Introduction to Pediatric Neoplasms

FCDS EDUCATIONAL WEBCAST SERIES
STEVEN PEACE, BS, CTR / MAYRA ESPINO, BA, RHIT, CTR
JANUARY 17, 2013
Program Outline

- Introduction
- Types of Pediatric Neoplasms
- Signs and Symptoms
- Causes and Risk Factors
- MPH Rules – Solid Tumors
- MPH Rules – Heme/Lymph Neoplasms
- Staging Pediatric Tumors
- Collaborative Stage Data Collection System
- Treatment Options
- Future Webcasts
- Q&A
Introduction

SEER Delay-Adjusted Incidence and US Mortality
All Childhood Cancers, Under 20 Years of Age
Both Sexes, All Races, 1975-2007

- Delay-Adjusted Incidence
- Mortality

Year of Diagnosis/Death
Rate per 100,000
Introduction

Figure 3. Five-Year Relative Survival Rates for Acute Lymphoblastic Leukemia in Children Under 15 Years, 1964-2006

# Introduction

## Building on 50 Years of Cooperative Research

## Pediatric Clinical Trial Enrollment

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Enrollment Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 and younger</td>
<td>&gt; 90%</td>
</tr>
<tr>
<td>10 and younger</td>
<td>75-90%</td>
</tr>
<tr>
<td>10 to 15</td>
<td>50%</td>
</tr>
<tr>
<td>Adolescents aged 15 to 19</td>
<td>15-25%</td>
</tr>
</tbody>
</table>
Introduction

Building on 50 Years of Cooperative Research

1940s

Remission achieved in pediatric leukemia patients using an antifolate drug, aminopterin
Introduction

Building on 50 Years of Cooperative Research

1950s

- 6-mercaptopurine treats pediatric acute lymphoblastic leukemia
- Combination chemotherapy introduced by NCI researchers
- NCI begins funding pediatric cooperative clinical trials
Introduction

1960s

• Dactinomycin first used to treat Wilms tumor
• National Wilms Tumor Study Group formed and multi-modality therapy first used in pediatric patients (surgery, radiation, chemo)
• Prophylaxis of occult central nervous system leukemia markedly improves outcome for children with ALL
• Laminar airflow technology creates "sterile rooms" for chemotherapy patients
Introduction

1970s

- Intergroup Rhabdomyosarcoma Study Group Committee pioneers repetitive-course, multi-agent chemotherapy for advanced rhabdomyosarcoma
- First successful bone marrow transplant (BMT) for leukemia
- Knudson describes the 2-hit hypothesis for retinoblastoma to describe genetics and heredity of cancer
**1980s**

- First tumor-suppressor gene, in retinoblastoma, is cloned
- MYCN identified as a target of genomic amplification in neuroblastoma
- Adjuvant chemotherapy improves relapse-free survival for pediatric osteosarcoma
- Different treatment for lymphoblastic lymphoma vs other lymphomas are realized
- Platinum-based chemo improves response rates in pediatric germ cell tumors
- National Marrow Donor Program begins
1990s

- Autologous BMT and 13-cis-retinoic acid improve survival for neuroblastoma
- Characteristic fusion genes identified for pediatric solid tumors
- Combined ifosfamide and etoposide improve outcomes for Ewing sarcoma
- Long-term survival rates of 80-90% achieved for advanced Burkitt lymphoma
- Genetic test for thyroid cancer enables prophylactic thyroidectomy before age 2
- NCI-funded Childhood Cancer Survivors Study begins
Introduction

2000s

- Four legacy research groups merge as the Children's Oncology Group (COG)
- COG publishes long-term follow-up guidelines for pediatric cancer survivors
- Imatinib added to intensive chemotherapy improves early outcomes for Ph+ ALL
- 5-year survival rates for children with cancer (age 0-14 years) approach 80%
Introduction

Annual Average Childhood Cancer Survival Rates for Childhood and Youth (Ages 0 - 19)

<table>
<thead>
<tr>
<th>Cancer Type</th>
<th>Survival Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute Lymphoblastic Leukemia</td>
<td>87%</td>
</tr>
<tr>
<td>Acute Myeloid Leukemia</td>
<td>60%</td>
</tr>
<tr>
<td>Hodgkin’s Lymphoma</td>
<td>94%</td>
</tr>
<tr>
<td>Non-Hodgkin’s Lymphoma</td>
<td>81%</td>
</tr>
<tr>
<td>Central Nervous System</td>
<td>75%</td>
</tr>
<tr>
<td>Neuroblastoma</td>
<td>70%</td>
</tr>
<tr>
<td>Retinoblastoma</td>
<td>99%</td>
</tr>
<tr>
<td>Kidney Tumours</td>
<td>91%</td>
</tr>
<tr>
<td>Liver Tumours</td>
<td>68%</td>
</tr>
<tr>
<td>Osteosarcomas</td>
<td>62%</td>
</tr>
<tr>
<td>Ewing’s Sarcoma</td>
<td>67%</td>
</tr>
<tr>
<td>Rhabdomyosarcomas</td>
<td>77%</td>
</tr>
<tr>
<td>Germ Cell Tumours</td>
<td>88%</td>
</tr>
</tbody>
</table>

Survival rate for all diagnostic groups or types of childhood cancer

Data from Canadian Cancer Society Report on Cancer in Children and Youth Ages 0–19, 2008
Pediatric Cancer Research
Pediatric Cancer Registries

Childhood Cancer Awareness
Children’s Oncology Group

The world's childhood cancer experts

COG includes more than 250 institutions in the United States, plus others in Canada, Australia, the Netherlands, Switzerland, and New Zealand.

http://cancer.gov/
Childhood Cancer Survivor Study

- Diagnosis 1970-1986
- 20,000 person cohort
- Survival at least 5 years
- Chance for long-term effects increase over time
- > 70% at least 1 chronic illness related to treatment
- > 25% have 3 or more chronic illnesses related to tx

http://cancer.gov/
Childhood Cancer Survivor Study

- Kidney Disease
- Second Cancers
- Cognitive Dysfunction
- Cardiovascular Disease
- Endocrine Abnormalities
- Musculoskeletal Conditions

Long-Term Active Follow-Up is CRITICAL...

http://cancer.gov/
## Childhood Cancer Survivor Study

<table>
<thead>
<tr>
<th>Health Effects</th>
<th>Predisposing Therapy</th>
<th>Clinical Manifestations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral/dental</td>
<td>Any chemotherapy in a patient who has not developed permanent dentition</td>
<td>Dental maldevelopment (tooth/root agenesis, microdontia, root thinning and shortening, enamel dysplasia)</td>
</tr>
<tr>
<td></td>
<td>Radiation impacting oral cavity and salivary glands</td>
<td>Salivary gland dysfunction</td>
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<tr>
<td></td>
<td></td>
<td>Xerostomia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accelerated dental decay</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Periodontal disease</td>
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<tr>
<td>Thyroid</td>
<td>Radiation impacting thyroid gland</td>
<td>Hypothyroidism</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hyperthyroidism</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thyroid nodules</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>Radiation impacting cardiovascular structures</td>
<td>Subclinical left ventricular dysfunction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cardiomyopathy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pericarditis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heart valve dysfunction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Conduction disorder</td>
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<td></td>
<td></td>
<td>Coronary, carotid, subclavian vascular disease</td>
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<tr>
<td></td>
<td>Anthracycline chemotherapy</td>
<td>Myocardial infarction</td>
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<tr>
<td></td>
<td></td>
<td>Stroke</td>
</tr>
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<td></td>
<td></td>
<td>Congestive heart failure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subclinical left ventricular dysfunction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cardiomyopathy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Congestive heart failure</td>
</tr>
</tbody>
</table>
# Childhood Cancer Survivor Study

## Pulmonary
- Radiation impacting the lungs
- Bleomycin
- Subclinical pulmonary dysfunction
- Pulmonary fibrosis

## Musculoskeletal
- Radiation of musculoskeletal tissues in any patient who is not skeletally mature
- Glucocorticosteroids
- Bone mineral density deficit
- Growth impairment
- Osteonecrosis

## Reproductive
- Alkylating agent chemotherapy
- Gonadal irradiation
- Infertility
- Hypogonadism

## Immune
- Splenectomy
- Overwhelming post-splenectomy sepsis

## Subsequent neoplasm or disease
- Alkylating agent chemotherapy
- Epipodophyllotoxins
- Radiation
- Myelodysplasia/acute myeloid leukemia
- Myelodysplasia/acute myeloid leukemia
- Solid benign and malignant neoplasms

http://cancer.gov/
Pediatric Cancer Registries

- COG – Childhood Cancer Research Network
- CDC NPCR – National Childhood Cancer Registry
- FAPTP – Florida Consortia Pediatric Cancer Registry
- Cancer Site/Type Specific Registries
- Bone Marrow Donor Registries
- National Children’s Study
- Other
Florida Association of Pediatric Tumor Programs

FAPTP
and
The Florida Pediatric CCOP
Member Directory

3650 Spectrum Blvd, Suite 100, Tampa, FL 33612
(813) 396-9528 (813) 910-5928 Fax
faptp@epi.usf.edu flccop@epi.usf.edu
www.faptp.org

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*Member of the Florida Pediatric Community Clinical Oncology Program-CCOP
**Member only of the Florida Pediatric Community Clinical Oncology Program

Source: FAPTP
Types of Pediatric Neoplasms
# Major Types of Pediatric Neoplasms

| Childhood Cancer Incidence Rates (SEER) by ICCC Group 2001-2004 – All Sex, All Race |
|---------------------------------|---------|
| Leukemia                        | 44.2    |
| Brain/CNS                       | 27.4    |
| Lymphoma                        | 23.2    |
| Soft Tissue                     | 12.0    |
| Germ Cell                       | 11.8    |
| Bone                            | 8.9     |
| Neuroblastoma                   | 7.6     |
| Renal                           | 6.0     |
| Retinoblastoma                  | 3.0     |

*Note: Rates are per 1,000,000 population*

http://cancer.gov/
Major Types of Pediatric Neoplasms

- Lymphoid Neoplasms
  - Hodgkin Lymphoma
  - Non-Hodgkin Lymphoma
  - Acute Lymphocytic Leukemia

- Myeloid Neoplasms
  - Myeloid Leukemia Associated with Down Syndrome
  - Chronic Myeloid Leukemia
  - Acute Myeloid Leukemia

http://cancer.gov/
Major Types of Pediatric Neoplasms

- **Brain and CNS – Non-Germ Cell Tumors**
  - Astrocytoma
  - Glioblastoma
  - Ependymoma
  - Medulloblastoma
  - PNET – Primitive Neuroectodermal Tumor

- **Brain and CNS – Germ Cell Tumors**
  - Atypical Teratoid/Rhabdoid Tumor
  - Mixed Germ Cell Tumor
  - Embryonal Tumor

http://cancer.gov/
Major Types of Pediatric Neoplasms

Source: http://www.montekids.org/services/neurosurgery/neurologicaldisorders/brain_tumor/
Major Types of Pediatric Neoplasms

Source: http://www.vivo.colostate.edu/hbooks/pathphys/endocrine/hypopit/anatomy.html
### Major Types of Pediatric Neoplasms

#### Pediatric Sarcoma

<table>
<thead>
<tr>
<th>Sarcoma – Bone</th>
<th>Sarcoma – Connective/Soft Tissue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ewing Sarcoma – Undifferentiated pPNET</td>
<td>pPNET – PNET with Neural Differentiation</td>
</tr>
<tr>
<td>Osteosarcoma</td>
<td>Rhabdomyosarcoma</td>
</tr>
<tr>
<td>Odontogenic Sarcoma</td>
<td>Lymphangiosarcoma</td>
</tr>
<tr>
<td>Chondrosarcoma</td>
<td>Fibrosarcoma</td>
</tr>
</tbody>
</table>

#### Ewing Family of Tumors

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>9473/3</td>
<td>PNET</td>
<td>Brain/CNS</td>
</tr>
<tr>
<td>9364/3</td>
<td>pPNET</td>
<td>Soft Tissue</td>
</tr>
<tr>
<td>9365/3</td>
<td>Askin Tumor</td>
<td>Soft Tissue</td>
</tr>
<tr>
<td>9260/3</td>
<td>Ewing Sarcoma</td>
<td>Bone</td>
</tr>
<tr>
<td>9260/3</td>
<td>Ewing Sarcoma – Extra Osseous</td>
<td>Soft Tissue</td>
</tr>
</tbody>
</table>

Major Types of Pediatric Neoplasms

Childhood Soft Tissue Sarcoma Treatment (PDQ®)

<table>
<thead>
<tr>
<th>National Cancer Institute at the National Institutes of Health</th>
<th>Age &lt;5 Y</th>
<th>Age 5–9 Y</th>
<th>Age 10–14 Y</th>
<th>Age 15–19 Y</th>
<th>% of the Total Number of STS Cases &lt;20 Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other specified soft tissue sarcomas</td>
<td>198</td>
<td>220</td>
<td>512</td>
<td>856</td>
<td>38</td>
</tr>
<tr>
<td>Ewing tumor and Askin tumor of soft tissue</td>
<td>22</td>
<td>28</td>
<td>57</td>
<td>81</td>
<td>4</td>
</tr>
<tr>
<td>pPNET of soft tissue</td>
<td>21</td>
<td>19</td>
<td>29</td>
<td>42</td>
<td>2.4</td>
</tr>
<tr>
<td>Extrarenal rhabdoid tumor</td>
<td>37</td>
<td>3</td>
<td>8</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Liposarcomas</td>
<td>5</td>
<td>6</td>
<td>22</td>
<td>66</td>
<td>2</td>
</tr>
<tr>
<td>Fibrohistiocytic tumors</td>
<td>53</td>
<td>69</td>
<td>172</td>
<td>293</td>
<td>12</td>
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<tr>
<td>Leiomyosarcomas</td>
<td>13</td>
<td>19</td>
<td>22</td>
<td>57</td>
<td>2.4</td>
</tr>
<tr>
<td>Synovial sarcomas</td>
<td>12</td>
<td>39</td>
<td>133</td>
<td>204</td>
<td>8.3</td>
</tr>
<tr>
<td>Blood vessel tumors</td>
<td>15</td>
<td>7</td>
<td>11</td>
<td>33</td>
<td>1.4</td>
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<tr>
<td>Osseous and chondromatous neoplasms of soft tissue</td>
<td>1</td>
<td>5</td>
<td>9</td>
<td>16</td>
<td>0.6</td>
</tr>
<tr>
<td>Alveolar soft parts sarcoma</td>
<td>3</td>
<td>7</td>
<td>19</td>
<td>26</td>
<td>1</td>
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<tr>
<td>Miscellaneous soft tissue sarcomas</td>
<td>16</td>
<td>18</td>
<td>31</td>
<td>35</td>
<td>2</td>
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<tr>
<td>Unspecified soft tissue sarcomas</td>
<td>70</td>
<td>58</td>
<td>136</td>
<td>163</td>
<td>9</td>
</tr>
</tbody>
</table>

pPNET = peripheral primitive neuroectodermal tumors; SEER = Surveillance Epidemiology and End Results.
*Dermatofibrosarcoma accounts for 75% of these cases.
Major Types of Pediatric Neoplasms

- Langerhans Cell Histiocytosis
- Retinoblastoma
- Neuroblastoma
- Wilms Tumor
- Melanoma
Major Types of Pediatric Neoplasms

Age-Adjusted and Age-Specific Cancer Incidence Rates for Patients 0-19 Years of Age (SEER 2005-2009)

0-14 Years:
- 31.1% Leukemia
- 25.4% CNS
- 10.0% Lymphomas
- 6.1% Neuroblastoma
- 4.7% Renal
- 2.5% Retinoblastoma
- 4.4% Bone tumors
- 1.5% Hepatic
- 6.6% Soft tissue
- 3.4% Germ cell
- 0.3% Other
- 4.0% Carcinomas and Melanoma

15-19 Years:
- 20.7% Lymphomas
- 18.7% CNS
- 13.8% Leukemia
- 12.3% Germ cell
- 6.8% Soft tissue
- 6.2% Bone tumors
- 0.7% Renal
- 0.6% Hepatic
- 0.4% Neuroblastoma
- 0.3% Other
- 19.6% Carcinomas and Melanoma

http://cancer.gov/
Signs and Symptoms

C ontinued, unexplained weight loss
H eadaches, often with early morning vomiting
I ncreased swelling or persistent pain in bones, joints, back, or legs
L ump or mass, especially in the abdomen, neck, chest, pelvis, or armpits
D evelopment of excessive bruising, bleeding, or rash
C onstant infections
A whitish color behind the pupil
N ausea which persists or vomiting without nausea
C onstant tiredness or noticeable paleness
E ye or vision changes which occur suddenly and persist
R ecurrent or persistent fevers of unknown origin

http://www.ped-onc.org/diseases/SOCC.html
Causes and Risk Factors

- Genetic Abnormalities
- Ionizing Radiation Exposure
- History of Chemotherapy and/or Radiation Therapy
- Infectious Agents Including Prenatal Infection
  - HIV
- Environmental Including Parental Exposure
  - Toxins
  - Solvents
  - Pesticides
  - Magnetic Fields
- Cancer Predisposition Syndromes
  - Down Syndrome
  - Li-Fraumeni Syndrome
  - Neurofibromatosis
  - Gorlin Syndrome

http://cancer.gov/
Causes and Risk Factors
MPH Rules – The Basics

1. Is the condition reportable?
2. How many cases do I abstract?
3. How do I code the primary site?
4. How do I code the histology?
5. How do I code the grade?
MPH Rules – Solid Tumors

• Identify the Primary Site

• Use Multiple Primary Rules
  ○ General Rules
  ○ Site-Specific Rules
    ▪ Brain – Malignant
    ▪ Brain – Benign/Borderline
    ▪ Melanoma
    ▪ Kidney
    ▪ N/A – breast, colon, head & neck, lung, urinary system
MPH Rules – Solid Tumors

- Histology Coding Rules
- What Drives Treatment Decisions?
- Pediatric Pathology – Characteristics and Terminology
- Tumor Characteristic Testing
- Tumor Marker Testing
- Genetic Testing
- Profile
MPH Rules – Heme/Lymph Neoplasms

- Hodgkin Lymphoma
- Non-Hodgkin Lymphoma
- Acute Lymphoblastic Leukemia
- Acute Myeloid Leukemia
- Chronic Myeloid Leukemia
- Myeloid Leukemia Associated with Down Syndrome
- Langerhans Cell Histiocytosis – solitary/multifocal
Staging Pediatric Tumors
Staging Pediatric Tumors

- Wilms Tumor Study Group Staging
- International Neuroblastoma Staging System
- Children’s Oncology Group Neuroblastoma Risk Grouping
- Intergroup Rhabdomyosarcoma Study Staging System
- Soft Tissue Sarcoma Tumor Pathological Grading System
- FNCLCC Grading System
- TNM Staging System
Collaborative Stage Data Collection System

CS Core Data Items and Site Specific Factors Used to Derive

- AJCC Cancer Stage
  - TNM 6th edition
  - TNM 7th edition
  - Clinical Stage
  - Pathologic Stage
  - Best Combined Stage
  - T, N, and M Core Elements
  - Anatomic/Prognostic Stage Group
- SEER Summary Stage 1977
- SEER Summary Stage 2000

NO Pediatric-Specific Staging Schema or SSFs

Staging is often Site/Type Specific or Clinical Trial-Specific
# Collaborative Stage Version 2

**TNM 7 Schema List (v.02.04)**

[Natural Order • Alphabetical Order]

<table>
<thead>
<tr>
<th>Organ/Affected Site</th>
<th>Organ/Affected Site</th>
<th>Organ/Affected Site</th>
<th>Organ/Affected Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>AdnexaUterineOther</td>
<td>GISTSmallIntestine</td>
<td>MelanomaLarynxGlottic</td>
<td>PalateHard</td>
</tr>
<tr>
<td>AdrenalGland</td>
<td>GISTStomach</td>
<td>MelanomaLarynxOther</td>
<td>PalateSoft</td>
</tr>
<tr>
<td>AmpullaVater</td>
<td>GumLower</td>
<td>MelanomaLarynxSubglottic</td>
<td>PancreasBodyTail</td>
</tr>
<tr>
<td>Anus</td>
<td>GumUpper</td>
<td>MelanomaLarynxSupraglottic</td>
<td>PancreasHead</td>
</tr>
<tr>
<td>Appendix</td>
<td>HeartMediastinum</td>
<td>MelanomaLipLower</td>
<td>PancreasOther</td>
</tr>
<tr>
<td>BileDuctsDistal</td>
<td>HemiRetic</td>
<td>MelanomaLipOther</td>
<td>ParotidGland</td>
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<tr>
<td>BileDuctsIntraHepatic</td>
<td>IIIDefinedOther</td>
<td>MelanomaLipUpper</td>
<td>Penis</td>
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<td>BileDuctsPerihilar</td>
<td>IntracranialGland</td>
<td>MelanomaLipother</td>
<td>Peritoneum</td>
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<tr>
<td>BilaryOther</td>
<td>KaposiSarcoma</td>
<td>MelanomaLymphothelialGland</td>
<td>PeritoneumFemaleGen</td>
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<tr>
<td>Bladder</td>
<td>KidneyParenchyma</td>
<td>MelanomaLymphovascularGland</td>
<td>PharyngealTonsil</td>
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<tr>
<td>Bone</td>
<td>KidneyRenaIPelvis</td>
<td>MelanomaLymphovascularRenal</td>
<td>PharynxOther</td>
</tr>
<tr>
<td>Brain</td>
<td>LacrimaGland</td>
<td>MelanomaLymphovascularUmbilicus</td>
<td>Placenta</td>
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<tr>
<td>Breast</td>
<td>LacrimaSac</td>
<td>MelanomaLymphovascularVulva</td>
<td>Pleura</td>
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<tr>
<td>BuccalMucosa</td>
<td>MalloryGland</td>
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<td>Prostate</td>
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<tr>
<td>CarcinoidAppendix</td>
<td>LarynxGlottic</td>
<td>MelanomaLymphovascularZeisssler</td>
<td>Rectum</td>
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<tr>
<td>Cervix</td>
<td>LarynxGlottic</td>
<td>MelanomaLymphovascularZimmer</td>
<td>RespiratoryOther</td>
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<td>LarynxGlottic</td>
<td>MelanomaLymphovascularZittelmansky</td>
<td>Retinoblastoma</td>
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<tr>
<td>Colon</td>
<td>LarynxSupraglottic</td>
<td>MelanomaLymphovaLymphoma</td>
<td>Retroperitoneum</td>
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<tr>
<td>Conjunctiva</td>
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<td>MelanomaLymphovascularLymphadenoma</td>
<td>SalivaryGlandOther</td>
</tr>
<tr>
<td>CorpusAdenosarcoma</td>
<td>LipLower</td>
<td>MelanomaLymphovascularLymphoma</td>
<td>Scrotum</td>
</tr>
<tr>
<td>CorpusCarcinoma</td>
<td>LipOther</td>
<td>MelanomaLymphovascularLymphoma</td>
<td>SinusEthmoid</td>
</tr>
<tr>
<td>CorpusSarcoma</td>
<td>LipUpper</td>
<td>MelanomaLymphovascularLymphoma</td>
<td>SinusMaxillary</td>
</tr>
<tr>
<td>CysticDuct</td>
<td>Liver</td>
<td>MelanomaLymphovascularLymphoma</td>
<td>SinusOther</td>
</tr>
<tr>
<td>DigestiveOther</td>
<td>Lung</td>
<td>MelanomaLymphovascularLymphoma</td>
<td>Skin</td>
</tr>
<tr>
<td>EndocrineOther</td>
<td>Lymphoma</td>
<td>MelanomaLymphovascularLymphoma</td>
<td>SkinEyelid</td>
</tr>
<tr>
<td>EpiglottisAnterior</td>
<td>LymphomaOccularAdnexa</td>
<td>MelanomaLymphovascularLymphoma</td>
<td>SmallIntestine</td>
</tr>
<tr>
<td>Esophagus</td>
<td>MelanomaBuccalMucosa</td>
<td>MelanomaLymphovascularLymphoma</td>
<td>SoftTissue</td>
</tr>
<tr>
<td>EsophagusGEJunction</td>
<td>MelanomaChoroid</td>
<td>MelanomaLymphovascularLymphoma</td>
<td>Stomach</td>
</tr>
<tr>
<td>EyeOther</td>
<td>MelanomaCiliaryBody</td>
<td>MelanomaLymphovascularLymphoma</td>
<td>SubmandibularGland</td>
</tr>
<tr>
<td>FallopianTube</td>
<td>MelanomaConjugtiva</td>
<td>MelanomaLymphovascularLymphoma</td>
<td>Testis</td>
</tr>
<tr>
<td>FloorMouth</td>
<td>MelanomaEpiglottisAnterior</td>
<td>MelanomaLymphovascularLymphoma</td>
<td>Thyroid</td>
</tr>
<tr>
<td>Gallbladder</td>
<td>MelanomaEyeOther</td>
<td>MelanomaLymphovascularLymphoma</td>
<td>TongueAnterior</td>
</tr>
<tr>
<td>GenitalFemaleOther</td>
<td>MelanomaFloorMouth</td>
<td>MelanomaLymphovascularLymphoma</td>
<td>TongueBase</td>
</tr>
<tr>
<td>GenitalMaleOther</td>
<td>MelanomaGumLower</td>
<td>MelanomaLymphovascularLymphoma</td>
<td>Trachea</td>
</tr>
<tr>
<td>GISTAppendix</td>
<td>MelanomaGumOther</td>
<td>MelanomaLymphovascularLymphoma</td>
<td>Urethra</td>
</tr>
<tr>
<td>GISTColon</td>
<td>MelanomaGumUpper</td>
<td>MelanomaLymphovascularLymphoma</td>
<td>UrinaryOther</td>
</tr>
<tr>
<td>GISELECTHophagus</td>
<td>MelanomaHypopharynx</td>
<td>MelanomaLymphovascularLymphoma</td>
<td>Vagina</td>
</tr>
<tr>
<td>GISTPeritoneum</td>
<td>MelanomaLarynx</td>
<td>MelanomaLymphovascularLymphoma</td>
<td>Vulva</td>
</tr>
<tr>
<td>GISTRectum</td>
<td>MelanomaLarynx</td>
<td>MelanomaLymphovascularLymphoma</td>
<td></td>
</tr>
</tbody>
</table>
Solid Tumor Staging

Source: SEER Summary Staging Manual 2000
Solid Tumor Staging - Example

- **Wilms Tumor**
  - **Stage I – 43%**
    - Tumor is limited to the kidney
    - Tumor is completely resected.
    - The renal capsule is intact.
    - Tumor is not ruptured or biopsied prior to removal.
    - No involvement of renal sinus vessels.
  - **Stage II – 20%**
    - Tumor is completely resected,
    - The tumor extends beyond the kidney as evidenced by any one of the following:
      - There is regional extension of the tumor (i.e., penetration of the renal sinus capsule).
      - Blood vessels in the nephrectomy specimen outside the renal parenchyma with tumor
  - **Stage III – 21%**
    - Residual non-hematogenous tumor present following surgery confined to the abdomen
  - **Stage IV – 11%**
    - Hematogenous metastases (lung, liver, bone, brain),
    - Lymph node metastases outside the abdomino-pelvic region are present
  - **Stage V – 5%**
    - Bilateral involvement by tumor is present at diagnosis
Brain and Cerebral Meninges

C70.0, C71.0-C71.9

- C70.0 Cerebral meninges
- C71.0 Cerebrum
- C71.1 Frontal lobe
- C71.2 Temporal lobe
- C71.3 Parietal lobe
- C71.4 Occipital lobe
- C71.5 Ventricle, NOS
- C71.6 Cerebellum, NOS
- C71.7 Brain stem
- C71.8 Overlapping lesion of brain
- C71.9 Brain, NOS

Note 1: This schema is compatible with the AJCC 4th edition TNM scheme for brain, updated to include metastatic and site-specific information from the AJCC 7th edition. The AJCC opted not to recommend a TNM scheme in the 6th or 7th editions.

Note 2: AJCC does not define TNM staging for this site.

<table>
<thead>
<tr>
<th>CS Tumor Size</th>
<th>CS Site-Specific Factor 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS Extension</td>
<td>Surgical Resection</td>
</tr>
<tr>
<td>CS Tumor Size/Ext Eval = 9</td>
<td>CS Site-Specific Factor 8</td>
</tr>
<tr>
<td>CS Lymph Nodes</td>
<td>Unifocal vs Multifocal Tumor</td>
</tr>
<tr>
<td>CS Lymph Nodes Eval = 9</td>
<td>CS Site-Specific Factor 9 = 988</td>
</tr>
<tr>
<td>Regional Nodes Positive = 99</td>
<td>CS Site-Specific Factor 10 = 988</td>
</tr>
<tr>
<td>Regional Nodes Examined = 99</td>
<td>CS Site-Specific Factor 11 = 988</td>
</tr>
<tr>
<td>CS Mets at DX</td>
<td>CS Site-Specific Factor 12 = 988</td>
</tr>
<tr>
<td>CS Mets Eval = 9</td>
<td>CS Site-Specific Factor 13 = 988</td>
</tr>
<tr>
<td>CS Site-Specific Factor 1</td>
<td>CS Site-Specific Factor 14 = 988</td>
</tr>
<tr>
<td>World Health Organization (WHO) Grade Classification</td>
<td>CS Site-Specific Factor 15 = 988</td>
</tr>
<tr>
<td>CS Site-Specific Factor 2</td>
<td>CS Site-Specific Factor 16 = 988</td>
</tr>
<tr>
<td>Ki-67/MIB-1 Labeling Index (LI): Brain</td>
<td>CS Site-Specific Factor 17 = 988</td>
</tr>
<tr>
<td>CS Site-Specific Factor 3</td>
<td>CS Site-Specific Factor 18 = 988</td>
</tr>
<tr>
<td>Functional Neurologic Status - Karnofsky Performance Scale (KPS)</td>
<td>CS Site-Specific Factor 19 = 988</td>
</tr>
<tr>
<td>CS Site-Specific Factor 4</td>
<td>CS Site-Specific Factor 20 = 988</td>
</tr>
</tbody>
</table>
### Leukemia Staging

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
</table>
| 100  | Localized disease:  
(Single/solitary/unifocal/isolated):  
May be coded for:  
- Mast cell sarcoma (9740)  
- Malignant histiocytosis (9750)  
- Langerhans cell histiocytosis (9751)  
- Histiocytic sarcoma (9755)  
- Langerhans cell sarcoma (9756)  
- Dendritic cell sarcoma (9757, 9758)  
- Myeloid sarcoma (9930) |
| 800  | Systemic disease  
(All histologies including those in 100) |
| 999  | Unknown; extension not stated  
Primary tumor cannot be assessed  
Not documented in patient record |
# Lymphoma Staging

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Involvement of a single lymphatic site (i.e., nodal region, Waldeyer's ring, thymus, or spleen) (I); or localized involvement of a single extralymphatic organ or site in the absence of any lymph node involvement (IE).</td>
</tr>
<tr>
<td>II</td>
<td>Involvement of two or more lymph node regions on the same side of the diaphragm (II); or localized involvement of a single extralymphatic organ or site in association with regional lymph node involvement with or without involvement of other lymph node regions on the same side of the diaphragm (IIE).</td>
</tr>
<tr>
<td>III</td>
<td>Involvement of lymph node regions on both sides of the diaphragm (III), which also may be accompanied by extralymphatic extension in association with adjacent lymph node involvement (IIIE) or by involvement of the spleen (IIIS) or both (IIIE,S).</td>
</tr>
<tr>
<td>IV</td>
<td>Diffuse or disseminated involvement of one or more extralymphatic organs, with or without associated lymph node involvement; or isolated extralymphatic organ involvement in the absence of adjacent regional lymph node involvement, but in conjunction with disease in distant site(s). Stage IV includes any involvement of the liver or bone marrow, lungs (other than by direct extension from another site), or cerebrospinal fluid.</td>
</tr>
</tbody>
</table>

**Designations applicable to any stage**

<table>
<thead>
<tr>
<th>Designation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>No symptoms.</td>
</tr>
<tr>
<td>B</td>
<td>Fever (temperature &gt;38°C), drenching night sweats, unexplained loss of &gt;10% of body weight within the preceding 6 months.</td>
</tr>
<tr>
<td>E</td>
<td>Involvement of a single extranodal site that is contiguous or proximal to the known nodal site.</td>
</tr>
<tr>
<td>S</td>
<td>Splenic involvement.</td>
</tr>
</tbody>
</table>


Source: [http://cancer.gov](http://cancer.gov) – Pediatric Non-Hodgkin Lymphoma NCI PDQ for Health Professionals
Treatment
Treatment Options – Basic Concepts

- Surgery
- Chemotherapy
- Radiation Therapy
- Hormonal Therapy
- Combination Therapy
- Continuation Therapy
- Bone Marrow/Stem Cell Transplant

Image Source: [http://greenplanetparadise.com](http://greenplanetparadise.com) and [http://avinoamlerner.com](http://avinoamlerner.com)
Treatment Options – Basic Concepts

- Pre-Induction Risk Assessment
- Induction Therapy
- Post-Induction Assessment
- Re-Induction Therapy
- Intensification/Consolidation Therapy
- Post-Consolidation Assessment
- BMT/Stem Cell Transplant
- Maintenance Therapy
- Maintenance Assessment
Treatment Options – Basic Concepts

- Risk-Based Treatment – Pre-Induction Risk
  - Patient Characteristics
    - Age at Diagnosis
    - WBC Count at Diagnosis
    - CNS Involvement
    - Gender
  - Neoplasm Characteristics
    - Morphology
    - Immunophenotype
    - Cytogenetics
  - Genetic Characteristics of Neoplasm
    - Philadelphia Chromosome Transloaction
    - MLL Translocations
    - CRLF2 and JAK Mutation
Treatment Options – Basic Concepts

- **Risk-Based Treatment – Induction Failure**
  - Patients at highest risk of induction failure:
    - T-cell phenotype (especially without a mediastinal mass).
    - B-precursor ALL with very high presenting leukocyte counts.
    - 11q23 rearrangement.
    - Older age.
    - Philadelphia chromosome

- **Risk-Based Treatment – ReInduction/Consolidation**
  - Re-Induction
  - Intensification
  - Consolidation

- **Risk-Based Treatment – Sanctuary Sites**

- **Risk-Based Treatment – Maintenance Therapy**

Source: [http://cancer.gov](http://cancer.gov) – Pediatric Lymphoid Neoplasm NCI PDQ for Health
Risk-Based Treatment Assessment

- Low Risk Disease – Stage I, II – no B symptoms, no bulky disease
- Intermediate Risk Disease – Stage I, II with B symptoms
- Intermediate Risk Disease – Stage I, II with bulky disease
- Intermediate Risk Disease – Stage IIIA, IVA
- High Risk Disease – Stage IIIB, IVB
- High Risk Disease – Poor response to initial chemotherapy

Source: [http://cancer.gov](http://cancer.gov) – Pediatric Lymphoid Neoplasm NCI PDQ for Health Professionals
Treatment Options – Basic Concepts

Images: [http://www.sciencedirect.com/science](http://www.sciencedirect.com/science) and [http://cancerhelpuk.org](http://cancerhelpuk.org)
Treatment Options – Lymphoid Neoplasms

- Hodgkin Lymphoma
- Non-Hodgkin Lymphoma
- Chronic Lymphocytic Leukemia
- Acute Lymphocytic Leukemia
- Other Lymphoid Neoplasm

### Table 5. Low-Risk Disease (Stages I–IIA; No Bulky Disease; No B Symptoms)

<table>
<thead>
<tr>
<th>Chemotherapy (No. of Cycles)</th>
<th>Radiation (Gy)</th>
<th>Stage</th>
<th>No. of Patients</th>
<th>Event-Free Survival (No. of Years of Follow-up)</th>
<th>Survival (No. of Years of Follow-up)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VAMP (4) [38]</td>
<td>15-25.5, IFRT</td>
<td>CS I/IP</td>
<td>110</td>
<td>89 (10)</td>
<td>96 (10)</td>
</tr>
<tr>
<td>VAMP (4) [44]</td>
<td>25.5, IFRT/None</td>
<td>CS I/IP</td>
<td>41/47</td>
<td>88/89 (5)</td>
<td>100/100 (5)</td>
</tr>
<tr>
<td>COPP/ABV (4) [14,17]</td>
<td>21, IFRT/None</td>
<td>CS IA/B, IIA</td>
<td>94/113</td>
<td>100/89 (10)</td>
<td>97/96 (10)</td>
</tr>
<tr>
<td>OPEA/OPPA (2) [18]</td>
<td>20-35, IFRT/None</td>
<td>I, IIA</td>
<td>281/113</td>
<td>94/97 (5)</td>
<td>N/A</td>
</tr>
<tr>
<td>AVE (2-4) [47]</td>
<td>25.5, IFRT</td>
<td>IA, IIA, IIIA</td>
<td>51</td>
<td>91 (6)</td>
<td>98 (6)</td>
</tr>
</tbody>
</table>

Source: [http://cancer.gov](http://cancer.gov) – Pediatric Hodgkin Lymphoma NCI PDQ for Health Professionals
## Treatment Options – Lymphoma

### Table 6. Intermediate-Risk Disease (All Stage I and Stage II Patients Not Classified as Early Stage; Stage IIIA; Stage IVA)

<table>
<thead>
<tr>
<th>Chemotherapy (No. of Cycles)⁵</th>
<th>Radiation (Gy)</th>
<th>Stage</th>
<th>No. of Patients</th>
<th>Event-Free Survival (No. of Years of Follow-up)</th>
<th>Survival (No. of Years of Follow-up)</th>
</tr>
</thead>
<tbody>
<tr>
<td>COPP/ABV (6) [17]</td>
<td>21, IFRT/None</td>
<td>CS I/IIb, CS IIb, CS III</td>
<td>103/122</td>
<td>84/78 (10)³</td>
<td>100 (3)</td>
</tr>
<tr>
<td>OEPA/OPPA (2) + COPP (2) [18]</td>
<td>20–35, IFRT</td>
<td>IIbA, IIb, IIIA</td>
<td>212</td>
<td>92 (5)</td>
<td>N/A</td>
</tr>
<tr>
<td>OEPA/OPPA (2) + COPDAC (2) [37]</td>
<td>20–35, IFRT</td>
<td>IIbB, IIIbA/B, IIIB, IVA/B</td>
<td>139</td>
<td>88.3 (5)</td>
<td>98.5 (5)</td>
</tr>
<tr>
<td>ABVE-PC (3–5) [32]</td>
<td>21, IFRT</td>
<td>IB, IIA, IIIA</td>
<td>53</td>
<td>84 (5)</td>
<td>95 (5)</td>
</tr>
</tbody>
</table>

Source: [http://cancer.gov](http://cancer.gov) – Pediatric Hodgkin Lymphoma NCI PDQ for Health Professionals
# Treatment Options – Lymphoma

## Table 7. High-Risk Disease (Stages IIIb, IVb)

<table>
<thead>
<tr>
<th>Chemotherapy (No. of Cycles)</th>
<th>Radiation (Gy)</th>
<th>Stage</th>
<th>No. of Patients</th>
<th>Event-Free Survival (No. of Years of Follow-up)</th>
<th>Survival (No. of Years of Follow-up)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OEPA/OPPA (2) + COPP (4) [18]</td>
<td>20–35, IFRT</td>
<td>IIIB, IIIA/A/B, IIIIB, IVA/B</td>
<td>265</td>
<td>91 (5)</td>
<td>N/A</td>
</tr>
<tr>
<td>OEPA/OPPA (2) + COPDAPC (4) [37]</td>
<td>20–35, IFRT</td>
<td>IIIB, IIIA/A/B, IIIIB, IVA/B</td>
<td>239</td>
<td>86.9 (5)</td>
<td>94.9 (5)</td>
</tr>
<tr>
<td>ABVE-PC (3-5) [32]</td>
<td>21, IFRT</td>
<td>IB, IIA, IIIA</td>
<td>163</td>
<td>85 (5)</td>
<td>95 (5)</td>
</tr>
<tr>
<td>BEACOPP (4); COPP/ABV (4) (RER; girls) [40]</td>
<td>None</td>
<td>IIB, IIIIB, IV</td>
<td>38</td>
<td>94 (5)</td>
<td>97 (5)</td>
</tr>
<tr>
<td>BEACOPP (4); ABVD (2) (RER; boys) [40]</td>
<td>21, IFRT</td>
<td>IIB, IIIIB, IV</td>
<td>34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BEACOPP (8) (SER) [40]</td>
<td>21, IFRT</td>
<td>IIB, IIIIB, IV</td>
<td>25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: [http://cancer.gov](http://cancer.gov) – Pediatric Hodgkin Lymphoma NCI PDQ for Health Professionals
Treatment Options – Myeloid Neoplasms

- Myeloid Leukemia Associated with Down Syndrome
- Chronic Myeloid Leukemia
- Acute Myeloid Leukemia
- Other Myeloid Neoplasm
- MPD/MPS/MDS

Source: http://cancer.gov – Pediatric Myeloid Neoplasm NCI PDQ for Health Professionals
• About **85%** of patients are **diagnosed in the chronic phase**

• The **accelerated phase** of CML is characterized by **10% - 19% blasts in the WBC of peripheral blood** (WHO)
  - Note: There are alternative ways to define the accelerated phase proposed by Sokal et al., the International Bone Marrow Transplant Registry, and MD Anderson.

• The **blast phase**, also referred to as **blast crisis**, is most often defined as **>20% blasts WBC of peripheral blood**

Source: [http://cancer.gov](http://cancer.gov) – Pediatric Myeloid Neoplasm NCI PDQ for Health Professionals
- Use same basic model as ALL – different agents

Source: [http://cancer.gov](http://cancer.gov) – Pediatric Myeloid Neoplasm NCI PDQ for Health Professionals
Treatment Options – CML/AML

- Ph+ chronic phase CML is typically treated with a tyrosine kinase inhibitor (TKI).
- TKIs include imatinib, nilotinib or dasatinib.
- All TKIs are given orally so there will be no “administration” documentation rather the patient will be given prescriptions.
- Other treatment options include clinical trial or Hematopoietic Stem Cell Transplant [HSCT].

Source: [http://cancer.gov](http://cancer.gov) – Pediatric Myeloid Neoplasm NCI PDQ for Health Professionals
Treatment Options – CML/AML

- Patients are evaluated for a cytogenetic response
- Treatment is based on response
  - Complete Response – no Ph⁺ positive metaphases
  - Partial Response – 1%-35% Ph⁺ positive metaphases
  - Major Response – 0%-35% Ph⁺ positive metaphases
    - Complete + Partial
  - Minor - > 35% Ph⁺ positive metaphases

Source: [http://cancer.gov](http://cancer.gov) – Pediatric Myeloid Neoplasm NCI PDQ for Health Professionals
Patients achieving a complete hematologic response are continued on their current medication at the same dose.

Patients who fail to achieve a complete hematologic response are evaluated for compliance, drug-drug interaction and possibly mutational status but generally are switched to an alternate TKI as second line treatment.

Other treatment options include evaluation and discussion of HSCT and clinical trial.

Source: http://cancer.gov – Pediatric Myeloid Neoplasm NCI PDQ for Health Professionals
Treatment Options – CML/AML

- **Growth Factors**
  - filgrastim (Neupogen®)
  - pegfilgrastim (Neulasta ®)

- **Diuretics** (aldactone, hydrochlorothiazide [HCTZ]),
  steroids (prednisone 20mg/day x 3 for effusions)

- **Topical steroids** (hydrocortisone cream)

- **Antidiarrheal agents** (loperamide [Imodium®])

- **Analgesics** (acetaminophen, ibuprofen)

Source: [http://cancer.gov](http://cancer.gov) – Pediatric Myeloid Neoplasm NCI PDQ for Health Professionals
## Treatment Options – Brain and CNS

Treated Based on Histology and Location

<table>
<thead>
<tr>
<th>Tumor Type</th>
<th>Pathologic Subtype</th>
<th>Staging and Treatment of Newly Diagnosed and Recurrent Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CNS = central nervous system.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Astrocytomas and Other Tumors of Glial Origin</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Low-Grade Astrocytomas</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diffuse fibrillary astrocytoma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gemistocytic astrocytoma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oligoastrocytoma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oligodendrogioma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pilocytic astrocytoma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pilomyxoid astrocytoma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pleomorphic xanthoastrocytoma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protoplasmic astrocytoma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subependymal giant cell astrocytoma</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>High-Grade Astrocytomas</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anaplastic astrocytoma</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: [http://cancer.gov](http://cancer.gov) – Pediatric Brain Tumors NCI PDQ for Health Professionals
## Treatment Options – Brain and CNS

### Treated Based on Histology and Location

<table>
<thead>
<tr>
<th>Tumor Type</th>
<th>Pathologic Subtype</th>
<th>Staging and Treatment of Newly Diagnosed and Recurrent Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anaplastic oligoastrocytoma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anaplastic oligodendroglioma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Giant cell glioblastoma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glioblastoma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glomatosis cerebri</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gliosarcoma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brain Stem Glioma</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diffuse intrinsic pontine gliomas</td>
<td>Childhod Brain Stem Glioma Treatment</td>
</tr>
<tr>
<td></td>
<td>Focal or low-grade brain stem gliomas</td>
<td></td>
</tr>
<tr>
<td>CNS Embryonal Tumors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Medulloblastoma</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Anaplastic</td>
<td>Childhod CNS Embryonal Tumors Treatment</td>
</tr>
<tr>
<td></td>
<td>Classic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Desmoplastic/nodular</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Large cell</td>
<td></td>
</tr>
</tbody>
</table>

Source: [http://cancer.gov](http://cancer.gov) – Pediatric Brain Tumors NCI PDQ for Health Professionals
## Treatment Options – Brain and CNS

**Treated Based on Histology and Location**

<table>
<thead>
<tr>
<th>Tumor Type</th>
<th>Pathologic Subtype</th>
<th>Staging and Treatment of Newly Diagnosed and Recurrent Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CNS Primitive Neuroectodermal Tumors (PNETs)</strong></td>
<td>Medulloblastoma with extensive nodularity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CNS ganglioneuroblastoma</td>
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<tr>
<td></td>
<td>CNS neuroblastoma</td>
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<tr>
<td></td>
<td>Ependymoblastoma</td>
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<tr>
<td></td>
<td>Medulloepithelioma</td>
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<tr>
<td><strong>Tumors of the Pineal Region</strong></td>
<td>Pineal parenchymal tumor of intermediate differentiation</td>
<td></td>
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<tr>
<td></td>
<td>Pineoblastoma</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pineocytoma</td>
<td></td>
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<tr>
<td></td>
<td>Papillary tumor of the pineal region</td>
<td></td>
</tr>
<tr>
<td><strong>CNS Atypical Teratoid/Rhabdoid Tumor</strong></td>
<td></td>
<td>Childhood CNS Atypical Teratoid/Rhabdoid Tumor Treatment</td>
</tr>
<tr>
<td><strong>CNS Germ Cell Tumors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Germinomas</strong></td>
<td></td>
<td>Childhood CNS Germ Cell Tumors Treatment</td>
</tr>
</tbody>
</table>

Source: [http://cancer.gov](http://cancer.gov) – Pediatric Brain Tumors NCI PDQ for Health Professionals
# Treatment Options – Brain and CNS

Trtreated Based on Histology and Location

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<tr>
<th>Tumor Type</th>
<th>Pathologic Subtype</th>
<th>Staging and Treatment of Newly Diagnosed and Recurrent Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teratomas</td>
<td>Immature teratomas</td>
<td></td>
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<tr>
<td></td>
<td>Mature teratomas</td>
<td></td>
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<tr>
<td></td>
<td>Teratomas with malignant transformation</td>
<td></td>
</tr>
<tr>
<td>Non-Germinomatous Germ Cell Tumors</td>
<td>Choriocarcinoma</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Embryonal carcinoma</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mixed germ cell tumors</td>
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<tr>
<td></td>
<td>Yolk sac tumor</td>
<td></td>
</tr>
<tr>
<td>Craniopharyngioma</td>
<td></td>
<td>Childhood Craniopharyngioma Treatment</td>
</tr>
<tr>
<td>Ependymoma</td>
<td></td>
<td>Childhood Ependymoma Treatment</td>
</tr>
<tr>
<td>Tumors of the Choroid Plexus</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: [http://cancer.gov](http://cancer.gov) – Pediatric Brain Tumors NCI PDQ for Health Professionals
Treatment Options - Teratoid/Rhabdoid Tumor

- CNS

- Non-CNS

- Both CNS and Non-CNS Involvement

- Rhabdomyosarcoma (see Sarcoma)

- Rhabdoid Tumor of Kidney

Source: http://cancer.gov – Atypical Teratoid/Rhabdoid Tumor NCI PDQ for Health Professionals
Primary Tumor Resection with Negative Margins
Regional Lymph Node Involvement is Rare
Radiation Therapy depends upon potential for surgery plus or minus chemotherapy to obtain local control
- Age
- Gender
- Tumor site
- Tumor size
- Tumor grade
Role for Adjuvant Chemotherapy Controversial
- Vincristine, dactinomycin, cyclophosphamide, doxorubicin

Source: [http://cancer.gov](http://cancer.gov) – Pediatric Soft Tissue Sarcoma NCI PDQ for Health Professionals
Treatment Options – Ewing Sarcoma

- Pre-Treatment Factors
  - Site of Tumor
  - Tumor Size or Volume
  - Age of Patient
  - Gender (favorable girls)
  - Metastases
  - Standard Cytogenetics
  - Detectable Fusion Transcripts

- Surgery
- Chemo – vincristine, doxorubicin, cyclophosphamide
- Radiation Therapy
Treatment Options – Wilms Tumor

- Preoperative chemotherapy prior to nephrectomy is indicated in the following situations:[10,17,20-23]
  - Metachronous bilateral Wilms tumor.
  - Wilms tumor in a solitary kidney.
  - Extension of tumor thrombus above the level of the hepatic veins.
  - Tumor involves contiguous structures whereby the only means of removing the kidney tumor requires removal of the other structures (e.g., spleen, pancreas, colon but excluding the adrenal gland).
  - Pulmonary compromise due to extensive pulmonary metastases.

- Patients with massive, nonresectable unilateral tumors, bilateral tumors, or venacaval tumor thrombus are candidates for preoperative chemotherapy
Treatment Options – Wilms Tumor

- Pre-Surgical Chemotherapy for High Risk Group
- Nephrectomy
- Chemotherapy
- Radiation Therapy

Table 2. Standard Chemotherapy Regimens for Wilms Tumor

<table>
<thead>
<tr>
<th>Regimen Name</th>
<th>Regimen Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regimen EE-4A [1]</td>
<td>Vincristine, dactinomycin x 16 weeks postnephrectomy</td>
</tr>
<tr>
<td>Regimen DD-4A [1]</td>
<td>Vincristine, dactinomycin, doxorubicin x 24 weeks postnephrectomy</td>
</tr>
<tr>
<td>Regimen I [2]</td>
<td>Vincristine, doxorubicin, cyclophosphamide, etoposide x 24 weeks</td>
</tr>
</tbody>
</table>
Treatment Options – Neuroblastoma

- **Low-Risk Neuroblastoma**
  - Surgery
  - Chemo - carboplatin, cyclophosphamide, doxorubicin, etoposide

- **Intermediate-Risk Neuroblastoma**
  - Surgery
  - Chemo as above x 2 cycles
  - Dose Intensive Multi-Agent Chemo

- **High-Risk Neuroblastoma**
  - Dose Intensive Multi-Agent Chemo as above plus ifosfamide, cisplatin
  - Surgery

- **Response Assessment – then next steps**
Treatment Options - Retinoblastoma

- **Goals of Treatment**
  - Eradicate the disease to save the patient's life.
  - Preserve as much vision as possible.
  - Decrease risk of late sequelae from treatment, particularly subsequent neoplasms.

- **Enucleation**
- **Radiation Therapy** (beam or brachytherapy)
- **Local Treatments** (Cryotherapy/Laser Therapy)
- Chemo – carboplatin, etoposide, vincristine
- Subteton (subconjunctival) Chemo - carboplatin
- Ophthalmic Artery Infusion Chemo – topotecan, carboplatin
Late Effects of Treatment

• Childhood Cancer Survivors Study
  o Chance for long-term effects increase over time
  o > 70% at least 1 chronic illness related to treatment
  o > 25% have 3 or more chronic illnesses related to tx
  o Kidney Disease
  o Second Cancers
  o Cognitive Dysfunction
  o Cardiovascular Disease
  o Endocrine Abnormalities
  o Musculoskeletal Conditions
National Cancer Institute Physician Data Query (PDQ) - Health Professionals

- Childhood Cancers Fact Sheet
- Childhood Acute Lymphoblastic Leukemia
- Childhood Acute Myeloid Leukemia
- Childhood Brain and Spinal Cord Tumors Overview
- Childhood Astrocytoma
- Childhood CNS Embryonal Tumors
- Childhood CNS Atypical Teratoid/Rhabdoid Tumors
- Childhood Hodgkin Lymphoma
- Childhood Non-Hodgkin Lymphoma
- Ewing Sarcoma
- Childhood Soft Tissue Sarcoma
- Childhood Rhabdomyosarcoma
- Neuroblastoma
- Wilms Tumor

References and Resources
References and Resources


- NCI Cancer Bulletin, Pediatric Oncology Partnerships are Models for Success, Volume 5/Number 6, March 18, 2008

- Advances in Neuroblastoma Risk Assessment and Treatment, Susan L Cohn, MD, University of Chicago Department of Pediatrics

- Florida Association of Pediatric Tumor Programs (FAPTP)

- Children’s Oncology Group (COG)
Future Pediatric Oncology Webcasts

Coming Soon!!
Questions