A Patient With Tumor Lysis Syndrome

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Tumor lysis syndrome (TLS) is a potentially life-threatening metabolic disorder characterized by an elevated uric acid level, elevated serum potassium and phosphorus levels, and a decreased calcium level. Most often seen 12 to 72 hours after administration of systemic chemotherapy for a hematologic malignancy, TLS occasionally may be present prior to the start of therapy. Hematologic malignancies of concern include those that have a high proliferative rate, such as Burkitt’s lymphoma, lymphoblastic lymphoma (LBL), and B–acute lymphoblastic leukemia (B-ALL). Patients with ALL, acute myelogenous leukemia (AML), or chronic lymphocytic leukemia (CLL) who have a high WBC counts could be at risk. Lower-risk patients include those who have indolent lymphomas. Patients with diffuse large-cell lymphoma (DLCL) would be considered at intermediate risk for TLS.[1]

The Patient, “Mr. B”

The patient, “Mr. B,” is a 64-year-old male with a history of CLL and a WBC count of 64,000 cells/mm³. He was treated with bendamustine (Treanda) at 100 mg/m² on days 1 and 2. Later in the day, after the second dose, the patient called the prescriber and complained of left flank pain and shortness of breath. He was instructed to return to the infusion room, where a review of systems revealed additional complaints of reduced urine output, dysuria, and anorexia. He had no cardiac complaints. Blood tests revealed a blood urea nitrogen (BUN) level of 50 mg/dL, a serum creatinine of 4.9 mg/dL, and a uric acid level of 19 mg/dL. His serum electrolyte levels were abnormal, with potassium at 5.4 mmol/L, phosphate at 8.9 mg/dL, and calcium at 6.9 mg/dL. An electrocardiogram revealed tall T waves and a heart rate of 88 beats per minute. His home medication list was reviewed by the nurse and included allopurinol at 300 mg daily. IV fluids of normal saline were started at an infusion rate 200 mL/hour, and the patient was admitted to a medical oncology nursing unit with telemetry, having been diagnosed with tumor lysis syndrome (TLS) with acute kidney injury (AKI). An indwelling urinary bladder catheter was inserted; 50 mL of urine was obtained and this was sent for urine analysis and a test of urine electrolytes. The patient was then prescribed rasburicase (Elitek) at 6 mg IV as a one-time dose and sodium polystyrene sulfonate at 15 grams orally.

Pathophysiology

TLS is the result of large numbers of malignant cells dying and releasing their intracellular components—potassium, phosphorus, nucleic acids, and proteins—into the bloodstream. Proteins and nucleic acids are broken down by the liver enzyme xanthine oxidase into uric acid.[2,3] The excess amount and rapid influx of these substances into the bloodstream may rapidly overwhelm the excretory capacity of the kidneys, resulting in elevated blood levels. Because the kidneys cannot excrete the excess uric acid, it begins to precipitate in the kidneys, resulting in uric acid nephropathy[4] and subsequently AKI. Concurrently, the kidneys attempt to eliminate the excess potassium in the blood, and this results in a fluid volume deficit.[2] The reduced intravascular volume, in turn, translates to decreased perfusion to the kidneys, causing AKI. Increased intravascular phosphorus also causes the kidneys to increase their output to bring down this elevated level. The excess phosphorus binds with serum calcium, resulting in calcium-phosphate precipitates in the kidneys and thereby exacerbating the renal problem.[2,4] The development of AKI in this setting is multifactorial and requires aggressive intervention.
Classification

According to the classification system developed by Cairo and Bishop,[4] TLS may be designated as either laboratory TLS or clinical TLS. Laboratory TLS is present when there are elevations in uric acid, potassium, and phosphorus levels (25% above baseline) and a reduced calcium level (25% below baseline). Clinical TLS is present when the creatinine level is 1.5 times the upper limit of normal or higher, or if the patient has seizures or cardiac dysrhythmias, or if there is sudden death.

<table>
<thead>
<tr>
<th>Sign and Symptoms</th>
<th>Organ / Organ System Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gastrointestinal</td>
<td>Anorexia, Nausea, Vomiting, Diarrhea</td>
</tr>
<tr>
<td>Heart</td>
<td>Dysrhythmias, Sudden death, Elevated T waves, Wide QRS, Hypertension</td>
</tr>
<tr>
<td>Kidneys</td>
<td>Decreased or absent urine output, Sediment, Hematuria, Acute kidney injury, Obstructive uropathy, Flank pain, Edema, Fluid overload</td>
</tr>
<tr>
<td>Neuronal</td>
<td>Tetany, Lethargy, Weakness, Cramps, Paralysis, Fatigue</td>
</tr>
<tr>
<td>Laboratory Results Affected by TLS</td>
<td>Elevated uric acid, Elevated potassium, Elevated phosphate, Decreased calcium</td>
</tr>
</tbody>
</table>

Table 1: Signs and Symptoms Associated With Tumor Lysis Syndrome

Signs and Symptoms

Patients may experience a variety of signs and symptoms related to TLS. Body systems primarily affected include the heart, kidneys, and gastrointestinal (GI) and neuromuscular systems.[5] Cardiac dysrhythmias due to hyperkalemia may be fatal. AKI and hematuria may be present. Neuromuscular symptoms include tetany, and gastrointestinal symptoms include nausea and vomiting. Table 1 outlines the signs and symptoms associated with TLS.

Nursing Management

The patient with TLS is acutely ill and requires astute nursing care to avoid complications from AKI and electrolyte imbalances. Hydration is critical. IV fluids are administered at a rate of 2 to 3 L/m²/day to promote diuresis, with the goal of a urinary output exceeding 100 mL/m²/hour.[4,6] Some patients may require a diuretic such as mannitol to promote diuresis, but this needs to be considered on an individualized basis. Strict intake-and-output and daily weight measurement are essential to assess and monitor the patient’s fluid balance. Historically, sodium bicarbonate has been added to IV fluids to alkalize the urine, with the goal of enhancing uric acid excretion. However, alkalization may promote calcium phosphate and uric acid renal precipitation, thereby causing metabolic acidosis, so its use is not recommended.[1,7] Alkalization is avoided in patients who are going to receive rasburicase.[1] Because Mr. B was scheduled to receive rasburicase, his IV fluids consisted of...
A Patient With Tumor Lysis Syndrome
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normal saline. Also, nephrotoxic agents such as non-steroidal anti-inflammatory agents (NSAIDs) are to be avoided.[6]
Electrolyte imbalances must be managed to prevent serious adverse events. Avoid adding calcium, potassium, and phosphates to IV fluids.[4] Medications containing potassium and phosphorus must be avoided. In addition, the patient’s diet may need to be modified to reduce potassium and phosphorus intake.[8]

**Hyperkalemia** develops quickly, often within 6 to 72 hours after chemotherapy has started.[9] Asymptomatic patients, like Mr. B, may be managed with oral or rectal (if patient is not neutropenic or thrombocytopenic) sodium polystyrene sulphonate (1 g/kg with 50% sorbitol).[4] Symptomatic patients are managed with IV glucose and rapid-acting insulin to force potassium back into the cells.[1,4,9] Cardiac monitoring is required for patients with hyperkalemia, to monitor for dysrhythmias.

**Hyperphosphatemia** is managed with ongoing hydration, diuresis, avoiding calcium infusions, and oral phosphate binders such as aluminum hydroxide (for 1 to 2 days only) or oral calcium carbonate (only if the serum calcium level is low).[1,6,9] Dextrose and insulin administered intravenously have also been used to manage elevated phosphate levels.[10]

**Hypocalcemia** is treated only if the patient has cardiac toxicity or neuromuscular symptoms (such as seizures, tetany), as calcium can combine with phosphorus and worsen precipitation in the soft tissues.[2] If ordered, calcium gluconate is administered while the patient is monitored for Bradycardia using cardiac monitoring.

**Hyperuricemia** Allopurinol is used to prevent formation of uric acid in at-risk patients. The drug is available both orally and as an IV formulation. Patients need to be monitored for rash, a common side effect. By interfering with xanthine oxidase, allopurinol interferes with the conversion of purines into hypoxanthine and then into xanthine, both of which are uric acid precursors.[4] As a result, there are elevated levels of both hypoxanthine and xanthine, and these could potentially precipitate in the kidneys. Allopurinol will not degrade existing uric acid in the blood, so it is not as effective in reducing pre-existing elevated levels as it is in preventing uric acid formation.[11] Doses administered range from 200 to 400 mg/m²/day divided in up to three doses per day (eg, every 8 hours).[1] Metabolized by the cytochrome P450 system, allopurinol affects the metabolism of 6-mercaptopurine. **TABLE 2**

### Use of Rasburicase in the Management of Tumor Lysis Syndrome

**Rasburicase** is recombinant urate oxidase. and it converts uric acid to allantoin, which is very soluble and therefore easier for the kidneys to eliminate.[12] It quickly reduces uric acid levels.[13,14] The most common side effects of rasburicase include headache, rash, fever, and vomiting, which are mostly mild.[13] Hyposensitivity reactions have occurred in less than 1% of patients; they require permanent drug discontinuation when the reaction is serious.[15,16] Dosing ranges from 0.2 mg/kg IV over 30 minutes daily for up to 5 days to a single dose of 6 mg IV over 30 minutes.[13–15] The US Food and Drug Administration approved dose of rasburicase is 0.2 mg/kg over 30 minutes IV daily for 5 days.[16] **Table 2** provides additional information related to rasburicase.

**Case Study**

**Patient Management**
The nurse prepares to treat Mr. B with rasburicase as prescribed. A medication reconciliation is performed to ensure that allopurinol has been placed on hold. Allopurinol may interfere with rasburicase activity, as allopurinol reduces uric acid formation and rasburicase acts on uric acid to convert it to allantoin. Patient allergies are checked and the patient’s history is reviewed for a known diagnosis of glucose-6-phosphate dehydrogenase (G6PD) deficiency. The negative history findings are confirmed with the patient. Hemolysis may occur in patients with G6PD deficiency who receive rasburicase, and it is therefore contraindicated.[16] Also, the nurse checks to ensure that Mr. B has no prior history of asthma or severe allergies to other medications or to rasburicase or urate oxidase.[17] In Mr. B’s case, none of these issues were present. If they are present, however, the nurse should discuss the findings with the prescriber. If required, allopurinol may be restarted about 24 hours after rasburicase has been administered.  

TABLE 3

Nursing Management of Patients With Tumor Lysis Syndrome

Mr. B was educated as to the signs and symptoms of a hypersensitivity reaction (HSR) and instructed to report their presence immediately to the nurse. Making sure emergency medications were readily available and his vital signs (VS) were assessed, the nurse started Mr. B’s rasburicase infusion to run over a period of 30 minutes. By staying at the patient’s bedside for at least 5 minutes to monitor for signs and symptoms of a HSR, and by continuing to monitor the patient and VS during the remainder of the infusion as per hospital policy,[17] the nurse ensured that the drug was safely administered. The nurse was prepared to stop the infusion and manage signs and symptoms of a HSR. Mr. B tolerated the infusion without any symptoms.

Laboratory Monitoring

When blood specimens are drawn and sent to the laboratory, special care and prompt processing are required, as rasburicase present in the patient’s blood also acts ex vivo to convert uric acid to allantoin, yielding false-low test results. The specimen should be drawn into a prechilled blood tube containing heparin and immersed in an ice-water bath. It must be sent to the laboratory promptly, as it needs to be processed within 4 hours after being drawn.[16,17] Blood testing for patients with TLS treated with rasburicase is done 4 hours after dosing and repeated every 6 to 8 hours until TLS has resolved. In addition to uric acid levels sent to the laboratory in chilled tubes on ice, other specimens obtained include those for renal function tests, electrolytes, levels of calcium, phosphorus, and LDH.[1]

Key Points

- TLS is a potentially life-threatening complication.
- Patient safety is crucial, including fall prevention
- On a routine basis, monitor fluid balance and electrolyte levels.
- Assess renal, cardiac, gastrointestinal, and neuromuscular systems for signs and symptoms.

Nursing Assessments and Interventions

Patients’ renal, cardiac, neuromuscular, and gastrointestinal systems may develop signs and
symptoms related to TLS, requiring physical assessments and frequent monitoring, with the frequency dependent upon the severity of TLS and the patient’s complaints and assessment findings. Safety measures are crucial, and the electrolyte disorders place the patient at risk of seizures and dysrhythmias. These patients are critically ill and at risk for injuries such as falls, so precautions against patient falls are critical. Additional nursing measures are highlighted in Table 3.

**Summary**

When caring for a patient with TLS, astute nursing care is required for positive patient outcomes. Assessments and monitoring are required for prompt management of complications and patient safety. Because of the skilled nursing care that Mr. B received, along with supportive medications and hydration, his renal function improved, with increased urine output, normalization of electrolytes, and return of his appetite.

**Financial Disclosure:** Jeanne Held-Warmkessel serves on the speakers bureau for Cephalon.

**References:**


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