Patient safety is at the forefront of health care and nursing practice. Oncology nurses strive to provide safe oncologic care in their management of cancer, treatments, and side effects. Oncologic emergencies such as tumor lysis syndrome (TLS), however, are serious complications of cancer and cancer treatment. TLS often is seen in hematologic malignancies, such as lymphomas and leukemias, that frequently occur in older adults. As the population in the United States continues to age, nurses must be prepared to manage oncologic emergencies in older adults. Understanding the risk factors and preventive strategies for TLS provides oncology nurses with a foundation for managing a serious treatment complication. Patients and their caregivers need to understand the importance of preventive measures for TLS; therefore, patient education must be a critical part of the oncology nurse’s plan of care.

**Case Study**

Mr. F, age 70, was diagnosed with myelodysplastic syndrome (MDS) two years ago. He developed acute myelogenous leukemia (AML) about one year later. He was treated with chemotherapy and, after a prolonged blood count recovery, he returned to his baseline MDS. However, several months later, Mr. F developed thrombocytopenia and was found (via a bone marrow biopsy) to have a relapse of his AML. He was admitted to the hospital with recurrent AML for chemotherapy. His other medical conditions included coronary artery disease and hypertension. His past surgical history included three coronary artery bypass graft surgeries, appendectomy, cholecystectomy, and left knee surgery.

On admission to the hospital, Mr. F presented with fatigue and an elevated creatinine of 1.24 mg/dl. His laboratory studies revealed a white blood cell count of 32,700 U/L, hemoglobin of 8.6 g/dl, hematocrit at 25%, and platelets at 14,000 U/L. Following a transfusion of platelets and blood, his physicians decided to begin chemotherapy treatment. IV fluids and oral allopurinol were initiated for several days prior to chemotherapy administration in an attempt to prevent or minimize TLS.

Despite those preventive strategies, Mr. F experienced asymptomatic TLS, which was detected by abnormalities in his blood chemistry. Laboratory studies before, during, and after chemotherapy are shown in Table 1. Treatment interventions included monitoring his serum electrolytes and renal function every six hours. Mr. F was placed on telemetry for arrhythmia monitoring and treated with IV insulin-glucose therapy and sodium polystyrene sulfonate for hyperkalemia. Aluminum antacids were prescribed for treatment of hyperphosphatemia, and he continued to receive IV hydration and daily allopurinol for hyperuricemia.

Mr. F was closely monitored through oral intake and output measures, daily weights, and physical assessment for fluid overload. In addition, he received intermittent IV furosemide. Mr. F and his family received education about TLS through verbal communication with the primary nurse; his understanding was evaluated based on verbal discussion with his nurse. Fortunately, his condition gradually improved in about seven days. Mr. F recovered completely from TLS.
and continued with his chemotherapy for AML.

**Incidence and Prevalence**

The incidence of TLS is not precisely understood (Doane, 2002; Ezzone, 1999). It occurs most commonly in hematologic malignancies such as leukemias and lymphomas. The risk for TLS is greater in diseases such as acute and chronic leukemias and Burkitt lymphoma because of rapid cellular proliferation (Doane, 2002; Gobel, 2002). TLS occurs less commonly in patients with solid tumors. However, case reports have noted TLS occurring in solid tumors, such as small cell lung cancer (Mott, Esana, Chakmakjian, & Herrington, 2005). Because small cell cancers can grow rapidly, TLS may be more prevalent (Mott et al., 2005). TLS results in metabolic derangement that places patients with baseline renal dysfunction, including elevated creatinine, decreased glomerular filtration rate, or who are anuric or oliguric, at higher risk for the syndrome (Gobel, 2002). Older adult patients are at greater risk because of many factors, including advanced disease, compromised renal function from other comorbidities, preexisting urinary tract obstruction, polypharmacy, and drug-drug interactions (Pumo, Sciacca, & Malaguarnera, 2007). The potential risk factors are important considerations in caring for older adults who may be at risk for TLS.

**Pathophysiology**

TLS is the result of malignant cell death as a result of chemotherapy or other cytotoxic treatment. Chemotherapeutic agents that have been specifically linked with an increased risk for TLS include cisplatin, cytosine arabinoside, etoposide, intrathecal methotrexate, and paclitaxel (Doane, 2002). Although chemotherapeutic agents are the most common cause of the breakdown of malignant cells, biotherapies, radiation, and surgery have been listed as causes of TLS as well (Doane, 2002). Intracellular contents include potassium, phosphorus, and nucleic acids that are released into the bloodstream when cells die (Kaplow, 2002). That release causes electrolyte imbalance, specifically hyperkalemia, hyperphosphatemia, hyperuricemia, and hypocalcemia (Kaplow, 2002; Vachani, 2006). Clinical signs and symptoms of metabolic imbalances are presented in Table 2. Hypocalcemia occurs from hyperphosphatemia. As phosphate levels increase in the body, calcium binds to phosphate, thereby decreasing the amount of calcium in the body and resulting in hypocalcemia (Vachani, 2006).

### Table 1. Case Study: Biochemical Parameters Before, During, and After Chemotherapy

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>NORMAL RANGE</th>
<th>DAY PRIOR TO CHEMOTHERAPY</th>
<th>DAY 1</th>
<th>DAY 2</th>
<th>DAY 3</th>
<th>DAY 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUN (mg/dl)</td>
<td>8–20</td>
<td>8</td>
<td>21</td>
<td>30</td>
<td>25</td>
<td>18</td>
</tr>
<tr>
<td>Calcium (mg/dl)</td>
<td>8.9–10.3</td>
<td>8</td>
<td>8.4</td>
<td>7.8</td>
<td>7.7</td>
<td>7.7</td>
</tr>
<tr>
<td>Creatinine (mg/dl)</td>
<td>0.64–1.27</td>
<td>1</td>
<td>1.01</td>
<td>1.04</td>
<td>0.84</td>
<td>1.08</td>
</tr>
<tr>
<td>LDH (U/L)</td>
<td>98–192</td>
<td>1,765</td>
<td>4,697</td>
<td>3,718</td>
<td>3,181</td>
<td>1,100</td>
</tr>
<tr>
<td>Phosphate (mg/dl)</td>
<td>2.4–4.7</td>
<td>5.6</td>
<td>6.2</td>
<td>6.6</td>
<td>3.7</td>
<td>2.7</td>
</tr>
<tr>
<td>Potassium (mmol/L)</td>
<td>3.6–5.1</td>
<td>3.7</td>
<td>5</td>
<td>5.5</td>
<td>4.1</td>
<td>3.3</td>
</tr>
<tr>
<td>Uric acid (mg/dl)</td>
<td>4.8–8.7</td>
<td>7.1</td>
<td>7</td>
<td>5.9</td>
<td>4.5</td>
<td>4.2</td>
</tr>
</tbody>
</table>

BUN—blood urea nitrogen; LDH—lactate dehydrogenase

**Prevention**

Preventive strategies are the foundation of TLS treatment and should be implemented when treatment is initiated in patients with malignancies commonly associated with TLS and patients whose preexisting clinical conditions might predispose them to TLS. Hydration is a key factor in the prevention of TLS. IV fluids are administered 24–48 hours before therapy begins and continued for as long as 72 hours after completion to ensure adequate diuresis (Richardson, 2004). When administering IV fluids to older adults, the nurse must monitor the patient for fluid overload, which may result in heart failure. Diuretics, such as furosemide, are used to decrease fluid retention and to aid excretion of intracellular contents of malignancy cells (Ezzone, 1999). Allopurinol is a pharmacologic mainstay of TLS prevention and works by inhibiting the enzyme xanthine oxidase, which, in turn, blocks conversion of particular enzymes to uric acid, thereby decreasing uric acid in the body (Richardson, 2004). Allopurinol is administered in 600–900 mg daily doses, one or two days before chemotherapy, to prevent TLS (Ezzone, 1999; Richardson, 2004). If allopurinol is unsuccessful, rasburicase is an alternative that may be used (Held-Warmkessel, 2010). Rasburicase converts uric acid to allantoin, which is more easily filtered in the urine than uric acid (Held-Warmkessel, 2010). If neither allopurinol nor rasburicase are successful, patients may require additional symptom management.

Although IV sodium bicarbonate is controversial in TLS prevention (Held-Warmkessel, 2010), it also can be used within preventive treatment measures by helping to make uric acid more soluble for excretion (Ezzone, 1999). Current evidence suggests that sodium bicarbonate can interfere with enzymes that allopurinol addresses, thus limiting allopurinol’s effectiveness (Held-Warmkessel, 2010). The severity of TLS is dependent on the volume of intracellular byproducts released into the bloodstream and the patient’s underlying renal function at baseline.

**Treatment**

Management of the acute effects of TLS must be implemented if prevention is unsuccessful. Direct management of hyperkalemia, hyperphosphatemia, hyperuricemia, and hypocalcemia is required and is titrated to serum levels of those electrolytes. In some patients, correcting electrolyte imbalances is not possible and dialysis may be initiated. Dialysis is begun for potassium levels greater than 7 mEq/L, serum uric acid levels greater than 10 mg/dl, or serum phosphorus levels greater than 10 mg/dl, along with increasing blood urea nitrogen and creatinine levels (Richardson, 2004).
Table 2. Metabolic Abnormalities in Tumor Lysis Syndrome

<table>
<thead>
<tr>
<th>METABOLIC ABNORMALITY</th>
<th>CLINICAL MANIFESTATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyperkalemia</td>
<td>Gastrointestinal effects: diarrhea, nausea, vomiting, anorexia Neurornuscular effects: weakness, paresthesia, muscle cramps, ascending flaccid paralysis Cardiovascular effects: bradycardia, ventricular tachycardia, ventricular fibrillation, asystole, cardiac arrest, blood pressure and pulse changes; electrocardiographic changes may include peaked and narrow T waves, shortened TQ interval, widened QRS complex, loss of P wave, sine wave (blending of QRS and T wave)</td>
</tr>
<tr>
<td>Hyperphosphatemia</td>
<td>Renal effects: oliguria, anuria, azotemia, renal insufficiency</td>
</tr>
<tr>
<td>Hyperuricemia</td>
<td>Gastrointestinal effects: nausea, vomiting, diarrhea, anorexia Renal effects: edema, flank pain, hematuria, oliguria, anuria, azotemia, cloudy urine, crystalluria General: lethal</td>
</tr>
<tr>
<td>Hypocalcemia</td>
<td>Neurologic effects: muscle twitching and cramping, grimacing, carpopedal spasm, tetany, laryngospasm, paresthesias, convulsions, positive Trouseau’s and Chvostek’s sign, impaired memory, confusion, delirium, hallucination Cardiovascular effects: hypotension, slow ventricular repolarization, 2:1 heart block, ventricular arrhythmias, cardiac arrest; electrocardiographic changes may include prolonged QT interval and ST segment, lowered and inverted T wave</td>
</tr>
</tbody>
</table>


Patient Safety Considerations

Oncology nurses play a vital role in recognizing the risk of TLS for patients and in administering preventive and therapeutic management. Understanding the importance of putting preventive measures in place is the first step toward safety for those patients. Hydration and administration of allopurinol or rasburicase are key preventive measures. Knowledge of abnormal laboratory values is crucial in the nurse’s assessment of TLS. Recognizing signs of hyperkalemia, hyperphosphatemia, hyperuricemia, and hypocalcemia allows the nurse to implement treatment early in TLS. Ongoing assessment of renal function enables the oncology nurse to manage TLS. Nurses should highlight urine output, daily weights, and laboratory values such as blood urea nitrogen and creatinine in their assessments (Held-Warmkessel, 2010). Oncology nurses also play a vital role in educating patients and their caregivers on TLS prevention and treatment. Patients and their caregivers should recognize the importance of taking allopurinol or rasburicase exactly as prescribed, allowing them to take an active part in their treatment and in preventing TLS. The nurse can provide written material, along with verbal teaching, to both patients and their caregivers. Return demonstration by the patient and caregiver should include their understanding of the cause of TLS, the fluid and metabolic abnormalities associated with TLS, and the management of TLS, including medications.

Conclusion

TLS is an oncologic emergency caused by massive tumor cell lysis and the release of large amounts of potassium, phosphate, and uric acid into the systemic circulation. Many patients undergoing cancer treatment, particularly older adults, are at risk for developing the syndrome. The best management of tumor lysis is prevention. Oncology nurses can enhance patient safety by identifying patients at risk for developing TLS, incorporating preventive strategies, and closely monitoring fluid and metabolic abnormalities as well as the patient’s response to treatment. Patient education must be a critical part of the oncology nurse’s plan of care.

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References


Do You Have an Interesting Topic to Share?

Safety provides readers with information on safety issues affecting patients with cancer and those caring for them. Length should be no more than 1,000–1,500 words, exclusive of tables, figures, insets, and references. If interested, contact Associate Editor Camille A. Servodidio, RN, MPH, CRNO, OCN®, CCRP, at cservod@harthosp.org.