Hello. My name is ZoAnn Dreyer. I’m a pediatric oncologist at Texas Children’s Cancer Center. Today we’re going to talk about childhood cancer, epidemiology, diagnosis, and treatment.
The objectives are that you should learn the most common pediatric cancers and their prevalence, and describe the prognosis for each of these common cancers.
Fifteen thousand children less than twenty years of age in the United States, or the equivalent of two classrooms a day, are diagnosed with cancer each year. By the age twenty, one child or adolescent in three hundred and thirty is diagnosed with cancer. Surprisingly survival rates have risen from five percent to eighty percent overall in the last fifty years.
However, cancer remains the leading cause of non-accidental death. More children die each year from cancer than from asthma, diabetes, cystic fibrosis, congenital abnormalities, and AIDS combined.
While the causes of cancer are not clear, we feel that most childhood cancers are actually spontaneous. Few are related to the environmental or familial risk factors, but we do know there are some risk factors to be concerned about, ionizing radiation, such as Hiroshima, certain immune deficiency disorders, a number of genetic conditions, including Down Syndrome, and in particular, and we have learned more about family history, or genetic predispositions within family cancer syndromes.
The distribution of childhood cancer is much different than that we see in adult cancer. ALL, or acute lymphoid leukemia, represents about thirty percent of childhood cancer, is by far the most common cancer. Central nervous system tumors, or brain tumors, are the second most common and represent a wide variety of presentations. Lymphomas, somewhat related to leukemia, represent ten percent. Neuroblastoma, a tumor of the adrenal gland, and Wilms tumor, a tumor of the kidneys, and acute myeloid leukemia, are much less common.
When we look at this curve, we see that mortality in the decreasing lines continues to improve over time if you look from the 1970s and up until the 2010. However, if you see the white bars, you’ll see that cure rates, or survival rates, continue to improve, and perhaps the best example is represented by the red line for acute lymphoid leukemia, from which mortality was extremely was high in the ‘60s and ‘70s, and, in fact, now it rarely causes death. The survival rates perhaps are the best in acute lymphoid leukemia of any of the cancers that we see.
There are three main subtypes of childhood leukemia, acute lymphoid leukemia, or ALL, acute myeloid leukemia, and very, very rarely the chronic leukemias -- CML and JCML. These leukemias are much more common in adults and quite rare in pediatrics.
Acute lymphoid leukemia is the most common childhood cancer, and there are about three to four cases per hundred thousand children. There are about 2,000 new diagnoses per year.
The symptoms for ALL can be quite vague. It may be persistent fever for a few weeks. It may be bone pain, or limping without a really good reason or cause. Sometimes children will present with swollen lymph nodes because the bone marrow is replaced by the leukemic cells. The blood cells are not made normally so the platelets may be low, causing bleeding, bruising. They may be quite anemic and have evidence of pallor, and, in fact, often times the liver and the spleen are quite enlarged with evidence of active leukemia. ALL is a fairly rapid onset disease, and typically these symptoms will have been present for maybe six to eight weeks, maybe twelve weeks. This is not something that a child will have had for a year before they’re finally diagnosed.
These slides are two representations of what the leukemic blasts look like. ALL blasts have very little cytoplasm, a very large nucleus, and sometimes have nucleoli, which you can see. Generally if you look at the bone marrow, a test taken with a needle from the hip, the marrow will be replaced by these very monotonous-looking cells. You may also sometimes see these cells in the peripheral circulation, as in this slide where you see the red cells. Also, they’re very similar in appearance.
There are many different things we do to diagnosis what subtype of ALL we’re working with. First of all, we look at the slides. We look at a bone marrow aspirate, and a peripheral blood smear, and we look under the microscope. We then do cytochemical markers, which help us to distinguish lymphoid blasts from myeloid blasts in leukemia cells, and the different subtypes of ALL. We also do a thorough cytogenetic or chromosomal analysis of the leukemic cells. Leukemic cells take on their own chromosomal picture, which is a sort of a fingerprint of that particular leukemia for that particular child. That’s very helpful. There are certain chromosomal features that are quite common in certain types of ALL. Lastly, we do an immunophenotype by what we call “flow cytometry.” This is a technique where all of those cells are put through a fancy machine called “a flow cytometer.” Immunophenotypic markers that are specific to the different types of ALL, and the different types of AML, will appear and that really helps to finalize our diagnosis, because the critical element is to be clear on what type of leukemia you have and what subtype of leukemia you have. Overall, childhood ALL cure rates have improved dramatically. In the ‘60s only five percent of children with ALL were cured.
Today, in 2015, close to ninety-five percent in some groups of children will be cured. Generally it’s eighty to ninety percent. There are different risk categories based on age at diagnosis, less than ten years is better; total white count at diagnosis, less than fifty thousand is better; and certain chromosomal markers that may actually put you into what we call “the lower risk group.” Those children have a cure rate of greater than ninety-five percent; standard risk, the greatest population, cure rates of eighty to ninety percent, and high-risk patients somewhere between seventy, to eighty, to eighty-five percent. So cure rates for childhood ALL are spectacular in today’s world.
AML, or myeloid leukemia, is a much less common type of childhood leukemia, and represents only about twenty percent of the childhood leukemias. It is much more rare, and it is much more difficult to treat and cure. There are only about five hundred cases each year. These kids are treated with short, intensive chemotherapy, and frequently, if they’re intermediate to high risk, will undergo a bone marrow transplantation, either from a matched sibling, or a matched, unrelated donor. That seems to have the biggest impact on cure rates. With chemotherapy alone in the good risk groups in AML, the cure rates are about fifty to sixty percent, so still obviously not nearly as good as ALL. For patients who undergo a matched sibling related bone marrow transplant, the cure rates range from sixty to sixty-five percent, so we have a long way to go with myeloid leukemia, but, in fact, we are seeing improvements over time.
The lymphomas are the third most common type of cancer, represent two different categories. There’s Hodgkin’s disease, which is what people typically think of as lymphoma, large knots in the neck, large lumps under the arms, and non-Hodgkin’s lymphoma. There are a variety of subtypes of non-Hodgkin’s Lymphoma, each of which are treated in a somewhat different way. However, generally speaking, all of the lymphomas have excellent cure rates, between eighty to ninety-five percent. Generally Hodgkin’s Disease has the shortest therapy and the best cure rates, even in high stage disease.
There are certain symptoms that are common to the lymphomas. Swollen lymph nodes are classically what we think about. Some patients, who have lymph nodes swollen in the chest, or a large mass in their chest, will actually present with shortness of breath, cough, and wheezing. They are sometimes misdiagnosed actually as having pneumonia or asthma, so it’s very important in a patient like that that you go ahead and get a chest X-ray to be sure whether you have a mass or not. Some patients will present with persistent fevers, with weight loss, with night sweats, and those are called “B symptoms.” Patients with Hodgkin’s lymphoma, in particular, that have these types of symptoms, will tend to have a little bit harder disease to cure, but still overall good cure rates.
Central nervous system tumors in childhood cancer are the second most common cancer. They represent a large range of tumors from benign to much more aggressive, malignant tumors. There are benign tumors, low-grade tumors, which include the astrocytomas, and high-grade tumors, such as medulloblastoma and glioblastoma multiforme, the most difficult brain tumor to treat and cure. The prognosis is widely varied.
Patients with brain tumors tend to have prolonged symptoms in many cases. They may have persistent severe headaches, which, of course, is not an uncommon finding in pediatrics. They may present with vomiting, especially in the morning, which is an uncommon finding in pediatrics, and represents increased intracranial pressure when the children have been laying down overnight. Sometimes parents will look back and say, “You know, his personality really started to change about six months ago,” or perhaps even behavior changes or changes in grades in school. Visual changes are fairly common, including double vision or an in turning of one eye. Generally that is because the mass is compressing one of the cranial nerves. There may be weakness on one side of the body, or even a gait disturbance that may be subtle, or may be quite obvious.
This is an MRI of a picture of a child with a brain tumor in the hypothalamic region, and as we know, the brain has a lot of space for a mass to grow before symptoms occur, so generally brain tumors in pediatrics are quite large by the time the diagnosis is made.
The treatment includes a variety of things. Nearly every patient will have surgery if that tumor is in an area that is safe to approach surgically. We now use chemotherapy, and even stem cell transplant for some of the more aggressive brain tumors. Radiation therapy is really a mainstay of the treatment for central nervous system tumors. And now we have even newly directed immunotherapy techniques, where we can actually target just the tumor cell. So brain tumor therapy has changed dramatically over the years, when we used to just have surgery and only radiation.
The prognosis is widely varied, depends on how much tumor is removed, what sort of tumor markers or biological features are specific to that tumor, and how old the child is. The sequelae of the therapy for the long-term survivor of a brain tumor can be quite significant. Generally these patients will tend to have significant neuropsychological issues, particularly if they were young when they received high dose radiation. They may have hormonal complications because of the central hormonal control mechanisms within the brain which are damaged by radiation, and, of course, clearly physical symptoms. Because we’re removing a large tumor from the brain they may remain hemiparetic, or have a weakness on one side of the body. They may continue to have visual problems. It just really depends on the location of the tumor.
Neuroblastoma has been one of our biggest challenges in childhood cancer, and represents about eight percent of childhood cancer. It’s generally of neural crest origin, particularly a mass above the adrenal gland. About half of the children who are diagnosed are less than two at the time of diagnosis, and certainly ninety percent less than the age of ten. What’s very unique to neuroblastoma is most children over the age of one will present with widespread, multifocal disease, no matter what their clinical symptom is. They may have one small mass that you can palpate, but when you do the scans you’ll see that multiple areas within the bony skeleton have been involved by the tumor. The prognosis is highly dependent on the age at diagnosis. Those less than the age of one generally do quite well, even with widespread disease. The tumor markers, the histology, there are certain features that make it favorable and certain that make it unfavorable, again, very important prognostically. There are tumor markers that are very, very important. One is called “MYCN,” and MYCN is a tumor marker that can be amplified in certain tumors, and those tumors are much harder to treat and cure. And, of course, the stage, how widespread, and how much you can resect is very important. Interestingly, in infants, there is a type of neuroblastoma described which will present and then spontaneously regress in infants, so that is a unique characteristic specific to neuroblastoma.
The symptoms in these children are a variety of different things. They may present with lumps in the head and neck, a large abdomen, which generally the parents are the first to find. They may present with what we call “dancing eyes,” where the eyes are kind of gyrating, or have opsodonus. They may present with owl’s eyes, or dark, black eyes, and that’s evidence of infiltration with the neuroblastoma cells. Tragically, some patients will present with spinal cord symptoms, with a large spinal cord mass, which causes weakness, difficulty walking, perhaps loss of bowel and bladder control. Those are definitely oncologic emergencies, because you need to intervene quickly to avoid long-term paralysis. Other symptoms that go along with the chemicals that come from this tumor include sweating, flushing, high blood pressure, sometimes diarrhea. So these are a variety of the different ways that neuroblastoma could present to the pediatrician.
This is a bone scan of a classic patient with neuroblastoma, and you can see with all these arrows that the disease is multifocal. It has spread really throughout the skeleton.
Wilms tumor is a less common tumor representing about six percent of childhood cancer. It most commonly presents in the kidney and, in fact, is the most common kidney tumor in children. The majority of children are diagnosed between the ages of three to four, and it may frequently be associated with congenital abnormalities, Beckwith-Wiedemann syndrome, hemihypertrophy, a number of other congenital syndromes. Occasionally it is bilateral, affecting both kidneys. The prognosis is generally quite good, though based on histology generally favorable versus unfavorable.
Most commonly these children present with a large abdominal mass that the parents will notice. They typically do not have any symptoms from that. Occasionally there can be bleeding into the tumor so they may be anemic, and the patients may present with high blood pressure because of the compression of the tumor on the kidneys.
This is a picture of a child with a bilateral Wilms tumor, and you can see that both kidneys are largely involved.
Childhood Cancer: Conclusions

- Rare
- Typically spontaneous with no clear cause
- Highly treatable and curable in most cases
- Majority of patients treated on research based collaborative protocols

In conclusion, childhood cancer is extremely rare. It’s typically spontaneous with no clear cut cause. It’s highly treatable and highly curable in most cases, and the majority of patients are treated on research based collaborative protocols which are shared among childhood cancer research institutions around the country. That is the reason that pediatric oncology patients have continued to improve over time.