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Pediatric Leukemia: Diagnosis to Treatment–A Review

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Abstract

Leukemia is cancer of the blood and bone marrow, it is the most common cancer found in children and is found to be more than one fourth of pediatric cancers. It causes white blood cells to become abnormal and the body to become weak. This deficiency in the immune system reduces the body's ability to fight infection or simple airborne illnesses, causing extensive treatment of common pathogens and cancer treatment. The present review covers all topics, from diagnosis to treatment of pediatric leukemia, as well as the stages of growth and physiological changes throughout the process. As leukemia has a high mortality rate the chances of survival are low. Discussion on survival rate will be breached and thoroughly deciphered. We also included the topic of treatment and at which point patients may be considered terminal or advanced. By approaching these points, we better understand leukemia (from a scientific standpoint) and its properties throughout the course of treatment.

Keywords: Pediatric leukemia; Diagnosis; Treatment; Bone marrow cancer

Introduction

Pediatric leukemia is one of the deadliest cancers, with one of the highest mortality rates throughout the globe. There are two major types of pediatric leukemia, Acute Lymphocytic (ALL) and Acute Myelogenous (AML). When a child has ALL, fully mature white blood cells are not able to form properly, therefore the patient is not able to fend off illnesses (such as the common cold) well and may become terminal from such ailment. White blood cells help us fight off infection. In the case of leukemia patients, white blood cells form abnormally and stem cells turn into lymphoblast (leukemia cells). This causes backlash on the body by decreasing the number of red blood cells and platelets the bones can produce. Red blood cells are the main reason for blood clotting, infection resistance, and iron retention [1-3]. Without functional red blood cells, heavy bleeding from a simple wound or anemia is possible.

An excess of myoblasts in the body causes acute myelogenous leukemia. Myoblasts, like lymphoblast are abnormally produced white blood cells that cause fast acting deterioration in patients. Since children's bodies are still growing and becoming accustomed to variations, leukemia in children tends to be acute and often becomes advanced/terminal. Chronic leukemia is generally diagnosed in patients who have reached adulthood and are no longer physically growing.

Signs, Symptoms, and Stages

Other diseases or other internal problems may cause the signs and symptoms of pediatric leukemia. Symptoms of pediatric leukemia may include anemia, weakness, feeling cold, pale skin, and shortness of breath. Symptoms are more prominent from low white blood cell counts. Low white blood cell count may cause infections, fevers, and low immunity. If a child gets an infection, and it persists over a long period of time, or gets one infection after another, it could be a symptom of childhood leukemia. The cancerous cells fight of the normal cells that protect the body's immunity. With low immunity comes more infection and inflammation. Joint pain and the swelling of the exterior of the stomach are caused by the collection of leukemia cells along the surface. Due to this, symptoms may impact appetite and weight. Swollen lymph nodes suggest a widespread of inflammation, but very inflamed lymph nodes can suggest that there is cancer in the body. Gradual inflammation occurring in different parts of the body may also display signs of cancer. The last sign of pediatric leukemia is extreme fatigue and weakness. In this case, leukemia cells have bombarded the blood circulation and they become so thick that they deplete blood flow to other organs, but most importantly to the brain. Although some of the symptoms associated with pediatric leukemia may be symptoms of other diseases, a doctor must examine those symptoms for the disease to be treated correctly.

Leukemia cells populate so quickly that the stages of leukemia are divided into sub-types. Acute leukemia is staged based on the types of cells involved and the appearance of the cells microscopically. Lymphocytic types of leukemia occur in lymphocytes. In this case, the white blood count is taken in to consideration. Due to the quick production of white blood cells in leukemia, specialists can detect the stage of the leukemia based on how many white blood cells are present around specific organs such as the spleen or the liver. Another type of leukemia is myeloid leukemia, where the diagnosis is based on the number of immature white blood cells, which can be found in either the bone marrow or in the blood [2].

Epidemiology

In the United States, about 16,000 children between the age of 0 and 19 are diagnosed with some form of cancer [4-6]. However, because pediatric cancers are diagnosed early, the survival rates are higher. Doctors recommend that children get regular check-ups so that no sign is overlooked concerning the development of recurring symptoms. Although the cause for cancer is unknown, genetics play a

role in children developing cancer. More than about 40,000 children undergo treatment for cancer annually [4]. Children that are 6 years old are on average diagnosed the most as shown in (Figure 1) [7-9].

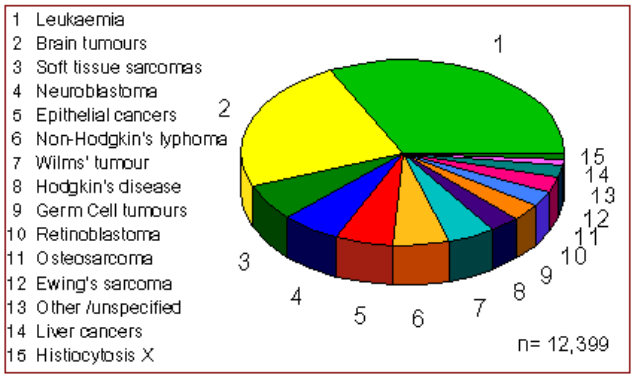

Figure 1: Pediatric Leukemia Statistics.

The Treatments of Childhood Acute Lymphoblastic Leukemia (Pediatric Leukemia)

There are different types of treatments for children with acute lymphoblastic leukemia that are accessible. The treatments presently used are radiation and chemotherapy, while other treatments must be tested in clinical trials. Clinical trials for treatment develop the existing treatments and gain more information for new treatments. An expert team of doctors who have the best knowledge of the childhood leukemia symptoms must plan all treatments. A pediatric oncologist is a specialized doctor in childhood leukemia, who works with other health professionals that have authority on treating children with leukemia. The health professional team should include: Pediatrician, Hematologist, medical oncologist, pediatric surgeon, radiation oncologist, neurologist, pathologist, radiologist, pediatric nurse specialist, child-life specialist and psychologist [3,9].

The three phases of pediatric leukemia treatments

1. Remission induction: it is the first phase of pediatric leukemia treatment. The purpose is killing the leukemia cancer cells in the blood and bone marrow, which placed the leukemia into a cancer reduction.
2. Consolidation/intensification therapy: it is the second phase of pediatric leukemia treatment. It starts after the leukemia is in the remission phase. The purpose is killing any leukemia cancer cells that remained in the body and it may lead to retrogression.
3. Maintenance: it is the third phase of pediatric leukemia treatment. The purpose is killing leukemia cancer cells that might regrow and to prevent retrogression. Frequently, the leukemia treatment is provided in lower doses, which are lower than the dosage during the remission induction and consolidation/intensification therapy phases. In this phase, if the medication is not taken, as it should, it can increase the chance for the cancer to come back. This phase is also considered as the continuation therapy phase [3].

The four standard treatment types of pediatric leukemia

Since leukemia may affect red and white blood cells and platelets as well, doctors must do their diagnoses based on physical exams and history, complete blood count with differential, blood chemistry studies and bone marrow aspiration and biopsy. These types of testing are helping the treatment determination options:

1. Chemotherapy is the most common cancer treatment that uses drugs to stop the cancer cells from growing either by stopping the division or by killing the cancer cells. Intrathecal chemotherapy can be used for treating leukemia that has spread or may reach the spinal cord or the brain.
2. Radiation therapy is one of the cancer treatments that use high-energy radiation like x-rays to kill cancer cells or stop the growth of cancer cells. The therapy has two radiation types; external radiation therapy that uses machines from outside of the human body to send radiation toward cancer cells, and internal radiation therapy that uses a radioactive substance bolted in seeds, wires, needles, or catheters which are placed near or inside cancer cells. Radiation therapy depends on the type of cancer that is needed to be treated.
3. Chemotherapy with stem cell transplant includes giving high doses of chemotherapy and replacing the bad blood-forming cells. The therapy is about removing stem cells from the bone marrow or the blood of a donor; the stem cells will be given to the patient through an infusion.
4. Targeted therapy uses drugs or similar substances to distinguish and offensive specific cancer cells only without any negative effect on normal cells. Targeted therapy drugs are such as Tyrosine Kinase Inhibitors (TKIs) and Monoclonal antibody therapies [5].

The clinical trials can be done to help cancer from coming back or reducing the side effects of the cancer treatments. All the treatment and clinical trials in the first place are depending on the prognosis and the doctor's orders for treatments. Risk factor is any risk that increase the opportunity of getting a disease but it doesn't mean that will be a cancer. Risk factor may include, exposing to radiation, past treatment of chemotherapy, smoking, or eating contaminated food. Pediatric leukemia is so expansive to treat and also depends on the type, phase and the stage of the treatment. It is extremely costly so often times the government gives free Medicare for people who cannot afford it [5,6].

Discussion and Conclusion

Understanding the key differences (or similarities) of Acute Lymphocytic and Acute Myelogenous Leukemia is the first step towards not only increasing awareness but also decreasing mortalities due to these cancers. The continued awareness of these diseases in every aspect allow us to further research to advance medical procedures, develop technologies, and not least importantly further research into areas that would have been out of reach to us. For example, the team of Thomas Pabst and Linda Kurtz recently published a study concerning the role lipids might play in "the heterogeneity and outcome of disease".

Prior research that discovered certain lipids being lower in presence in the cells of AML; also, coupled with the fact that most research is being exhausted in understanding signalling cascades, was the primary motive behind their research. Their work took them into studying several plasma lipids concluding that there are various lipids that are considerably altered in patients suffering from AML. Total cholesterol,

phospholipids, sphingolipids, and cholesterol esters emphasize to the range of the altered lipid profile. Specifically, eicosanoids (a class of hormone like fatty acids produced from arachidonic acid) positively correlate to not only a strong indication of the disease; however, it also positively correlates to the severity of the disease.

Not to be all negative, the study also discovered that a lipid indicated plasma PGF2α may act as a marker at the time of diagnosis for limited disease severity. The furthered advancement doesn't just stop with our continued understanding of AML or Acute Lymphocytic Leukemia (ALL). A study by Man, Morris and Keng provides a comprehensive review of all the new therapeutic strategies in ALL. Last year alone (2016) 171,500 people were expected to be diagnosed with some form of Leukemia; subsequently, tens of thousands of people die from this disease every year. With continued research and understanding we can hopefully, not only decrease the amount of people dying from this disease but maybe, the amount of people who have it.

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