OVERVIEW OF CHILDHOOD CANCER

MODULE #1

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LEARNING OUTCOMES

- Identify the basic principles of cancer and its causes
- Compare the differences between childhood and adult cancers
- Describe methods for diagnosing childhood cancer
- Discuss the most common types of cancers in infants, children, and adolescents
- List different modalities used to treat pediatric malignancies
WHAT IS CANCER?

- Cancer occurs when there is an uncontrolled growth of abnormal cells.
- Cancer cells divide and grow in an unregulated way and can crowd out healthy cells.
- Cancer cells can start growing in almost any part of the body and sometimes spread to other areas. This process is called **metastasis**.

Fundamentals of Cancer (NCI, 2015)
WHAT IS CANCER?

Healthy Cells
- Perform specific functions throughout the body
- Grow and divide as the body needs them
- Go through programmed cell death when they are old or damaged and are replaced by new healthy cells

Cancer Cells
- Are unable to perform specific functions in the body
- Do not grow and divide in a well-organized way
- Fail to go through programmed cell death when they are old or damaged. New cells are produced even when they are not needed
Cancer begins when the DNA in normal cells is permanently damaged.

Damage to oncogenes and/or tumor suppressor genes of cancer cells impact how cells grow, divide, and die.

Some children have genetic disorders that put them at an increased risk for cancers.

Rarely, childhood cancers are linked to environmental exposures such as:

- Radiation
- Viruses
- Pesticides
- Chemicals

Charity gifts for children with cancer foundation Vanessa Isabel (Wilfredor, 2013)
HOW COMMON IS CHILDHOOD CANCER?

- Childhood cancer comprises 0.5%-4.6% of all cancers worldwide.
- Cancer is diagnosed each year in about 225,000 children worldwide.
- >80% of these children live in low and middle-income countries.

Global distribution of childhood cancer by region (World Bank Databank, 2012)
Learning Activity

Answer each statement as true or false

- Cancer occurs when there is uncontrolled growth and division of cells
- Healthy cells live forever, but cancer cells die too quickly
- Cancer cells can still perform functions as well as normal healthy cells
- Oncogenes and tumor suppressor genes help control how cells grow, divide and die and can be impacted by DNA damage
Learning Activity Answers

Mark each statement as TRUE or FALSE

- Cancer occurs when there is uncontrolled growth and division of cells  TRUE
- Healthy cells live forever, but cancer cells die too quickly  FALSE
- Cancer cells can still perform functions as well as normal, healthy cells  FALSE
- Oncogenes and tumor suppressor genes help control how cells grow, divide and die and can be impacted by DNA damage  TRUE
DIFFERENCES IN CHILDHOOD CANCER & ADULT CANCER

**Childhood Cancers**
- Better overall response and survival rates
- Children tend to tolerate treatment therapies better
- Genetic changes that cause cancer are more likely due to mutations that occur early in the child’s life as cells are rapidly dividing

**Adult Cancers**
- Worse overall outcomes and survival rates
- Adults tend to have more difficulties with treatment and have more comorbidities
- Genetic changes are more often due to lifestyle choices (tobacco/alcohol use), environmental exposures, and age
**CLASSIFICATIONS OF CHILDHOOD CANCERS**

<table>
<thead>
<tr>
<th>Childhood cancer is not one disease, but a group of diseases that can be classified into either <strong>hematologic malignancies</strong> or <strong>solid tumors</strong>.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tumors are often named based on the type of tissue that they are made of or the area of the body where they develop.</td>
</tr>
</tbody>
</table>
## COMMON CHILDHOOD CANCERS

### Hematologic Malignancies
- Leukemia (blood/bone marrow)
- Lymphoma (lymph)

### Solid Tumors
- Central Nervous System (CNS) Tumors (brain/spine)
- Neuroblastoma (sympathetic nervous system)
- Rhabdomyosarcoma (muscle)
- Wilms Tumor (kidney)
- Ewing Sarcoma/Osteosarcoma (bone)
- Retinoblastoma (eye)

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Acute lymphoblastic leukemia smear (Grellier, 2013).
HOW IS CHILDHOOD CANCER DIAGNOSED?

- Physical exam
- Bone marrow aspiration and biopsy
  - Evaluates the cells in the bone marrow
- Lumbar puncture
  - Evaluates the cells in the cerebrospinal fluid
- Diagnostic imaging
  - X-rays, CTs, MRIs
- Laboratory testing
  - Complete blood counts, chemistry panels, liver/kidney function testing

Bone marrow aspiration and biopsy (NCBI, 2015)
A 4-year-old girl comes to the emergency department with her mother. She is pale, has bruising and petechiae on her arms and legs, and has a low-grade fever. The mother tells the nurse that her daughter has been very tired and complaining of leg pain for the last 3 weeks. Dr. Le orders a complete blood count, which shows peripheral blasts.

- What are some possible diagnoses for this patient?
- Dr. Le suspects the patient has leukemia. What other diagnostic testing might Dr. Le order for this patient?
Learning Activity
Using the word bank, complete the following sentences

• Childhood cancers can be classified into ____________________ and ______________.

• Ewing's sarcoma and osteosarcoma are both cancers that affect the ____________.

• Leukemia is a hematologic malignancy that affects the ___________ and ____________.

• __________ and __________ may be used when diagnosing childhood cancer.

WORD BANK  hematologic malignancies  laboratory testing  bone
solid tumors  bone marrow aspiration  blood
bone marrow
Learning Activity Answers
Using the word bank, complete the following sentences

• Childhood cancers can be classified into hematologic malignancies and solid tumors.

• Ewing’s sarcoma and osteosarcoma are both cancers that affect the bone.

• Leukemia is a hematologic malignancy that affects the blood and marrow.

• Laboratory testing and bone marrow aspiration may be used when diagnosing childhood cancer.
**Leukemia** is a cancer of the blood and blood forming organs, including the bone marrow, lymph nodes and spleen.

- Occurs as a result of abnormal growth of immature blood cells (lymphoblasts or myeloblasts)

*What is leukemia? (West Cancer Center & Research Institute, 2020)*
<table>
<thead>
<tr>
<th>Type</th>
<th>Timing of Development</th>
<th>Cell Line Affected</th>
<th>Frequency seen in children (HIC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute Lymphoblastic Leukemia (ALL)</td>
<td>Acute</td>
<td>Lymphoid • Further classified as T-cell or B-cell based on type of lymphoid cell affected</td>
<td>75-80% of childhood leukemias</td>
</tr>
<tr>
<td>Acute Myelogenous Leukemia (AML)</td>
<td>Acute</td>
<td>Myeloid</td>
<td>15-20% of childhood leukemias</td>
</tr>
<tr>
<td>Chronic Lymphoblastic Leukemia (CLL)</td>
<td>Chronic</td>
<td>Lymphoid</td>
<td>Very rarely seen in children</td>
</tr>
<tr>
<td>Chronic Myelogenous Leukemia (CML)</td>
<td>Chronic</td>
<td>Myeloid</td>
<td>&lt;5% of childhood leukemias</td>
</tr>
</tbody>
</table>
Lymphoma is a group of tumors that begin in immune system cells (lymphocytes).

The abnormal lymphocytes gather in one or more lymph nodes or lymph tissue causing a tumor.

The two major classifications of lymphoma are:

- Hodgkin lymphoma
- Non-Hodgkin lymphoma
Learning Activity
Match each statement to the correct disease (leukemia or lymphoma)

- Two major classifications are Hodgkin and Non-Hodgkin
- Caused by abnormal growth of immature lymphoblasts or myeloblasts
- Can cause tumors in lymph nodes or lymph tissues
Learning Activity Answers
Match each statement to the correct disease (leukemia or lymphoma)

- Two major classifications are Hodgkin and Non-Hodgkin
  - lymphoma

- Caused by abnormal growth of immature lymphoblasts or myeloblasts
  - leukemia

- Can cause tumors in lymph nodes or lymph tissues
  - lymphoma
SOLID TUMORS: CENTRAL NERVOUS SYSTEM (CNS) TUMORS

- **CNS tumors** occur in the brain or spinal cord
- Tumors can be malignant or benign
- CNS tumors are named for:
  - The location in the brain
  - The type of cell they derive from

Brain tumors in children. (CureSearch. 2020)
SOLID TUMORS: **NEUROBLASTOMA**

- **Neuroblastoma** starts in the neural crest cells that make up the sympathetic nervous system.
- Commonly originates in the adrenal gland, but can also occur in the neck, chest, abdomen or pelvis.
- Graded using the International Neuroblastoma Risk Group Staging.
Rhabdomyosarcoma arises from primitive cells that turn into striated skeletal muscle tissue.

Primary tumor can be almost anywhere in the body.

Two main cell types:
- Alveolar
- Embryonal
SOLID TUMORS: WILMS TUMOR

- Also referred to as “nephroblastoma”
- Primary tumor arising from the kidney
  - May occur in both kidneys (stage V)
- Tumors are typically large, rapidly growing, and vascular
- Two histologic cell types
  - Favorable histology
  - Anaplastic
**Ewing Sarcoma**
- Arises from marrow space of long bones or nearby soft tissue
- Occurs most commonly in adolescents
- Most common sites:
  - Pelvis, femur, upper extremities, vertebrae, ribs, clavicle

**Osteosarcoma**
- Primary malignant tumor of the bone
- Arises from precursor cells that form fibrous tissue, cartilage, or bone
- Most common sites are the distal ends of long bones

SOLID TUMORS: **EWING SARCOMA & OSTEOSARCOMA**

Osteosarcoma. (Biermann, 2014)
Retinoblastoma is a tumor of the retina

Caused by an abnormal division of retinoblasts resulting in an intraocular mass

Can be unilateral or bilateral

Signs include leucokoria or a cat’s eye reflex, which can be seen in the picture to the right.

Retinoblastoma. (NHS, 2018)
Learning Activity
Answer each statement as **TRUE** or **FALSE**

- Neuroblastoma is a type of tumor originating in the brain
- Ewing sarcoma and osteosarcoma both commonly affect long bones
- Retinoblastoma can occur unilaterally or bilaterally
- All CNS tumors are malignant
- Rhabdomyosarcoma can develop almost anywhere in the body
Learning Activity Answers
Answer each statement as **TRUE** or **FALSE**

- Neuroblastoma is a type of tumor originating in the brain **FALSE**
- Ewing sarcoma and osteosarcoma both commonly affect long bones **TRUE**
- Retinoblastoma can occur unilaterally or bilaterally **TRUE**
- All CNS tumors are malignant **FALSE**
- Rhabdomyosarcoma can develop almost anywhere in the body **TRUE**
TREATMENT MODALITIES FOR CHILDHOOD CANCER

- Chemotherapy
- Radiation
- Biotherapy
- Surgery
- Hematopoietic Stem Cell Transplant (HSCT)

(Sackley, 2016)
CHEMOTHERAPY

- Medication that works by killing rapidly dividing cells
- May work by preventing the cell from dividing or killing the cell directly
- Can be given as an injection, intravenously, by mouth or into spinal fluid
- Chemotherapy can be given alone or in conjunction with other therapies (radiation, HSCT, surgery)
Uses radiation beams to target and kill cancer cells directly, by causing irreparable damage to the DNA of cancer cells

- Not all cancers are sensitive to radiation
- Can be used alone, or in combination with other modalities
- May be used in emergency situations to shrink tumor prior to other treatments or for palliative care

(Brain Tumour Research, 2017)
Also referred to as immunotherapy

There are multiple different mechanisms of action, but overall biotherapies work by either suppressing or stimulating the body’s immune system

Some biotherapies are targeted to specific marker on the outside of cells (e.g. monoclonal antibodies)

Sometimes biotherapies are used to lessen side effects of other cancer treatments (e.g. GCSF)

Biotherapies can be given orally, subcutaneously or intravenously
The physical removal of a tumor. Surgery may be a part of the treatment plan that also includes other modalities such as chemotherapy or radiation.

Other types of surgeries include:
- Biopsies (to determine tumor type)
- Resection (full or partial)
- Functional (supportive care, palliation)

(Stix, 2016)
HEMATOPOIETIC STEM CELL TRANSPLANT (HSCT)

- Also referred to as a **bone marrow transplant**
- Involves killing damaged, destroyed, or malfunctioning cells with high dose chemotherapy and/or total body irradiation and then replacing them with healthy cells
- Cells may be from a donor (allogeneic) or from the patient (autologous)
Learning Activity

Match the treatment modality to the correct statement

- **Surgery**
  - May be allogeneic or autologous

- **Chemotherapy**
  - Can be used for biopsy, resection or for functional purposes

- **Biotherapy**
  - Can be used in emergencies or for palliative care

- **HSCT**
  - Medication that works by killing rapidly dividing cells

- **Radiation**
  - Works with the body’s immune system to fight cancer
Learning Activity Answers
Match the treatment modality to the correct statement

- **Surgery**: Can be used for biopsy, resection or for functional purposes
- **Chemotherapy**: Medication that works by killing rapidly dividing cells
- **Biotherapy**: Works with the body’s immune system to fight cancer
- **HSCT**: May be allogeneic or autologous
- **Radiation**: Can be used in emergencies or for palliative care
CHILDHOOD CANCER KEY TAKEAWAYS

- Cancer occurs when there is an uncontrolled growth of abnormal cells
- Causes of childhood cancer include genetic and environmental factors
- Childhood and adult cancers differ in response, outcomes, and etiology
- There are many tools and treatments used to diagnose, treat, and cure childhood cancers