Case Study #4

Meningitis
A 14-year old male complained to his parents of feeling quite ill with headache, dizziness, nausea, and feeling very weak. After a rise in his body temperature, an increase in the severity of his headache, and the development of a rash, his mother took him into their medical clinic where he was examined by a family nurse practitioner (FNP). Upon examination, the FNP noted the patient also complained of a stiffness in his neck and nausea. The patient had a temperature of 103.5 and an increased heart rate. She noted a rash had developed on parts of the patient's extremities and wrists. Concerned with meningitis, she consulted the clinic's family practice physician and asked her to examine the patient.
1. What symptoms did the patient exhibit that pointed to meningitis?
Upon his examination, a complete blood count (CBC), blood for culture and lumbar puncture (LP) were performed since there was a strong clinical suspicion of bacterial meningitis. The LP examination included tests for the presence of bacteria (Gram stain), cell count and differential, glucose and protein. A culture of the fluid is also a standard test and detects the type of bacteria, if any, that may be present. Radiology was called to perform a CAT scan on the patient.
2. Which health professional would perform the lumbar puncture?
3. Which health professional would examine the CSF fluid?
4. What is meningitis?
5. What are common symptoms of meningitis?
6. How is bacterial meningitis treated?
7. How do people "catch" meningitis?
8. Have you had a vaccine for a strain of meningitis?
CBC and CSF Results

Interpretation: As we see from the tests above, the patient has an infection of the brain and meninges referred to as meningitis. The blood white cell count is elevated due to the body’s response against the bacterial infection. Analysis of the spinal fluid shows the presence of gram negative, diplococcoid bacteria (Gram stain) and a moderate to high elevation of the number and type of cells in the spinal fluid clearly indicate a bacterial meningitis. Consistent with the findings are decreased glucose and elevated protein levels in the fluid. The bacteria utilize the CSF glucose causing levels to be decreased. Protein is elevated due to increased cellular matter. Fortunately, the intracranial pressure was only slightly elevated since the higher the pressure, the greater risk of damage to brain and possibility of seizures. Values above 300-600 mm are dangerously high. In addition to the potential damage to the brain and meninges by the invading bacteria, there is also the danger of disseminated intravascular coagulation (DIC). Since this is a complex and life-threatening medical condition, blood tests were ordered to assess the risk of DIC in this patient. Essentially, DIC is a complex systemic series of events that leads to widespread bleeding into tissues and organs. Our patient had early DIC as evidenced by the petechial rash. Since early diagnosis and treatment were made, the condition was brought under control early.

<table>
<thead>
<tr>
<th>CBC Value</th>
<th>Patient</th>
<th>Normal Value *</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Blood Cell</td>
<td>24,000 mm³</td>
<td>5000 - 10,000 mm³</td>
</tr>
<tr>
<td>Neutrophiles</td>
<td>87%</td>
<td>65%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spinal Fluid Analysis (Abnormal Results Highlighted in Red)</th>
<th>Test Parameter</th>
<th>Patient</th>
<th>Normal Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Hazy</td>
<td>Clear</td>
<td></td>
</tr>
<tr>
<td>Glucose</td>
<td>16 mg/dl</td>
<td>50-80 mg/dl</td>
<td></td>
</tr>
<tr>
<td>Total Protein</td>
<td>88 mg/dl</td>
<td>15-45 mg/dl</td>
<td></td>
</tr>
<tr>
<td>White Blood Cells</td>
<td>2300 mm³</td>
<td>0-3 mm³</td>
<td></td>
</tr>
<tr>
<td>Cell Differential</td>
<td>96% neutrophiles</td>
<td>0-1 neutrophiles</td>
<td></td>
</tr>
<tr>
<td>Gram Stain (see results)</td>
<td>neutrophiles and gram negative diplococci</td>
<td>no bacteria should be present. CSF is a sterile fluid</td>
<td></td>
</tr>
<tr>
<td>Intracranial Pressure</td>
<td>174 mm/H2O</td>
<td>&lt; 140 mm/H2O</td>
<td></td>
</tr>
</tbody>
</table>
9. Which CBC and spinal fluid parameters are indicative of bacterial meningitis?
From the information provided, coupled with the patient's clinical symptoms, the diagnosis of acute bacterial meningitis was made by the medical team. The morphological characteristics of the bacteria and the clinical picture strongly suggests an infection due to *Neisseria meningitidis*.

The patient was administered intramuscular antibiotic therapy, as well as a steroid medication called dexamethasone to reduce inflammation around the brain and its associated seizure risk. The patient was promptly admitted to the hospital's critical care unit. Bacterial meningitis is a serious, life threatening disease that requires prompt and intensive therapy. The rash seen on initial exam are called *petechiae*. 
10. Why are steroids used to treat patients with meningitis?
11. What procedure has greatly reduced the incidence of bacterial meningitis?
12. How long must infectious airborne precautions be maintained after the start of antibiotics?
13. What causes the petechial rash in meningitis?

Case Questions
Once the patient had been admitted to the hospital's critical care unit, intravenous fluids were started. Included were penicillin G, steroids, and essential fluid and nutrient replacements. Nursing care is intensive to include monitoring neurologic parameters for seizures, blood pressure, temperature, fluid replacement, administration and others.

The neurologist ordered a standard radiograph (X-ray), as well as a computerized axial tomograph (CAT) scan of the patient's cranium to determine the extent of swelling caused by the inflammatory presence of the bacteria.
14. Can you explain how a CAT scan works?
15. Why would a physician request a CAT scan over an X-ray?
16. Why would an X-ray be ordered over a CAT scan?

Case Questions
48 hours after the lumbar puncture, spinal fluid and blood cultures confirmed the presence of *Neisseria meningitidis*.

The patient responded well to all medications and supportive care. He was kept in the hospital's intermediate care unit for several days and then discharged.

**Note:** Since bacterial meningitis is a highly infectious disease and poses a public health threat, states require physicians to immediately report the case to departments of public health. A state or county **epidemiologist**, individuals trained to follow community diseases, follow standard protocols set forth by the Centers for Disease Control to assure proper follow-up with individuals that have been in close contact with the patient. Close contacts are defined as individuals who may have had contact with the patient's saliva through kissing, sharing drinking straws and a number of other interactions. These are usually household members and girlfriends/boyfriends. In these cases, the close contacts must be treated with prophylactic (preventative) antibiotics and closely watched for signs of the disease. Since the patient attended a school, the local health agency, usually the county health department, sends a notification to parents as a precaution. Such notices advise the parents of signs and symptoms of meningococcal meningitis and encourage the parent to seek medical care for their child quickly if the child exhibits any one of those symptoms.
17. Which health professional would be responsible for running the tests to detect bacterial meningitis?
Symptoms include fever, increased heart rate, headache, rash, stiffness in neck, and nausea.

Physician

Clinical Laboratory Scientist

Meningitis is an infection of the fluid of a person’s spinal cord and the fluid that surrounds the brain. People sometimes refer to it as spinal meningitis. Meningitis is usually caused by a viral or bacterial infection.

High fever, headache, stiff neck.

Antibiotics given early in the course of the disease.

Through respiratory and throat secretions. It may be spread through coughing or kissing. It is not as contagious as the common cold or other easily spread diseases.

Most children are now given the Hib vaccine which protects against a strain of bacteria that causes meningitis in children. Another common vaccine, the pneumococcal vaccine, protects elderly people against a strain of meningitis they are most susceptible to.

CBC: WBC is elevated


To reduce inflammation and swelling around the brain. This reduces the chance of seizures.

Vaccination

24 hours

Hemorrhage

A series of x-ray beams from many different angles are used to create cross-sectional images of the patient’s body. The computer assembles these images into a three-dimensional picture.

Organs, bones, and tissues can be displayed in great detail in a three-dimensional picture in a CAT scan. An X-ray only shows a single dimension. Much more can be seen from a CAT scan.

In many cases, an X-ray picture is all that is needed. It is significantly more inexpensive than a CAT scan.

Clinical Laboratory Scientist

Case Answers
Pinpoint, round spots that appear on the skin as a result of bleeding under the skin. The bleeding causes the petechiae to appear red, brown or purple. Petechiae commonly appear in clusters and may look like a rash. Usually flat to the touch, petechiae don't lose color when you press on them (non-blanching).

Petechiae are tiny, usually measuring less than an eighth of an inch (about 3 millimeters). Larger varieties of these types of spots are called purpura. Petechiae may indicate a number of conditions, ranging from minor blood vessel injuries to life-threatening medical conditions.

What is Petechiae?
DIC is a serious disorder in which the proteins that control blood clotting become abnormally active.

- Normally when you are injured, certain proteins in the blood become activated and travel to the injury site to help stop bleeding. However, in persons with DIC, these proteins become abnormally active. This often occurs due to inflammation, infection, or cancer.
- Small blood clots form in the blood vessels. Some of these clots can clog up the vessels and cut off blood supply to various organs such as the liver, brain, or kidney. These organs will then be damaged and may stop functioning.
- Over time, the clotting proteins are consumed or "used up." When this happens, the person is then at risk for serious bleeding, even from a minor injury or without injury. This process may also break up healthy red blood cells.

Disseminated Intravascular Coagulation