

Acute Lymphocytic Leukemia

Case #7

Leukemia is a cancer of white blood cells. In an acute leukemia, the abnormal cells divide rapidly, quickly overtaking functional white and red blood cells. The most common form of cancer in children 0-14 years of age is acute lymphocytic leukemia (ALL). The survival rate in children has improved more than 50% in the last half century. Currently there is a 65.3% overall survival rate; in children under 5 the survival rate increases to 90.4%. Come experience the cancer journey with 6-year-old Noah.

Case Objectives

- 1) After reviewing the blood unit of the cardiovascular system in the text, and completing the Acute Lymphocytic Leukemia case, the student should be able to:
 - a. Define hemopoiesis.
 - b. Describe the origin and development of blood cells.
 - c. Define the tissue where blood cells are formed before and after birth.
 - d. List the 5 types of circulating leukocytes and describe their microscopic appearance and function.
- 2) After reviewing the medical terminology links in the case study, the student should be able to define the following terms: anemia, leukopenia, leukocytosis, lymphoblast, thrombocyte, blasts, blood-brain barrier, hypercellularity, meninges, pneumonia, pus, petechiae, remission, upper-lobe infiltrate, transfusion, cytochemical stains, immunologic marker studies.
- 3) After reviewing the CBC diagnostic testing site, the student should be able to:
 - a. Define CBC, WBC, RBC, Hb, Hct, and platelets.
 - b. List 5 pathological conditions that may cause an elevation in the WBC count.
- 4) After reviewing the diagnostic testing in the case to include throat culture, bone marrow aspirate, lumbar puncture, and chest x-ray, the student should be able to:
 - a. Define the principle of the test.
 - b. Describe when the test is indicated.
 - c. Describe how the test is performed.
 - d. Summarize the diseases that can be diagnosed by the test.
- 5) Review the gram stain link and:
 - a. Define the two groups of bacteria differentiated by a gram stain.
 - b. Discuss why the gram stain is an important first step in the identification of a pathogen.
- 6) After reviewing the leukemia link, the student should be able to:
 - a. List the 4 major types of leukemia.

- b. Define the predominant age group of each type of leukemia.
 - c. Describe the difference between a lymphocytic and a myeloid leukemia.
 - d. Describe the difference between an acute and chronic leukemia.
 - e. Describe how an acute leukemia is treated differently than a chronic leukemia.
 - f. List possible risk factors of leukemia.
 - g. Describe the clinical symptoms of leukemia.
 - h. Describe the procedures used to diagnose leukemia.
- 7) Review the following treatments for leukemia: chemotherapy, radiation, bone marrow transplant.
- a. Define the principle of the treatment.
 - b. Describe how the treatment is given.
 - c. Discuss the benefits and side effects of treatment.
- 8) After reviewing the health professional links and the case study, discuss the role of the following health care professionals in diagnosing and/or treating a patient with leukemia:
- a. physician to include the following physician specialties: pediatrician, oncologist, radiation oncologist, pathologist, and radiologist.
 - b. clinical laboratory scientist
 - c. registered nurse
 - d. radiology technician
 - e. respiratory therapist



Noah, 6 years old, was brought back to his pediatrician three weeks following a streptococcal throat infection. His mother was worried that the Strep infection had not cleared up as the child was still complaining of a sore throat and had been very lethargic.

The physician noted that the child looked quite pale. The child's throat was still red, although the [pus](#) and [petechiae](#) previously noted with the Strep infection were absent. Ears and chest appeared to be clear although the child cried and seemed to be in pain when the doctor pressed on the sternum. Upon further examination, the physician noted that the child's spleen felt slightly enlarged, as did the lymph nodes. He noted that the child had multiple bruises over his lower extremities. Upon questioning, the mother commented that the child had been experiencing excessive nosebleeds. The physician ordered a [CBC](#), and a [throat culture](#).

- 1) *What symptoms did Noah exhibit?*
- 2) *Are Noah's symptoms consistent with a Strep infection?*

The results of the laboratory tests were returned the following day.

Preliminary Throat Culture Report

CBC Results

- 3) *Which health professional is responsible for performing Noah's laboratory tests?*
- 4) *What abnormalities were present in the laboratory tests?*
- 5) *Which health professional would Noah's pediatrician be most likely to consult with?*

Upon receiving the results, the physician informed the stunned mother that her child had leukemia and would need to be admitted to the hospital for further testing and treatment.

- 6) *Define leukemia.*
- 7) *What is the difference between a chronic and acute leukemia? How do the symptoms differ?*
- 8) *What are the four most common types of leukemia? In which age groups is each most predominantly found?*
- 9) *What are the common symptoms of leukemia?*
- 10) *What tests help a physician diagnose a leukemia?*

After admission to the hospital, Noah was referred to a pediatric oncologist, a doctor who specializes in pediatric diseases of the blood. The oncologist ordered a bone marrow aspirate.

Bone Marrow Smear Results

- 11) *What is a bone marrow procedure?*
- 12) *What abnormality in Noah's bone marrow smear was suggestive of a Leukemia?*

Cytochemical stains were ordered as well as immunologic marker studies. Both studies pointed to an acute lymphoblastic leukemia (ALL) type L1.

Instructor's notes:

Cytochemical stains and immunologic marker studies are advanced testing methods used to differentiate leukemias. The student is not expected to have an in depth understanding of either testing method but should be exposed to both.

A spinal tap was ordered to see if the leukemic cells had crossed the blood/brain barrier. There were many lymphoblasts in the spinal fluid. In ALL the leukemic cells are often harbored in the meninges.

- 13) *What is a spinal tap or lumbar puncture?*
- 14) *Why is a lumbar puncture performed?*
- 15) *What is cerebral spinal fluid?*
- 16) *What chemicals or constituents can be measured from the cerebral spinal fluid?*

Noah was started on [chemotherapy](#) which would kill as many of the cancer cells as possible. He was also given a [transfusion](#) of 2 units of packed red blood cells to help alleviate his anemic condition. Noah was released from the hospital but continued chemotherapy treatments weekly. After 3 weeks of chemotherapy treatments, Noah developed a fever of 102°F. Examination revealed coarse breath sounds in the right anterior chest. An order was sent to the radiology technician for a series of [chest radiographs](#).

- 17) *What is chemotherapy? How is it given? What are some of the side effects of chemotherapy?*
- 18) *Why did Noah develop a fever?*
- 19) *Why would the physician order a chest x-ray?*
- 20) *What is a chest x-ray?*
- 21) *What abnormalities can be detected from a chest x-ray?*

Chest x-ray results

A sputum culture was obtained and sent to the lab for [gram stain](#), culture, and sensitivities.

Gram stain and culture report

- 22) *What health care professional is responsible for gram stain and culture testing?*
- 23) *A gram stain differentiates bacteria into what two classes?*
- 24) *Why would an immunocompromised patient be more susceptible to disease?*

Noah was again admitted to the hospital and started on antibiotics to treat a gram negative [pneumonia](#). After 10 days of aggressive antibiotic therapy, another set of chest x-rays were ordered

Chest x-ray results

- 25) *What is pneumonia? What can pneumonia be caused by?*
- 26) *What is the difference between Noah's initial and final chest x-ray?*
- 27) *Which health care professionals worked together to diagnose and treat Noah's pneumonia? Define each role.*

CBC and Bone Marrow Aspirate Results

- 28) *Do Noah's CBC and Bone marrow aspirate results indicate he is making progress? Base your answer on specific results.*

Noah was now in [remission](#). Two weeks after achieving complete remission, Noah visited a radiology oncologist who administered [radiation therapy](#) to the spinal column. Radiation therapy was necessary to insure all leukemic cells harbored in the meninges were eradicated.

- 29) *What is radiation therapy?*

Noah continued maintenance chemotherapy treatments for two years. A CBC and bone marrow were performed at the end of two years.

CBC Results

Bone Marrow Results

30) *What evidence can be noted in the CBC and Bone Marrow results to indicate Noah is in remission?*

Eight years later, Noah is free of any signs of leukemia and is living a normal life.

Answers to Case Questions

Question 1

Symptoms include pallor, bone tenderness, enlarged spleen and lymph nodes, bruising, bleeding (nosebleeds).

Question 2

Symptoms are not consistent with a Strep infection.

Question 3

Clinical Laboratory Scientist

Question 4

Elevated WBC count, decreased RBC, Hct, and platelet count. Decrease in normal White Blood Cells; elevated abnormal White Blood Cells (blasts).

Question 5

Pediatric oncologist.

Question 6

Leukemia is a cancer of the blood. A large number of abnormal blood cells are produced which do not function properly.

Question 7

In *acute leukemia*, the abnormal blood cells are blasts that remain very immature and cannot carry out their normal functions. The number of blasts increases rapidly, and the disease gets worse quickly. In *chronic leukemia*, some blast cells are present, but in general, these cells are more mature and can carry out some of their normal functions. Also, the number of blasts increases less rapidly than in acute leukemia. As a result, chronic leukemia gets worse gradually.

In acute leukemia, symptoms appear and get worse quickly. People with this disease go to their doctor because they feel sick. In chronic leukemia, symptoms may not appear for a long time; when symptoms do appear, they generally are mild at first and get worse gradually. Doctors often find chronic leukemia during a routine checkup--before there are any symptoms.

Question 8

Acute lymphocytic leukemia (ALL) is the most common type of leukemia in young children. This disease also affects adults, especially those age 65 and older.

Acute myeloid leukemia (AML) occurs in both adults and children.

Chronic lymphocytic leukemia (CLL) most often affects adults over the age of 55. It sometimes occurs in younger adults, but it almost never affects children.

Chronic myeloid leukemia (CML) occurs mainly in adults. A very small number of children also develop this disease.

Question 9

Symptoms include:

- a. Fever, chills, and other flu-like symptoms;
- b. Weakness and fatigue;
- c. Frequent infections;
- d. Loss of appetite and/or weight;
- e. Swollen or tender *lymph nodes, liver, or spleen*;
- f. Easy bleeding or bruising;
- g. Tiny red spots (called *petechiae*) under the skin;
- h. Swollen or bleeding gums;
- i. Sweating, especially at night; and/or
- j. Bone or joint pain

Question 10

CBC, bone marrow smear, cytochemical stains, immunologic marker studies.

Question 11

A bone marrow procedure (commonly referred to as a bone marrow or bone marrow aspiration) is a technique used to obtain the blood-forming portion (marrow) of the inner core of bone for examination in the laboratory or for transplantation. The bone marrow consists of inserting a special needle into a bone that contains marrow and withdrawing the marrow by suction or coring out a sample of the marrow.

Question 12

A preponderance of one cell line, blasts.

Question 13

A lumbar puncture (an LP) is the insertion of a needle into the fluid within the spinal canal. It is termed a "lumbar puncture" because the needle goes into the lumbar portion (the "small") of the back.

Question 14

Diagnostic purposes: obtain a sample of spinal fluid for examination. Therapeutic purposes: administer antibiotics, cancer drugs or anesthetic agents.

Question 15

The CSF circulates around the brain and spinal cord (the central nervous system). This "water bath" acts as a support of buoyancy for the brain and spinal cord. The support of the CSF helps to protect the brain from injury.

Question 16

Protein, glucose, cell count and pressure.

Question 17

Chemotherapy is treatment with drugs to kill cancer cells. Drugs are generally administered through an I.V. (intravenously) and given in cycles. Side effects differ depending upon the drugs used and the patient. Side effects may include fatigue, bleeding or bruising, loss of appetite, nausea and vomiting, hair loss, or mouth sores.

Question 18

A fever is a symptom of a possible infection.

Question 19

The physician suspects a pneumonia, which can be detected on a chest x-ray.

Question 20

A chest x-ray is a radiology test that involves exposing the chest briefly to radiation to produce an image of the chest and the internal organs of the chest.

Question 21

Abnormalities of the lungs including: pneumonia, bronchitis, asthma, cysts, and cancers.

Abnormalities of the heart including: fluid around the heart, enlarged heart, heart failure, abnormal anatomy. Broken chest bones.

Question 22

Clinical Laboratory Scientist

Question 23

Gram positive and gram negative bacteria.

Question 24

An immunocompromised patient has a depressed immune system, and is unable to mount a response to disease.

Question 25

An infection that occurs when fluid and cells collect in the lungs. Pneumonia can be caused by bacteria, viruses, and other pathogenic organisms. It can also be caused by chemicals or other irritants.

Question 26

Noah's initial chest x-ray showed infiltrates (a cloudy area) indicative of a pneumonia. His final chest x-ray was clear indicating a clearing of the infection.

Question 27

A nurse or respiratory therapist collected a sputum sample for culture. A clinical laboratory scientist performed the gram stain and culture on the sample and issued a report. A radiology technician performed a chest x-ray. A radiologist read the x-ray and issued a report. The physician ordered antibiotics to treat the pneumonia based on the x-ray and culture reports. Respiratory therapists administered and monitored oxygen, monitored blood gas levels, and administered chest physiotherapy.

Question 28

Different cell lines are represented in the CBC and Bone Marrow smear instead of just one abnormal one. This indicates that progress is being made.

Question 29

Radiation in high doses is aimed at tumors or specific areas of the body containing disease.

Question 30

Normal cell values and normal cell lines are present.

Health Professionals Introduced in this Case

[Hematology/Oncology](#)

[Pathology](#)

[Pediatrics](#)

[Respiratory Therapist](#)

[Radiation Oncology](#)

Health Professionals Previously Introduced

[Physician](#)

[Radiology](#)

[Clinical Laboratory Scientist](#)

[Nursing](#)

[Radiology technician](#)

Additional sites of interest:

[National Cancer Institute](#)