is it important that doctors determine which disease is causing Mike's symptoms?

4. Based on the information in the chart, what diseases are most likely to be causing Mike's symptoms?
Part 2: Is it Viral or Bacterial Meningitis?

The emergency room doctor found two worrisome symptoms that indicate Mike Wright may have meningitis.

- An inability to straighten his legs when his hips were flexed to 90 degrees.
- Severe neck stiffness that caused his hips and knees to flex when his neck was flexed.

Use the information in the Fact Sheet: Meningitis to answer questions 1 through 4.

1. What is meningitis?

2. Why is it important to determine if Mike has bacterial meningitis or viral meningitis?

3. Which type of meningitis (bacterial or viral) requires immediate treatment with antibiotics?

4. The doctor orders a lumbar puncture to collect the patient's cerebrospinal fluid (CSF).
   - What is a lumbar puncture?
   - What is cerebrospinal fluid (CSF)?
5. You will test the patient’s CSF to determine if Mike has bacterial or viral meningitis. Conduct the tests described on the CSF Testing Procedures sheet in your lab kit.

6. Record the results of the CSF tests in the data table below

<table>
<thead>
<tr>
<th></th>
<th>Glucose</th>
<th>Protein</th>
<th>Most Common White Blood Cells</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mike Wright</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Patient)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Bacterial meningitis</strong></td>
<td>low</td>
<td>high</td>
<td>neutrophils</td>
</tr>
<tr>
<td><strong>Viral meningitis</strong></td>
<td>normal</td>
<td>normal or high</td>
<td>lymphocytes</td>
</tr>
</tbody>
</table>

7. Based on the results of Mike Wright’s CSF tests, what type of pathogen is causing his meningitis—a viral pathogen or a bacterial pathogen?
Part 3: Which Type of Bacteria?

There are three types of bacteria that commonly cause bacterial meningitis:
- *Streptococcus pneumonia (Sp)*
- *Neisseria meningitides (Nm)*
- *Haemophilus influenza (Hi)*

1. Use the information in the Fact Sheet: Meningitis. State two reasons why it is important to know which specific type of bacteria may be causing Mike’s meningitis.

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   - 

Base your answers to questions 2 through 5 on the information in the box below.

An antibody-coated bead test can be used to identify the type of bacteria that are causing the patient’s meningitis. This test uses microscopic beads coated with specific kinds of antibodies that can combine with specific antigens (proteins) on the surface of bacteria. When antigens on the bacteria attach to the antibodies on the beads, the beads will clump together and appear as a white cloudy substance.

2. Explain how the three specific kinds of antibodies (Nm antibodies, Hi antibodies, and Sp antibodies) attached to the beads are different.
3. Explain how the three specific kinds of bacteria (Nm bacteria, Hi bacteria, and Sp bacteria) are different.

4. Explain why Nm bacteria clump together when mixed with beads that are coated with Nm antibodies. Use the words antigen and antibody in your answer.

5. Explain why Hi bacteria do not clump together when mixed with beads that are coated with Nm antibodies. Use the words antigen and antibody in your answer.

6. Follow the instructions below to test the Patient CSF to determine which type of bacteria is causing Mike’s meningitis. Use the Antibody-Coated Bead Test Strip and three tubes of beads (Nm, Sp, and Hi) provided in your kit.
   
   a. Place two drops of antibody-coated beads (Nm beads, Sp beads, or Hi beads) in the appropriate circles on the Antibody-Coated Bead Test Sheet.
   
   b. Place two drops of the Patient CSF into each of the circles on the Antibody-Coated Bead Test Sheet.
   
   c. A cloudy appearance indicates that Patient CSF contains that specific type of bacteria. It is easier to see the cloudy appearance if the test sheet is placed on a dark surface.

7. Which antibody-coated beads turned cloudy when mixed with the Patient CSF?

8. Explain what caused these antibody-coated beads, and not the other antibody-coated beads, to turn cloudy. Use the words antigens and antibodies in your answer.
9. What type of bacteria is causing the patient’s meningitis? Support your answer with evidence from the Antibody-Coated Bead Test.

__________________________________________________________________________________

Use the information in the Fact Sheet: Meningitis to answer questions 10 through 15.

10. State two reasons why meningitis caused by this type of bacteria is considered serious.
   • ____________________________________________
   • ____________________________________________

11. Explain how meningitis bacteria damage the brain. Be specific!

__________________________________________________________________________________

12. What health problems might result from this brain damage? Be specific!

__________________________________________________________________________________

13. What treatments can be used for a patient with this type of meningitis?

__________________________________________________________________________________

14. How could this type of meningitis be prevented?

__________________________________________________________________________________

15. What action should be taken by unvaccinated people who may have been exposed to the bacteria that cause this type of meningitis?

__________________________________________________________________________________
### Possible Diseases

**Viral Meningitis**

Viral meningitis is an infection of the meninges (the covering of the brain and spinal cord) that is caused by a virus. People with viral meningitis usually recover completely without specific treatment.

There are several viruses that can cause viral meningitis. Most viral meningitis cases are caused by enteroviruses that infect the digestive tract. Other viruses that can cause meningitis include the viruses that cause mumps, chicken pox, influenza, and measles.

Viral meningitis infection is characterized by a sudden onset of fever, headache, and stiff neck. It is often accompanied by other symptoms, such as nausea, vomiting, sensitivity to light, and confusion.

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**Bacterial Meningitis**

Bacterial meningitis is a serious and sometimes fatal infection of the meninges (the covering of the brain and spinal cord) that is caused by bacteria. While most people with bacterial meningitis recover, the disease can cause serious complications, such as brain damage, hearing loss, learning disabilities, or even death.

There are several types of bacteria that can cause bacterial meningitis. Common causes of bacterial meningitis include *Streptococcus pneumoniae*, *Neisseria meningitidis*, and *Haemophilus influenzae*.

Early symptoms of meningitis infection include a sudden onset of fever, headache, and stiff neck. Other symptoms may include nausea, vomiting, increased sensitivity to light, and confusion. Later symptoms of bacterial meningitis include seizures and coma.

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**Influenza**

Influenza (the flu) is a contagious respiratory illness caused by influenza viruses that infect the nose, throat, and lungs. It can cause mild to severe illness, and at times can lead to death.

People who have the flu often have a fever, headache, cough, fatigue, and muscle or body aches. Some people also experience vomiting and diarrhea.

Flu is unpredictable, and how severe it is can vary widely depending on the type of virus causing it. Older people, young children, pregnant women and people with certain health conditions (such as asthma, diabetes, or heart disease), and persons who live in facilities like nursing homes may be more at risk for severe flu symptoms.

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**West Nile Encephalitis**

West Nile encephalitis is a potentially serious disease caused by the West Nile virus. This virus is often transmitted by the bite of an infected mosquito. Mosquitoes become infected when they feed on infected birds.

Most people who become infected with the virus will not show any symptoms. However, some people have symptoms such as fever, headache, body aches, nausea, and vomiting. Rarely, infected people experience confusion, coma, tremors, convulsions, muscle weakness, vision loss, numbness and paralysis.
Fact Sheet: Meningitis

Meningitis is an inflammation of the meninges (the thin membranes surrounding the brain and spinal cord). It is usually caused by a viral or bacterial infection.

Viral meningitis is more common than bacterial meningitis, but it is less serious. Viral meningitis usually clears up on its own and does not cause any permanent harm. It can be caused by several types of viruses, including enteroviruses (which cause the stomach flu), the human immunodeficiency virus (HIV), and the virus that causes mumps.

Bacterial meningitis is not as common as viral meningitis, but it is much more serious and requires emergency treatment. Bacterial meningitis can cause brain damage, learning disabilities, hearing loss, or even death.

To diagnose meningitis, doctors will do a lumbar puncture (spinal tap). A lumbar puncture allows the doctor to collect some of the cerebrospinal fluid (CSF) that surrounds the brain and spinal cord. During a spinal tap, patients usually lie on their side curled into a ball. First, the doctor will numb the skin with medication. Patients need to lie very still while the doctor inserts a very thin needle into the spinal column. Fluid is removed and collected in tubes.

After the cerebrospinal fluid is collected, it will be examined under a microscope to see if it contains bacteria, white blood cells, or other substances that indicate inflammation or infection. Usually, by looking at the spinal fluid, a doctor will be able to tell if someone has meningitis. The fluid will also be sent to a laboratory to be tested for bacteria and viruses. Once the doctors know what pathogen is causing the meningitis, they can choose the best medication to treat the infection.
The bacteria that cause bacterial meningitis colonize in the nose and throat. From there they get into the bloodstream and enter the cerebrospinal fluid (CSF) that bathes the brain and spinal cord. This fluid is an ideal medium for the bacteria because it provides nutrients for their multiplication. When the bacteria die, toxins are released. These toxins can damage brain blood vessels and lead to shock or swelling of the brain. White blood cells circulating in the CSF are attracted to the bacteria. These white blood cells may release powerful enzymes that damage brain tissue.

There are several types of bacteria that may cause bacterial meningitis. Therefore, it is important that doctors conduct tests to determine which type of bacteria is causing a patient’s meningitis, so they can select the proper treatment.

One type of bacteria, *Neisseria meningitides*, causes a dangerously contagious and life-threatening type of meningitis. This type of bacterial meningitis is more common in people who are living in a crowded setting, such as a dormitory, school, or child care facility.

Bacterial meningitis caused by *Neisseria meningitides* is very serious and prompt treatment is essential if the patient is to survive. Patients need to be in the hospital during treatment. Strong antibiotic medicine will be given intravenously (through an IV - a thin tube that goes into a vein to give medicine) to get rid of the bacteria. Fluids containing glucose (sugar) and minerals may also be given through the IV to help patients recover.

About 25–30% of people with bacterial meningitis die from it. People who survive bacterial meningitis may have complications including: hearing loss, seizures, cerebral edema (brain swelling), weakness on one side of the body, speech problems, visual impairment or blindness, difficulty coordinating movements, trouble breathing, respiratory arrest, and recurring meningitis.

The Centers for Disease Control (CDC) recommends that children age 11 or older receive the meningococcal vaccine (MCV4) that prevents bacterial meningitis.

Doctors will want to know who was in close contact with a person who has bacterial meningitis. Close contact means living with or spending a lot of time with the person, or sharing the same utensils or cups. This is important because people who have not been vaccinated for bacterial meningitis may need antibiotics for a few days, just in case they were infected with the bacteria.
CSF (cerebrospinal fluid) Testing Procedures

Test for glucose levels - Use the plastic Glucose and Protein Test Sheet:

- Place 2 drops of the patient’s CSF sample in the circle labeled “Use for Glucose Test.”
- Dip the Glucose Test Paper into the CSF sample in the circle.
- Use the Glucose Test Color Chart to determine whether the patient’s CSF glucose level is low, normal, or high.

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| Low Glucose | Normal Glucose | High Glucose |
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Test for protein levels - Use the plastic Glucose and Protein Test Sheet:

- Place two drops of the patient’s CSF sample in the circle labeled “Use for Protein Test.”
- Add two drops of Protein Test Solution to the CSF sample in the circle.
- Use the Protein Test Color Chart to determine whether the patient’s CSF protein level is low, normal, or high.

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| Low Protein | Normal Protein | High Protein |
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White Blood Cell Count:

- Observe the pictures of stained white blood cells in the patient’s CSF sample.
- Refer to the diagrams below that show different types of white blood cells. Identify which type of white blood cell is most common in the patient’s CSF.

**White Blood Cells**

- Lymphocyte
- Monocyte
- Eosinophil
- Neutrophil