Objectives

1. To identify which pediatric oncology patients are at greatest risk for specific treatment related emergencies

2. To identify the presenting signs and symptoms of common treatment related emergencies in pediatric oncology patients

3. To understand the principles of treatment for common treatment related emergencies in pediatric oncology patients
Topics Covered

Cardiopulmonary Emergencies
• Superior Vena Cava Syndrome and Superior Mediastinal Syndrome
• Pericardial Effusion and Cardiac Tamponade

Metabolic Emergencies—Tumor Lysis Syndrome
Hyperleukocytosis & Disseminated Intravascular Coagulopathy

Abdominal Emergencies
• Typhlitis
• Pancreatitis
• Constipation
Cardiopulmonary Emergencies

• Superior Vena Cava Syndrome & Superior Mediastinal Syndrome
• Pericardial effusion/tamponade
Cardiopulmonary Emergencies

• Superior Vena Cava Syndrome (SVCS): Refers to signs and symptoms from compression, obstruction or thrombosis of the superior vena cava
• Superior Mediastinal Syndrome (SMS): SVC signs and symptoms + tracheal compression
• Terms often used interchangeably in children
Anatomy of SVCS and SMS

SVCS & SMS

Symptoms: Dyspnea, Cough, Dysphagia, Orthopnea, Hoarseness, Anxiety, Confusion, Lethargy, Headache, Distorted vision, Central Venous Stasis

Signs on Physical Exam: Edema, Plethora, Cyanosis of face, neck and upper extremities, Cervical and thoracic venous distention, Conjunctival suffusion and edema, Wheezing, Stridor

Sometimes no signs or symptoms until stressed
Radiology Findings of SVCS & SMS: X-ray

T-Cell ALL

Hodgkin’s Disease
Radiology Findings of SVCS & SMS: CT

- Mediastinal Mass
- Cardiac Compression
- Pleural Effusion
- Collapsed R lung
- Normal L lung
Radiology Findings of SVCS & SMS: CT

- Pleural Effusion
- Tracheal compression
- Pericardial effusion with tamponade
## SVCS & SMS: Who is at risk?

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Patients (no)</th>
<th>Mediastinal Mass (%)</th>
<th>SVCS with Mediastinal Mass (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute lymphoblastic leukemia</td>
<td>1464</td>
<td>130 (8.4)</td>
<td>6 (4.6)</td>
</tr>
<tr>
<td>Acute nonlymphocytic leukemia</td>
<td>392</td>
<td>9 (2.3)</td>
<td>0</td>
</tr>
<tr>
<td>Hodgkin’s disease</td>
<td>333</td>
<td>102 (30.6)</td>
<td>2 (2.0)</td>
</tr>
<tr>
<td>Non-Hodgkin’s lymphoma</td>
<td>330</td>
<td>230 (69.7)</td>
<td>8 (3.4)</td>
</tr>
<tr>
<td>Neuroblastoma</td>
<td>332</td>
<td>69 (20.8)</td>
<td>3 (4.3)</td>
</tr>
<tr>
<td>Germ cell tumors</td>
<td>114</td>
<td>10 (8.8)</td>
<td>2 (20.0)</td>
</tr>
<tr>
<td>Sarcoma</td>
<td>696</td>
<td>26 (3.7)</td>
<td>3 (11.0)</td>
</tr>
</tbody>
</table>

Ingram L, Med Pediatr Oncol, 1990
SVCS & SMS: Treatment

1. Allow patient to rest in the position where they are most comfortable & minimize agitation.

2. Minimize/avoid sedation
   - Supine $\rightarrow$ impedes venous return or air flow
     - Note: Can do CT scan supine if needed
   - General anesthesia and sedatives $\rightarrow$
     - ↓ respiratory muscle tone
     - Relaxes bronchial smooth muscle
     - ↓ lung volume
     - Peripheral vasodilation and ↓ venous return
SVCS & SMS: Treatment

3. Make the diagnosis in the least invasive manner
   - Thoracentesis if pleural effusion
   - Bone marrow aspirate if suspect leukemia/lymphoma
   - Biopsy of peripheral node

4. Avoid intubation/ventilator if possible: can be very difficult to secure airway and ventilate

5. Monitor closely (frequent VS, pulse ox)
SVCS & SMS: Emergency Treatment

1. Radiation Therapy
   - 200-400 cGy

2. Corticosteroids
   - Solumedrol 5-15 mg/m\(^2\) q6-8 hrs
   - Decadron 0.5-2mg/kg q8 hrs

**Both of these delay definitive diagnosis so start empiric therapy if necessary (may still be able to get diagnosis later)**
SMS: Treatment Response

Patient and CXR at diagnosis
Resolved SMS: S/P 1 week of Chemotherapy
S/P chest tube placement
Pericardial Effusion with Tamponade

Cardiac tamponade occurs when the left ventricle fails to maintain output because of compression.

Causes: Mediastinal mass, pericardial effusion, leukemic infiltrate, inflammation or infection, fibrosis due to radiation, tumor.

Symptoms: Cough, Chest pain, Dyspnea, Abdominal pain.

Signs: Tachycardia, Cyanosis, Hypotension, Pulsus paradoxus greater than 10 mm.

"Waterbag" cardiac shadow
Pericardial Effusion with Tamponade

Treatment

• Transfer to PICU
• Echocardiogram/Cardiology Consult
• Pericardiocentesis
• If effusion reaccumulates can consider intervention such as a pericardial window or sclerosing agents
Metabolic Emergencies

• Tumor Lysis Syndrome
Tumor Lysis Syndrome

- Metabolic abnormalities that result from the death of tumor cells and release of contents into the circulation
Tumor Lysis Syndrome

Risk Factors:
- Large tumor burden
- Cancers that rapidly divide
- Cancers that are extremely sensitive to chemotherapy

Burkitt’s Lymphoma > Lymphoblastic Lymphoma > T- cell Acute lymphoblastic leukemia > B- cell Acute lymphoblastic leukemia
Large Volume Bulk Disease
Cancers Rapidly Dividing—Up Close

Burkitt's Lymphoma: Starry Sky

Burkitt cells contain numerous intracytoplasmic lipid droplets. Nobody knows why.

As some cancer cells die, their lipid is phagocytized by benign macrophages, which become the "stars".
Tumor Lysis Syndrome

Metabolic Triad of TLS (Pre-chemo to 12-72 hours after):
- Hyperuricemia
- Hyperphosphatemia (+ hypocalcemia)
- Hyperkalemia

Hyperuricemia $\rightarrow$ Urate Crystals $\rightarrow$ Oliguria/Renal Failure

Hyperkalemia $\rightarrow$ Cardiac arrhythmias

Hyperphosphatemia $\rightarrow$ Hypocalcemia $\rightarrow$ Tetany
Tumor Lysis Prevention

Labs: Creatinine, Uric acid, Calcium, Phosphorus, Potassium every 4-12 hours depending on risk

Maintain urine output at least 3 mL/kg/hr

• Begin IV hydration at least 24 hours prior to starting chemotherapy and run at least 1 ½ - 2x Maintenance

• Maintain diuresis:
  – Lasix 0.5-1 mg/kg
  – Mannitol 0.5 g/kg
Tumor Lysis Syndrome: Treatment

Uric Acid:
- Allopurinol 300 mg/m²/day divided TID
- Alkalinize Urine with bicarbonate
- Rasburicase
  - Recombinant urate oxidase

Purines → Hypoxanthine → Xanthine (soluble) → Uric Acid (insoluble) → Allantoin (soluble)

Allopurinol → Xanthine oxidase → Rasburicase
Tumor Lysis Syndrome: Treatment

Phosphorus:
- Low phosphate diet (no dairy, soda)
- Lower urine pH
- Phosphate binder: Sevelamer (Renogel)
- TUMS for hypocalcemia

Potassium
- NO potassium in the IV fluids
- Emergency management of hyperkalemia
  - Lasix, Kayexalate, bicarbonate etc
Tumor Lysis Syndrome: When to Dialyze

Symptomatic Fluid Overload or Heart Failure

Elevated Potassium +/- EKG findings

Elevated Creatinine (?) How high)

Elevated Phosphorus (?) How high)

Hypocalcemia +/- Tetany
Hyperleukocytosis
Disseminated Intravascular Coagulopathy (DIC)
Hyperleukocytosis

Definition: WBC greater than 100,000/uL
- Seen in 10% ALL and 15-20% AML

Patients at Risk:
- T-cell ALL with mediastinal mass
- AML
- Infant ALL
- Hypodiploid ALL or Ph+ ALL
- Blast phase CML
Hyperleukocytosis

Symptoms from Hyperviscosity, leukostasis
• Respiratory distress/failure, oxygen requirement
• Blurred vision, Papilledema
• Confusion, Somnolence, Seizure
• Pain in hands and feet
• Priapism

Relatively small lymphoblasts  
Large myeloblasts
Hyperleukocytosis: Treatment

• IV Hydration (rates similar to TLS)
• Avoid PRBC transfusions if not absolutely needed
  – Wait until WBC decreases (< 100,000)
  – Don’t target a high Hgb
• Transfuse platelets to > 20,000
  – To prevent CNS hemorrhage
  – Platelets don’t contribute as much to blood viscosity
• Leukopheresis
  – For severe symptoms o/w controversial regarding the benefit
Hyperleukocytosis

Can result in death from:
- CNS hemorrhage or thrombosis
- Pulmonary leukostasis
Disseminated Intravascular Coagulopathy (DIC)

- Pathologic process where there is generalized activation and dysregulation of the hemostatic system resulting in generation of microthrombi and consumption of platelets and clotting factors.

![DIC Diagram]

http://themicalbiochemistrypage.org/blood-coagulation.php
DIC

- Patients at risk: APML and infection or sepsis
- Signs & Symptoms: Bleeding, petechiae, purpura and laboratory derangements

- Treatment:
  - Treat and remove the trigger
  - Replace products: platelets, fresh frozen plasma, cryoprecipitate
  - Sometimes heparin is used
Abdominal Emergencies: Acute Abdomen

- Typhlitis
- Pancreatitis
- Constipation/Ileus
Acute Abdomen

Symptoms: Pain (location, quality & timing), blood in stool or emesis, constipation, absence of flatus

Signs/Assessment: Location of pain, pain with movements, abdominal distention, assessment of bowel sounds

Critical Points for Oncology Patients:

1. Classic Physical Exam findings may not be present in a neutropenic patient

2. Steroids mask signs & symptoms of acute abdomen
Acute Abdomen

Differential Diagnosis

• Typhlitis (neutropenic enterocolitis):
  - necrotizing colitis of the terminal ileum cecum
• Pancreatitis:
• Constipation/Ileus
• Appendicitis: Don’t forget about it!
Radiology Findings: Typhlitis

Gas in bowl wall

Thickening of cecal wall
Radiology Findings: Pancreatitis

Acute Pancreatitis: Mottled appearance of pancreas

Complication of Pancreatitis: Development of large pseudocyst
# Abdominal Emergencies

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Patients at Risk</th>
</tr>
</thead>
</table>
| Typhlitis      | • Any patient after chemotherapy  
                  • Immunocompromised patients with prolonged neutropenia                      |
| Pancreatitis   | • ALL or lymphoblastic lymphoma patients receiving asparaginase                   |
| Constipation   | • Patients receiving frequent Vincristine  
                  • Patients post-op from abdominal surgery (Wilm’s, neuroblastoma)  
                  • Patients on chronic narcotics or recently started on new PCA           |
Acute Abdomen: Management

Typhlitis:
- NPO, antibiotics, supportive care
- Indications for Surgery
  • Persistent GI bleeding
  • Free air
  • Evidence for uncontrolled infection

Pancreatitis:
- Bowel rest, antibiotics
- Surgical drainage of abscess may be necessary

Constipation
  - Aggressive stool softeners, motility agents
Conclusions

• There are patterns to risk for oncologic emergencies: what type of patients, when during treatment, etc.
• Consider all aspects of treatment for each oncologic emergency when caring for the patient
• Always be prepared! Think about potential oncologic emergencies when patients present.
Thank you for your attention. Questions?
Reference