Oncologic emergencies in pediatrics

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Abstract

Childhood cancer survival rate has significantly improved since the 1970s, owing not only to advances in treatment but also to better supportive care. Knowing, recognizing, and promptly diagnosing hematologic-oncologic emergencies has also played a fundamental role in the improvement in survival, because these complications are life-threatening and associated with high morbidity. In general, these complications occur not only at the time of diagnosis but also during treatment or when the disease relapses. This improved survival has come hand in hand with an increase in the complications caused by both the disease and its treatment, and the use of novel drugs may cause new complications to arise. It is imperative that pediatricians be familiar with these complications, to allow for a prompt diagnosis that helps reduce their morbidity and mortality.

Resumen

La supervivencia del cáncer infantil ha aumentado significativamente desde los años 70, no solo por los avances en los tratamientos, sino también por un mejor tratamiento de soporte. Conocer, identificar y diagnosticar precozmente las urgencias oncológicas también juega un papel fundamental en este incremento de la supervivencia, dado que son complicaciones potencialmente letales y con una alta morbilidad asociada. En general, las complicaciones no son exclusivas del momento del diagnóstico, pudiendo aparecer también durante el tratamiento o en momentos de recaída. El incremento de la supervivencia también ha supuesto un aumento de las complicaciones asociadas tanto a la enfermedad como al tratamiento, y el empleo de nuevos fármacos puede hacer que aparezcan complicaciones nuevas. Es fundamental que todo pediatra conozca estas complicaciones para poder facilitar un diagnóstico precoz que reduzca la morbimortalidad de estos procesos.

Key words: *Febrile neutropenia; Tumor lysis syndrome; Leukostasis; Superior vena cava syndrome; Spinal cord compression.*

Palabras clave: Neutropenia febril; Síndrome de lisis tumoral; Leucostasis; Síndrome de vena cava superior; Compresión medular.

OBJECTIVES

- To know the initial emergency department management of oncology patients with fever and neutropenia.
- To recognize the clinical presentation of superior vena cava syndrome and know how to apply general supportive measures.
- To be able to identify the symptoms associated with leukostasis and the strategies to prevent it.
- To maintain a high index of suspicion to recognize spinal cord compression syndrome and identify it as a true emergency.

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Introduction

The reasons for pediatric emergency department visits by patients with cancer may be due to conditions typical of their age or related to their underlying diagnosis or the treatment received[1].

The increase in childhood cancer survival over recent decades is due to improvements in treatment and to advances in supportive care, which include appropriate recognition and management of oncologic emergencies[2,3]. In this article we address some of the most relevant ones, whether because of their frequency or their severity, to facilitate their identification when oncology patients present emergently.

Fever and neutropenia

Oncology patients with fever should be evaluated promptly, without delaying administration of the first dose of intravenous antibiotic.

Fever and neutropenia is one of the most relevant complications in pediatric cancer patients, both for its frequency and for its morbidity and mortality. These patients have multiple risk factors for infection, and fever may be the only sign present, because neutropenia or corticosteroid treatment can mask local inflammatory signs.

Fever may be due to multiple causes, including the underlying disease itself.

Table I. Risk factors for clinically significant infection and bacteremia in febrile neutropenia

Patient-dependent	– Age under 12 months – Down syndrome – Bone marrow aplasia (except that secondary to chemotherapy) – Primary immunodeficiency
Diagnosis-dependent	– Recent diagnosis of oncologic disease (6 weeks ago or less) – Diagnosis of AML – Recent or active chemotherapy (except: maintenance phase in ALL or Langerhans cell histiocytosis, or weekly vinblastine)
Treatment-dependent	– ALL induction phase – Allogeneic or autologous stem cell transplant 3 months ago or less – History of hematopoietic stem cell transplant with immunosuppressive treatment at present
Dependent on the current presentation	– Poor general condition – Hemodynamic instability at the time of arrival at the emergency department – Increase in acute-phase reactants – Neutrophils ≤ 300/mm³ – Platelets ≤ 50,000/mm³

ALL: acute lymphoblastic leukemia; AML: acute myeloid leukemia.

However, because of the risk of severe, potentially life-threatening bacterial infection, it is recommended to systematically initiate early empiric antibacterial treatment.

According to the guideline of the Spanish Society of Pediatric Infectious Diseases and the Spanish Society of Pediatric Hematology and Oncology, fever and neutropenia is defined as a single axillary temperature of at least 38.3°C or two readings of 38°C or higher separated by at least one hour, in a patient with a neutrophil count ≤500/µL, or ≤1,000/µL with an expected decline over the following 48 hours (for example, due to chemotherapy in the previous week)[4].

Multiple risk factors for clinically significant infection have been described, some of which are listed in table I[5].

Initial management of the patient with fever and neutropenia begins with assessment of the Pediatric Assessment Triangle, followed by the ABCDE sequence in unstable patients. Because of the immunosuppressed state, every patient should be evaluated promptly with a complete physical examination, with particular attention to the oral cavity, the perianal region, and the central venous catheter (CVC) area.

In all patients with fever and suspected neutropenia, a complete laboratory workup with acute-phase reactants and blood cultures from all lumens of the CVC should be obtained. Depending on the accompanying symptoms, the following should also be performed: paired peripheral blood cultures (when CVC infection is suspected), urinalysis and urine culture obtained without catheterization (especially in incontinent patients or with symptoms compatible with urinary tract infection), chest radiograph (with respiratory symptoms), or stool culture with *Clostridium difficile* testing (if diarrhea is present)[6]. Routine collection of paired blood cultures is recommended in some guidelines, although so far without a demonstrated benefit.

Intravenous antibiotic treatment should be started early, without waiting for laboratory results, since delaying it is associated with higher mortality and severe sepsis. Regarding antibiotic selection, local resistance patterns, whether the patient is colonized by resistant organisms, and the clinical status must be taken into account. In all cases, coverage for *Pseudomonas aeruginosa* must be provided, with cefepime or piperacillin-tazobactam being the most frequently used. In unstable patients, the most commonly used first-line regimen is meropenem combined with an aminoglycoside and a glycopeptide (triple therapy). In cases of severe mucositis, cellulitis, or suspected CVC infection, a glycopeptide should be added to better cover gram-positive organisms, and if an abdominal source is suspected, anaerobic coverage should be ensured (see Algorithm 1 at the end of the article).

Additional measures include protective isolation and admission to individual rooms. Antiviral, antifungal, and trimethoprim-sulfamethoxazole prophylaxis should be maintained, while other antibiotic prophylaxis should be discontinued. Treatment with granulocyte colony-stimulating factor should also be continued, and it should be initiated in patients with solid tumors, while its use in patients with hematologic malignancies should be assessed individually.

Broadening coverage is not recommended in stable patients during the first 72 hours, except to provide targeted treatment. In case of clinical deterioration, escalation to triple therapy is indicated.

In confirmed CVC infection, removal is mandatory in cases of persistently positive blood cultures after 72 hours of appropriate antibiotic therapy, hemodynamic instability, complications, or if the causative pathogens are: *S. aureus, P. aeruginosa*, fungi, or mycobacteria.

If fever persists for more than 96 hours after the start of antibiotic therapy, an invasive fungal infection should be suspected. Some risk factors are: prolonged neutropenia, acute myeloid leukemia (AML), high-risk or relapsed leukemia, immunosuppressive treatment (including high-dose corticosteroids), and the first year after bone marrow transplantation. In these patients, a diagnostic workup with abdominal ultrasound and chest CT is recommended, along with initiation of empiric treatment with liposomal amphotericin B or caspofungin.

Hyperleukocytosis (and leukostasis)

Hyperleukocytosis increases morbidity and mortality, which rises further when it manifests clinically as leukostasis.

Hyperleukocytosis is defined as a white blood cell count greater than 100,000/µL in a patient with leukemia. It carries increased morbidity and mortality because of the risk of bleeding and of leukostasis. It occurs most frequently in patients with AML and acute lymphoblastic leukemia (ALL)[7].

Leukostasis refers to symptomatic hyperleukocytosis. It is due to tissue hypoxia caused by the excess of blasts, which slow blood flow and cause thrombosis at the capillary level. It occurs mainly in myeloid leukemias; in ALL it is very uncommon, so other possible causes should always be evaluated, even when hyperleukocytosis is present.

The diagnosis of hyperleukocytosis is based on laboratory findings and may produce:

- Tumor lysis syndrome (TLS).
- Coagulopathy: disseminated intravascular coagulation occurs in up to 40% of patients with hyperleukocytosis.
- Thrombocytopenia: a consequence of bone marrow infiltration and peripheral consumption.

The diagnosis of leukostasis, on the other hand, is clinical and may manifest as:

- CNS involvement: this is the most frequent (40% of patients) and consists of headache, ataxia, visual disturbances, drowsiness and, in severe cases, coma.
- Respiratory failure: this is the second most frequent manifestation and usually involves severe hypoxemia with diffuse alveolar or interstitial infiltrates.
- Fever: a consequence of systemic inflammation.
- Signs and symptoms of organ dysfunction in other organs due to infarcts (less frequent).

Treatment, whose early initiation improves survival, is based on:

- Supportive care:
  - Prevention of TLS: diuretics should be avoided when hyperleukocytosis is present so as not to reduce intravascular volume.
  - Transfusion therapy: red blood cells increase blood viscosity, so red cell transfusions should be avoided. If essential, the dose should be limited to 5 mL/kg. Platelets and fresh frozen plasma do not alter viscosity and can be transfused freely.
  - Correction of coagulopathy: by administration of fibrinogen, platelets, or fresh frozen plasma.
- Cytoreductive therapy: this is the mainstay for reversing hyperleukocytosis and minimizing symptoms[8]:
  - Pharmacologic: chemotherapy should be used in AML and corticosteroids in ALL.
  - Leukapheresis: a procedure by which leukocytes are selectively removed. It carries a high risk of mortality and its effect is transient if chemotherapy is not started, so it is reserved for selected cases.

Metabolic emergencies

Metabolic complications are very common in oncology patients, some of them being exclusive to patients with tumoral disease.

Tumor lysis syndrome

Definition

TLS is a metabolic complication caused by the massive and rapid cytolysis of tumor cells. Although it is severe and potentially life-threatening, it can be prevented in many cases with appropriate prophylaxis.

The defining criteria (Table II)[9] may be based on laboratory findings alone or may be accompanied by clinical abnormalities. It usually appears after the start of chemotherapy, although it can occur spontaneously.

Pathophysiology

Cytolysis of tumor cells releases potassium, phosphate, and nucleic acids into the bloodstream. When many cells are destroyed rapidly, homeostatic mechanisms are overwhelmed, resulting in hyperkalemia (the first abnormality observed), hyperphosphatemia (and, secondarily, hypocalcemia), and hyperuricemia. In the kidney, uric acid and calcium phosphate crystals precipitate, reducing the elimination of cell-death products and increasing renal damage. This initiates a vicious cycle that, if appropriate measures are not taken, will lead to clinical TLS.

Risk stratification

This is essential, as it allows the prophylaxis strategy to be decided. It is based on three pillars: the patient, the disease, and the treatment (see Algorithm 2 at the end of the article)[10,11].

With respect to the patient, it is essential to know whether there is renal dysfunction or the use of medications that raise the laboratory parameters of TLS. Renal tumor infiltration or renal damage are considered high-risk situations for TLS.

With respect to the disease, TLS is more frequent in neoplasms with a large tumor burden, a high proliferation rate, or high treatment sensitivity. The risk increases with elevated LDH, a mass ≥10 cm, or marked hepatosplenomegaly.

With respect to treatment, the greatest risk is during the initial phase (induction).

Prophylaxis

Its goal is to prevent electrolyte abnormalities and the precipitation of crystals in the kidney. It is based on hyperhydration, uricosuric drugs, and renal protection.

Table II. Definition of tumor lysis syndrome

Laboratory tumor lysis syndrome (presence of ≥ 2 criteria)	
Uric acid	≥8 mg/dL or a 25% increase over baseline
Potassium	≥6 mEq/L or a 25% increase over baseline
Phosphorus	≥2.1 µmol/L or ≥6.5 mg/dL or a 25% increase over baseline
Calcium	≤1.75 µmol/L or ≤7 mg/dL or a 25% decrease from baseline
Clinical tumor lysis syndrome (presence of ≥ 1 laboratory criterion and ≥ 1 clinical criterion)	
Creatinine ≥1.5 times the upper limit of normal (age-adjusted)	
Cardiac arrhythmia	
Sudden death	
Seizure	

Source: Cairo MS et al.[9]

Hyperhydration

This is essential, both for prophylaxis and for treatment. It consists of intravenous administration of potassium-free fluid at a rate of 2.5-3 L/m^2/day (200 mL/kg/day if weight <10 kg). A urine output of at least 60-80% of intake should be ensured, for which furosemide may be needed.

Uricosuric medications

Two are available for use in pediatrics: allopurinol and rasburicase.

- Allopurinol: administered orally at a dose of 100 mg/m^2 every 8 hours. It is the treatment of choice in patients at low or intermediate risk.
- Rasburicase: before its use, glucose-6-phosphate dehydrogenase deficiency must be ruled out, since it can trigger hemolysis. It is used in patients at high risk of TLS, with elevated uric acid levels, or with a laboratory trend toward TLS despite allopurinol prophylaxis. The dose is 0.2 mg/kg every 24 hours intravenously.

Monitoring

This must be clinical (fluid balance and blood pressure) and laboratory-based (renal function and electrolytes). The frequency will depend on the risk; it is usually performed every 8-12 hours.

Treatment

The mainstay remains hyperhydration and rasburicase, correction of electrolyte abnormalities, and, in severe cases, renal replacement therapy. Appropriate initial management can halt progression to the clinical form.

Hyperhydration and fluid-electrolyte balance

If the patient tolerates it, the rate can be increased up to 4 L/m^2/day, always with strict fluid and electrolyte monitoring.

Hyperuricemia

Treatment is with rasburicase, at the same dose as for prophylaxis. It can be continued for up to 7 days if needed to resolve the TLS.

Correction of electrolyte abnormalities

The corresponding abnormality is treated, with the exception of hypocalcemia, which is corrected only if symptomatic (arrhythmias, seizures, or tetany).

Renal replacement therapy

The indications are the same as for other causes of acute renal failure. It should be considered early, since electrolyte abnormalities can worsen very rapidly in these patients.

Malignant hypercalcemia

Malignant hypercalcemia (corrected serum calcium >12 mg/dL) is a rare complication in pediatric oncology (0.4-1.3% of patients). It most commonly occurs at diagnosis. The most frequent origin is as a paraneoplastic syndrome due to secretion of PTH-related protein, which stimulates osteoclasts and bone resorption[12].

Symptoms depend on blood calcium levels; values <13 mg/dL are usually asymptomatic. Manifestations may be gastrointestinal (anorexia, nausea, or constipation), cardiovascular (bradycardia or arrhythmias), renal (polyuria or polydipsia), or neuromuscular (asthenia, hypotonia, or stupor). The most severe symptoms are acute renal failure, severe arrhythmias, or coma.

Treatment is based on:

- Increasing renal elimination of calcium with abundant hydration and furosemide. This may be sufficient in mild cases.
- Decreasing bone resorption of calcium:
  - Glucocorticoids: useful in hematologic malignancies.
  - Bisphosphonates: the most commonly used is pamidronate, and they are usually effective within 24-48 hours.
  - Calcitonin: can prolong the effect of bisphosphonates.
- Other: dietary calcium restriction, treatment of the underlying disease, or hemodialysis in severe cases.

Syndrome of inappropriate antidiuretic hormone secretion (SIADH)

SIADH is due to excessive secretion of ADH unrelated to plasma osmolality, which increases renal water reabsorption and causes dilutional hyponatremia. It accounts for up to 30% of the causes of hyponatremia in children with cancer[13].

It usually has a pharmacologic origin, especially due to vincristine. It may also be caused by CNS tumors or lymphomas, stress, or pulmonary inflammation.

It is diagnosed by the presence of euvolemic hyponatremia associated with a plasma osmolality <275 mOsm/L and a urinary sodium excretion >20 mEq/L. Patients are usually asymptomatic; the clinical picture relates to the severity or rapidity of onset. It is usually nonspecific and may present with headache or nausea, lethargy, seizures, or coma in more severe situations.

Treatment is based on fluid restriction. Intravenous intake should be 40 mL/kg/day in infants and 30-40 mL/kg/day in children, with a solution containing 40 mEq/L of sodium. In cases of severe or symptomatic hyponatremia, treatment with 3% hypertonic saline (3-5 mL/kg) is required. Correction of serum sodium should not exceed 8-12 mEq/L in the first 24 hours.

Adrenal crisis

Pediatric cancer patients often receive prolonged corticosteroid therapy, which exposes them to a risk of chronic adrenal insufficiency and adrenal crises in situations of stress, with a high risk to life.

It presents with nonspecific symptoms such as weakness, asthenia, anorexia, myalgia, or vomiting; for this reason, it should always be considered when a patient has been exposed to corticosteroids and presents with signs of infection or hemodynamic instability. On laboratory testing, it may present with hyponatremia, hyperkalemia, metabolic acidosis, and hypoglycemia[14].

Treatment varies according to clinical severity. It is usually recommended to administer a hydrocortisone bolus of 50-100 mg/m^2 (maximum dose 100 mg), followed by that same dose distributed over 4 daily doses. In addition, laboratory abnormalities should be corrected, and it is recommended that all patients receive a fluid bolus with 5% dextrose/0.9% saline at 10 mL/kg.

Thoracic complications

Because it is a semirigid cavity, the presence of a mass or of fluid in the thorax can compromise cardiorespiratory function.

Superior vena cava syndrome (SVCS)

In the pediatric age group, because of its caliber, thin wall, and low intravascular pressure, the vena cava is easily collapsible. SVCS refers to the signs and symptoms resulting from obstruction of

blood flow through the superior vena cava. It is called superior mediastinal syndrome when it is associated with tracheal compression.

The most frequent cause of SVCS in pediatrics is a mediastinal mass, followed by thrombosis. In pediatric oncology, the most frequent causes of a mediastinal mass are lymphomas, T-cell lymphoblastic leukemias, germ cell tumors, and tumors of neuroblastic lineage[15].

The most common symptoms are dyspnea, cough, stridor, or orthopnea, typically worsened in the supine position. On examination, we may find edema of the head and neck, venous distension and collateral circulation, facial plethora or chemosis, and headache that increases when lying down.

Initial diagnosis is made with a chest radiograph, which is completed with a chest CT, always considering the risks of the procedure, particularly when patients require sedation.

When cancer is suspected, samples should be taken from the most accessible tissue or from body fluids (such as pleural effusion) for diagnosis, prioritizing the use of local anesthesia whenever possible to minimize risk.

Treatment should be started as soon as possible. General measures include positioning the head of the bed at 30-45º, respiratory and hemodynamic support, prevention of TLS, and anticoagulant treatment if appropriate. When the suspected diagnosis is lymphoma or leukemia, corticosteroid treatment should be started; when a solid tumor is suspected without a histologic diagnosis, chemotherapy should be used, or radiotherapy if there is no response to the former[16].

Pleural effusion, and cardiac effusion and tamponade

Effusions occurring in the child with cancer are usually due to thoracic or mediastinal tumors, fluid overload, hypoalbuminemia, or heart failure.

Clinically, pleural and pericardial effusions usually present with a similar picture: dyspnea, tachycardia, orthopnea, respiratory distress, chest pain, and cough, although they frequently follow a silent and indolent course. Treatment consists of drainage of the fluid, which is performed in symptomatic cases or when an etiologic diagnosis is needed[17,18].

Cardiac tamponade occurs when, as a result of the accumulation of pericardial fluid, the left ventricle loses preload and, therefore, cardiac output decreases. Its onset is directly related to the rate at which fluid accumulates. Up to one third of cardiac effusions in pediatrics have a tumoral cause, although they rarely cause tamponade. It presents with dyspnea, chest pain, or cough, in addition to tachycardia, hypotension, and pulsus paradoxus (a decrease in systolic blood pressure of more than 10 mmHg with inspiration). On the chest radiograph, a "water-bottle" heart may be seen, but the diagnosis will be made by echocardiography. Treatment consists of rapid drainage of the fluid, along with appropriate hydration and oxygenation of the patient.

Gastrointestinal emergencies

Multiple complications present with acute abdominal pain, and it is essential to recognize those that require surgical or antibiotic treatment.

The differential diagnosis of abdominal pain in an immunocompromised patient includes general conditions (appendicitis, pancreatitis, gastroenteritis, or paralytic ileus) and more specific entities (veno-occlusive disease, mucositis, or typhlitis).

Mucositis

This is one of the most frequent side effects of chemotherapy and radiotherapy, and consists of inflammation and ulceration of the mucous membranes. It can affect any part of the gastrointestinal tract. In its most severe form, it is associated with bacteremia and increased mortality.

Treatment is based on analgesia (both systemic and local, by means of specific mouthwashes) and nutritional support (with parenteral nutrition in severe cases). It is important to monitor for and treat superimposed infections, whether fungal (candidiasis), viral (herpetic stomatitis), or bacterial (both local and systemic, since mucositis facilitates bacterial translocation).

Typhlitis or neutropenic enterocolitis

This is inflammation of the intestinal wall that can affect any part of the intestine and typically occurs in neutropenic patients. It is thought to be related to infiltration by the bacterial flora due to damage to the intestinal mucosa caused by treatment.

There is a higher risk in cases of prolonged neutropenia, as occurs in acute leukemias in the induction phase, non-Hodgkin lymphomas, or neuroblastomas.

The typical presentation is febrile neutropenia with abdominal pain, which may be associated with vomiting, diarrhea, abdominal distension, or decreased bowel sounds.

The presumptive diagnosis is clinical and is confirmed by abdominal ultrasound, with visualization of thickening of the intestinal wall. Abdominal CT is used in cases of doubt[19].

Most cases respond well to conservative treatment: nil by mouth, empiric antibiotic therapy (with anaerobic coverage), intravenous hydration, analgesia, and individual assessment of the use of granulocyte colony-stimulating factors. In severely ill patients, an aminoglycoside and vancomycin should also be added, and the addition of antifungal treatment should be considered.

Bowel obstruction

It presents as abdominal pain and distension with bilious vomiting. It may be due to the tumor itself, to chemotherapy, or to previous abdominal surgery.

It is diagnosed by a recumbent abdominal radiograph, showing an abnormal pattern of air distribution and air-fluid levels.

It usually responds well to conservative treatment: nil by mouth, an open nasogastric tube, antibiotic therapy, and intravenous hydration.

Bowel perforation

It should be suspected when abdominal pain, abdominal distension, and decreased bowel sounds are present together. Neutropenic patients or those treated with corticosteroids may not show signs of peritoneal irritation on examination.

It is diagnosed by the presence of free air on an abdominal radiograph or free fluid on abdominal ultrasound or CT. It requires urgent surgical treatment.

Sinusoidal obstruction syndrome or hepatic veno-occlusive disease

This is a hepatic complication caused by endothelial damage in the sinusoid, which leads to sinusoidal destruction

Table III. Diagnostic criteria for hepatic veno-occlusive disease

Clinical criteria
- Weight gain on 3 consecutive days despite the use of diuretics, or weight gain ≥ 5% of baseline weight
- Hepatomegaly (ideally confirmed by imaging)
- New-onset ascites (preferably confirmed by imaging)

Laboratory criteria
- Transfusion-refractory thrombocytopenia not explained by other causes
- Increase in bilirubin over baseline on 3 consecutive days, or hyperbilirubinemia ≥ 2 mg/dL for 72 hours

At least 2 must be met.

that can progress to liver failure and multiorgan damage. It is typically diagnosed after hematopoietic stem cell transplantation (allogeneic or autologous), but it has also been described in relation to chemotherapeutic drugs outside this context.

The characteristic symptoms are fluid retention and hepatomegaly that is painful on palpation, with thrombocytopenia refractory to transfusions and elevated transaminases on laboratory testing, and may be associated with jaundice and hyperbilirubinemia. It is diagnosed by clinical and laboratory criteria (Table III)[20].

On hepatic Doppler ultrasound, a reduction or reversal of portal flow may be found, which is a specific but late sign.

Treatment is primarily supportive: restriction of intake and diuretics, correction of coagulopathy and hypofibrinogenemia if associated, discontinuation of hepatotoxic and nephrotoxic drugs as far as possible, and transfusion support. In the post-transplant setting, defibrotide is approved, a drug that acts at the endothelial level and whose early initiation has been shown to improve survival.

Neurologic complications

Neurologic complications are true medical emergencies and, in these patients, corticosteroid therapy is the mainstay of treatment.

Spinal cord compression syndrome

Spinal cord compression syndrome refers to the symptoms resulting from compression of the spinal cord or its nerve roots and constitutes a medical emergency.

Up to 5% of pediatric cancer patients present with acute clinical spinal cord compression[21]. The most frequently associated tumors are: sarcomas, neuroblastomas, lymphomas, and germ cell tumors. It can also be caused by traumatic bleeding.

The most frequent symptom is back pain, which worsens at night or when the patient is lying down. In every patient with cancer and back pain, spinal cord compression syndrome should always be suspected. Other associated symptoms may be gait disturbances, muscle weakness or limb paresis, sensory disturbances, and impaired sphincter control. The involvement and localization are summarized in table IV.

The diagnostic test of choice is magnetic resonance imaging. It should be performed urgently in any patient with focal neurologic symptoms, especially if they are associated with back pain[22]. In those who present with back pain without findings on neurologic examination, MRI may be delayed for up to 24 hours, provided there is no other cause that accounts for the clinical picture.

The neurologic prognosis will depend on the severity of symptoms at diagnosis and the time to initiation of treatment. The greater the clinical severity or the longer the time to treatment, the lower the likelihood of functional recovery.

Dexamethasone is the first-line treatment and should be started promptly to improve the neurologic prognosis. The recommended doses vary; in general, in pediatric patients a loading dose of 1-2 mg/kg is recommended, followed by a dose of 0.2-0.5 mg/kg every 6 hours (see Algorithm 3 at the end of the article).

When the compression is due to an epidural mass (particularly when the diagnosis is unknown) or to bleeding, surgical treatment should be performed.

In patients in whom the diagnosis is known, treatment will depend on whether or not the tumor is radiosensitive. If it can respond, the treatment of choice will be radiotherapy. In other types of tumors, chemotherapy combined with dexamethasone can help reduce tumor size.

Intracranial hypertension (ICH)

ICH is defined by the presence of symptoms and signs due to an increase in intracranial pressure. In pediatric oncology, it may be due to primary neoplasms, device malfunction (mainly ventriculoperitoneal shunts), infections, adverse effects of treatment, or hemorrhage.

Table IV. Clinical features and localization in spinal cord compression syndrome

Localization	*Weakness*	*Sensory*	*Sphincters*	*Tendon reflexes*	*Babinski*
Cervical	Profound tetraparesis	High sensory level	Infrequent involvement	Generalized hyperreflexia	Extensor
Thoracic (70% of cases)	Profound paraparesis	Sensory levels: T4 nipple line T10 umbilicus	Constipation and neurogenic bladder	Hyperreflexia in the lower limbs	Extensor
Conus medullaris	Symmetric, variable weakness	Saddle involvement	Early involvement	Increased at the knee, decreased at the ankle	Extensor
Cauda equina	Asymmetric and may be mild	Asymmetric and radicular	May be spared	Asymmetric and decreased	Plantar

The clinical picture varies with age. In infants or young children, it usually presents with more nonspecific symptoms, such as irritability or developmental changes, and signs such as macrocephaly, bulging of the anterior fontanelle, or strabismus[23]. In older children and adolescents, the most frequent symptom is headache, more intense in the morning and with nocturnal awakenings, which is relieved by vomiting. It may be associated with cranial nerve palsy, cerebellar signs, hemiparesis, or language impairment[24]. Later findings include the Cushing triad (bradycardia, hypertension, and irregular breathing), a decreased level of consciousness, and decerebrate posturing.

The initial diagnosis should be made with a head CT. In selected patients, performing a fundoscopic examination beforehand may be useful.

Management is a life-threatening emergency, and the airway, breathing, and circulation (ABC rule) should be assessed before treating the cause. General measures include: elevating the head of the bed to 30°, head in the midline, maintenance of neutral homeostasis, and treatment of associated symptoms. In patients with edema caused by tumors, abscesses, or other causes, dexamethasone should be administered (loading dose of 1-2 mg/kg followed by 0.25-0.5 mg/kg every 6 hours, with a maximum of 6 mg/dose). If herniation is suspected, hyperosmolar therapy (hypertonic saline or mannitol) should be administered[25]. If the cause is obstructive hydrocephalus, placement of a ventricular drain should be considered.

Nephrourologic complications

The most relevant nephrourologic emergencies are hemorrhagic cystitis and acute kidney injury. In both, prophylaxis and anticipation are essential.

Hemorrhagic cystitis

This consists of bladder inflammation that manifests with gross hematuria or clots in the urine, causing dysuria, urinary frequency, and urinary urgency. In pediatric oncology, the most frequent cause is chemotherapy, especially with cyclophosphamide or ifosfamide, and it usually presents within 24-48 hours after administration[26]. In the post-transplant period, the main cause is viral, mainly the BK virus[27]. It can also be caused by radiotherapy.

The diagnosis is made by the clinical picture and the history, although other causes of hematuria must be ruled out: infectious, lithiasic, or tumor infiltration. A complete urinalysis, a microbiologic study, and an imaging test should be performed to rule out obstructive uropathy secondary to the hematuria and clots, or an alternative cause of the hematuria.

Although the most important thing is prevention with hyperhydration and MESNA (a urothelial protectant), the treatment of chemotherapy-induced hemorrhagic cystitis is based on hyperhydration (3 L/m^2) and correction of thrombocytopenia or coagulation abnormalities. Pain should also be treated with analgesia and antispasmodics such as oxybutynin. In situations of urinary tract obstruction, a bladder catheter should be placed to allow continuous bladder irrigation with saline. In cystitis caused by viruses, antiviral treatment should be added.

Acute kidney injury (AKI)

This is defined as the abrupt loss of renal function that entails a decrease in glomerular filtration, dysregulation of fluid and electrolyte balance, and retention of urea and other nitrogenous products. The first assessment should be aimed at discerning whether it is prerenal, intrinsic, or postrenal in origin[28].

In children with cancer, the most frequent prerenal cause is septic shock, although it can also occur in situations of dehydration or intravascular depletion as a consequence of the secondary toxicities of chemotherapy. Abdominopelvic tumors are the most common cause of postrenal renal failure, due to obstruction of the urinary tract, although it can also occur as a consequence of clots or bleeding. Intrinsic AKI is usually due to systemic treatments with chemotherapy, targeted therapies, or anti-infectives[29].

Treatment of prerenal AKI is rehydration, which should be closely monitored in patients with systemic proinflammatory states because of the risk of capillary leak. Obstructive causes that cannot be resolved at diagnosis may require the use of urinary catheters or, as a last resort, nephrostomy. Treatment of the underlying disease will relieve the compression. In situations of AKI, the use of nephrotoxic drugs should be closely monitored, and they should be discontinued or substituted when possible.

Extravasation of cytostatic agents

Extravasation of cytostatic agents is a medical emergency, and its severity depends on the type of drug, its concentration, and the volume extravasated.

The accidental leakage of antineoplastic treatment into the perivascular or subcutaneous space is a medical emergency that requires early treatment to avoid complications. It can have serious consequences and cause tissue necrosis. Its incidence has decreased thanks to the development of preventive measures.

There are general measures that must be started as soon as extravasation is suspected: stop the infusion, disconnect the line and attempt to withdraw the residual drug by aspirating gently, immobilize the limb and keep it elevated (if the line is located in a limb), avoid compressing the area, aspirate the contents of any blisters (if they form), administer analgesics, and inform the pharmacist (who may also recommend specific measures when indicated).

As a general rule, antineoplastic drugs are classified as vesicants, irritants (high or low risk), or non-irritants, according to the likelihood of causing tissue damage (Table V)[30]. The effect in case of extravasation is also influenced by factors such as the volume extravasated, the concentration of the drug, its osmolality (greater tissue damage with higher concentration or osmolality), or the presence of certain excipients such as ethanol, which cause greater irritation.

It is essential to closely monitor patients, since the lesions may progress over days or even weeks.

Role of the Primary Care pediatrician

The primary care pediatrician may be the first point of contact for a patient at several moments of the disease, at diagnosis or at relapse. It is essential that they be familiar with the possible complications that can arise at different times during treatment in order to recognize them and act promptly, stabilizing and referring the patient.

Table V. Classification of the most commonly used cytostatics in pediatrics according to the type of tissue damage caused in case of extravasation

Vesicants (can cause both local and extensive necrosis)	– Actinomycin D – Anthracyclines (daunorubicin, doxorubicin, mitoxantrone) – Vinca alkaloids (vincristine, vinblastine, vindesine, vinorelbine)
High-risk irritants (cause local irritation, but cases of necrosis have also been described)	– Bendamustine – Busulfan – Cisplatin – Melphalan
Low-risk irritants (cause local irritation)	– Carboplatin – Etoposide – Fluorouracil – Gemcitabine – Ifosfamide – Irinotecan – Topotecan – Arsenic trioxide
Non-irritants	– Asparaginase – Cyclophosphamide – Cytarabine – Fludarabine – Methotrexate – Thiotepa

Conflict of interest

The authors declare that they have no conflicts of interest.

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References

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1. Kline C, Li AM, Newman H, Freedman JL. Oncologic Emergencies. In: Blaney SM, Adamson PC, Helman LJ, eds. Pizzo and Poplack's Principles and Practice of Pediatric Oncology. 9.ª ed. Wolters Kluwer; 2025. p. 931-61.
2. Prusakowski MK, Cannone D. Pediatric Oncologic Emergencies. Hematol Oncol Clin North Am. 2017; 31: 59-980. Available at: https://doi.org/10.1016/j.hoc.2017.08.003.
3. Mendoza Sánchez MC, Riesco Riesco S, González Prieto A. Urgencias oncológicas en Pediatría. Pediatric Oncology Emergencies. Pediatr Integral. 2019; 2: 65-80. Available at: https://www.pediatriaintegral.es/wp-content/uploads/2019/xxiii02/01/n2-065-080_Mendoza.pdf.
4.** Martínez Campos L, Pérez-Albert P, Ferrés Ramis L, Rincón-López EM, Mendoza-Palomar N, Pere Soler-Palacín, Aguilera-Alonso D. Documento de consenso de manejo de neutropenia febril en el paciente pediátrico oncohematológico de la Sociedad Española de Infectología Pediátrica (SEIP) y la Sociedad Española de Hematología y Oncología Pediátricas (SEHOP). Consensus Document on the Management of Febrile Neutropenia in Pediatric Oncohematology Patients by the Spanish Society of Pediatric Infectious Diseases (SEIP) and the Spanish Society of Pediatric Hematology and Oncology (SEHOP). An Pediatr. 2023; 98: 446-59. Available at: https://doi.org/10.1016/j.anpedi.2023.03.012.
5. Jackson TJ, Napper R, Haeusler GM, Pizer B, Bate J, Grundy RG, et al. Can I go home now? The safety and efficacy of a new UK paediatric febrile neutropenia protocol for risk-stratified early discharge on oral antibiotics. Arch Dis Child. 2023; 108: 192-7. Available at: https://doi.org/10.1136/archdischild-2021-323254.
6. Lehrnbecher T, Robinson PD, Ammann RA, Fisher B, Patel P, Phillips R, et al. Guideline for the Management of Fever and Neutropenia in Pediatric Patients With Cancer and Hematopoietic Cell Transplantation Recipients: 2023 Update. J Clin Oncol. 2023; 41: 1774-85. Available at: https://doi.org/10.1200/jco.22.02224.
7.** Arad-Cohen N, Zeller B, Abrahamsson J, Fernández Navarro JM, Cheuk D, Palmu S, et al. Supportive care in pediatric acute myeloid leukemia: Expert-based recommendations of the NOPHO-DB-SHIP consortium. Expert Rev Anticancer Ther. 2022; 22: 1183-96. Available at: https://doi.org/10.1080/14737140.2022.2131544.
8. Zeller B, Arad-Cohen N, Cheuk D, De Moerloose B, Navarro JMF, Hasle H, et al. Management of hyperleukocytosis in pediatric acute myeloid leukemia using immediate chemotherapy without leukapheresis: results from the NOPHO-DBH AML 2012 protocol. Haematologica. 2024; 109: 2873-83. Available at: https://doi.org/10.3324/haematol.2024.285285.
9. Cairo MS, Bishop M. Tumour lysis syndrome: new therapeutic strategies and classification. Br J Haematol. 2004; 127: 3-11. Available at: https://doi.org/10.1111/j.1365-2141.2004.05094.x.
10.** Chan YLT, El-Sharkawi D, Shah P, Chanouzas D, O'Connor D, Marks SD, et al. British Society for Haematology updated guidelines for the diagnosis and management of tumour lysis syndrome in adults and children with haematological malignancies: A focus on patient safety. Br J Haematol. 2025; 207: 1248-58. Available at: https://doi.org/10.1111/bjh.70092.
11. Cairo MS, Coiffier B, Reiter A, Younes A; TLS Expert Panel. Recommendations for the evaluation of risk and prophylaxis of tumour lysis syndrome (TLS) in adults and children with malignant diseases: an expert TLS panel consensus. Br J Haematol. 2010; 149: 578-86. Available at: https://doi.org/10.1111/j.1365-2141.2010.08143.x.
12.** Sargent JT, Smith OP. Haematological emergencies managing hypercalcaemia in adults and children with haematological disorders. Br J Haematol. 2010; 149: 465-77. Available at: https://doi.org/10.1111/j.1365-2141.2010.08173.x.
13.** Ellison DH, Berl T. Clinical practice. The syndrome of inappropriate antidiuresis. N Engl J Med. 2007; 356: 2064-72. Available at: https://doi.org/10.1056/nejmcp066837.
14. Hebbar KB, Petrillo T, Fortenberry JD. Adrenal insufficiency and response to corticosteroids in hypotensive critically ill children with cancer. J Crit Care. 2012; 27: 480-7. Available at: https://doi.org/10.1016/j.jcrc.2012.03.013.
15.** Nossair F, Schoettler P, Starr J, Chan AKC, Kirov I, Paes B, et al. Pediatric superior vena cava syndrome: An evidence-based systematic review of the literature. Pediatr Blood Cancer. 2018; 65: e27225. Available at: https://doi.org/10.1002/pbc.27225.
16. Garey CL, Laituri CA, Valusek PA, St Peter SD, Snyder CL. Management of anterior mediastinal masses in children. Eur J Pediatr Surg. 2011; 21: 310-3. Available at: https://doi.org/10.1055/s-0031-1279745.
17. Modi D, Jang H, Kim S, Deol A, Ayash L, Bhutani D, et al. Incidence, etiology, and outcome of pleural effusions in allogeneic hematopoietic stem cell transplantation. Am J Hematol. 2016; 91: E341-7. Available at: https://doi.org/10.1002/ajh.24435.
18. Kühn B, Peters J, Marx GR, Breitbart RE. Etiology, management, and outcome of pediatric pericardial effusions. Pediatr Cardiol. 2008; 29: 90-4. Available: https://doi.org/10.1007/s00246-007-9014-1.
19.** Cross SJ, Patel JR, Wolf J. Diagnosis and Management of Typhlitis and Neutropenic Enterocolitis in Children with Cancer. Pediatr Infect Dis J. 2022; 41: e326-8. Available at: https://doi.org/10.1097/inf.0000000000003556.
20. Corbacioglu S, Carreras E, Ansari M, Balduzzi A, Cesaro S, Dalle JH, et al. Diagno-

sis and severity criteria for sinusoidal obstruction syndrome/veno-occlusive disease in pediatric patients: a new classification from the European Society for Blood and Marrow Transplantation. Bone Marrow Transplantation. 2018; 53: 138-45. Available at: https://doi.org/10.1038/bmt.2017.161.

21.** Quraishi NA, Palliyil N, Hassanin MA, D'Aquino D, Shetaiwi A, Walker D. Malignant spinal cord compression in the paediatric population-a systematic review, meta-analysis. Eur Spine J. 2023; 32: 4306-13. Available at: https://doi.org/10.1007/s00586-023-07820-3.

22. Loblaw DA, Mitera G, Ford M, Laperriere NJ. A 2011 updated systematic review and clinical practice guideline for the management of malignant extradural spinal cord compression. Int J Radiat Oncol Biol Phys. 2012; 84: 312-7. Available at: https://doi.org/10.1016/j.ijrobp.2012.01.014.

23.** Aylward SC, Reem RE. Pediatric Intracranial Hypertension. Pediatr Neurol. 2017; 66: 32-43. Available at: https://doi.org/10.1016/j.pediatrneurol.2016.08.010.

24. Fernández-García MÁ, Cantarín-Extremera V, Andión-Catalán M, Duat-Rodríguez A, Jiménez-Echevarría S, Bermejo-Arnedo I, et al. Secondary Intracranial Hypertension in Pediatric Patients with Leukemia. Pediatr Neurol. 2017; 77: 48-53. Available at: https://doi.org/10.1016/j.pediatrneurol.2017.08.013.

25. Pitfield AF, Carroll AB, Kissoon N. Emergency management of increased intracranial pressure. Pediatr Emerg Care. 2012; 28: 200-4. Available at: https://doi.org/10.1097/pec.0b013e318243fb72.

26. Decker DB, Karam JA, Wilcox DT. Pediatric hemorrhagic cystitis. J Pediatr Urol. 2009; 5: 254-64. Available at: https://doi.org/10.1016/j.jpurol.2009.02.199.

27. Cheerva AC, Raj A, Bertolone SJ, Bertolone K, Silverman CL. BK virus-associated hemorrhagic cystitis in pediatric cancer patients receiving high-dose cyclophosphamide. J Pediatr Hematol Oncol. 2007; 29: 617-21. Available at: https://doi.org/10.1097/mph.0b013e3181461f6c.

28. Khandelwal P, McLean N, Menon S. Update on Pediatric Acute Kidney Injury. Pediatr Clin North Am. 2022; 69: 1219-38. Available at: https://doi.org/10.1016/j.pcl.2022.08.003.

29. Raina R, Abu-Arja R, Sethi S, Dua R, Chakraborty R, Dibb JT, et al. Acute kidney injury in pediatric hematopoietic cell transplantation: critical appraisal and consensus. Pediatr Nephrol. 2022; 37: 1179-203. Available at: https://doi.org/10.1007/s00467-022-05448-x.

30. Sociedad Española de Farmacia Hospitalaria - SEFH. Prevención y tratamiento de extravasaciones de fármacos antineoplásicos. Madrid: SEFH; 2020. Spanish Society of Hospital Pharmacy (SEFH). Prevention and treatment of extravasation of antineoplastic drugs. Available at: https://gruposdetrabajo.sefh.es/gedefo/images/stories/documentos/2020/monografia_extravasaciones.pdf.

Recommended bibliography

– Martínez Campos L, Pérez-Albert P, Ferrés Ramis L, Rincón-López EM, Mendoza-Palomar N, Pere Soler-Palacín, Aguilera-Alonso D. Documento de consenso de manejo de neutropenia febril en el paciente pediátrico oncohematológico de la Sociedad Española de Infectología Pediátrica (SEIP) y la Sociedad Española de Hematología y Oncología Pediátricas (SEHOP). Consensus Document on the Management of Febrile Neutropenia in Pediatric Oncohematology Patients by the Spanish Society of Pediatric Infectious Diseases (SEIP) and the Spanish Society of Pediatric Hematology and Oncology (SEHOP). An Pediatr. 2023; 98: 446-59. Available at: https://doi.org/10.1016/j.anpedi.2023.03.012.

Updated national guideline with recommendations for the management of fever and neutropenia in the oncology patient.

– Chan YLT, El-Sharkawi D, Shah P, Chanouzas D, O'Connor D, Marks SD, et al. British Society for Haematology updated guidelines for the diagnosis and management of tumour lysis syndrome in adults and children with haematological malignancies: A focus on patient safety. Br J Haematol. 2025; 207: 1248-58. Available at: https://doi.org/10.1111/bjh.70092.

Updated guidelines for the prophylaxis and treatment of tumor lysis syndrome (TLS).

– Nossair F, Schoettler P, Starr J, Chan AKC, Kirov I, Paes B, et al. Pediatric superior vena cava syndrome: An evidence-based systematic review of the literature. Pediatr Blood Cancer. 2018; 65: e27225. Available at: https://doi.org/10.1002/pbc.27225.

Systematic review of the diagnosis and treatment of superior vena cava syndrome in pediatrics, including non-oncologic causes.

– Quraishi NA, Palliyil N, Hassanin MA, D'Aquino D, Shetaiwi A, Walker D. Malignant spinal cord compression in the paediatric population-a systematic review, meta-analysis. Eur Spine J. 2023; 32: 4306-13. Available at: https://doi.org/10.1007/s00586-023-07820-3.

Systematic review addressing the epidemiology and treatment of neoplastic spinal cord compression syndrome in pediatrics.

Clinical case

A 5-year-old boy is brought to the emergency department for a 7-day history of fever, with a maximum measured temperature of 38.5°C, associated over the last two days with cough and lethargy.

He was a previously healthy patient, appropriately vaccinated, with no relevant personal or family history.

On examination he presents good general condition, normally hydrated and perfused. He is conscious, oriented, and cooperative. He has mucocutaneous pallor, without skin lesions. No retractions. Bilateral laterocervical lymphadenopathy that appears reactive. Cardiac auscultation rhythmic, tachycardic; no murmurs heard. Pulmonary auscultation with good bilateral air entry without added sounds. Abdomen soft and depressible, no masses or organomegaly palpable, nontender on palpation. Oropharynx is hyperemic, but without exudates. No focal neurologic signs, negative meningeal signs.

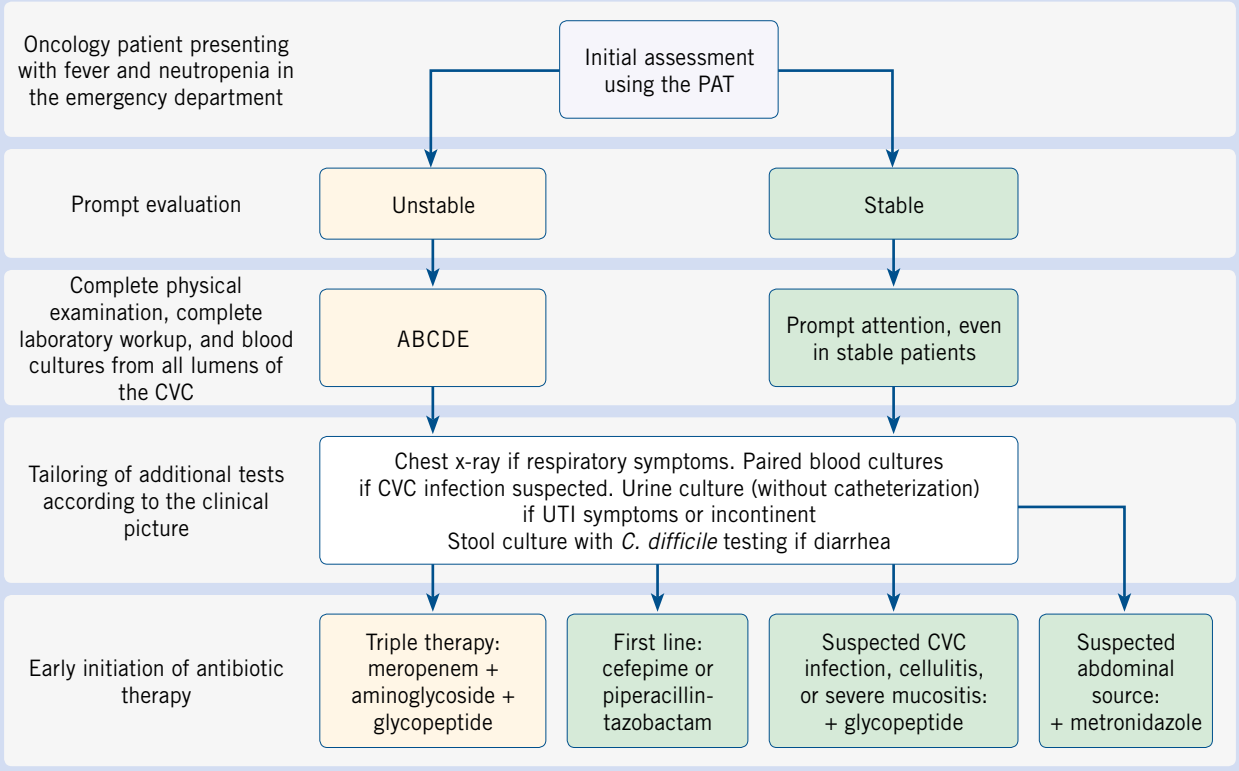
Vital signs: weight: 19.7 kg; height: 113 cm; axillary temperature: 36.4°C; BP: 108/67 mm Hg; HR: 132 bpm; RR: 24 breaths/min; SpO_2: 98%.

Because of the prolonged fever, a blood workup is obtained with the following results: complete blood count with hemoglobin of 7.4 g/dL and white blood cells of 21,500/µL (neutrophils 100/µL, lymphocytes 21,300/µL). Chemistry: creatinine 0.44 mg/dL (0.3-0.5); urea 37 mg/dL; sodium 134 mmol/L; potassium 4.4 mmol/L; and LDH 512 IU/L (207-383). Normal hepatic profile. CRP of 135 mg/L.

Given the anemia, neutropenia, and leukocytosis driven by lymphocytes, a peripheral smear is requested, which reports 78% of immature-appearing cells, suspicious for blasts, and recommends a hematologic workup for a possible new diagnosis of acute leukemia.

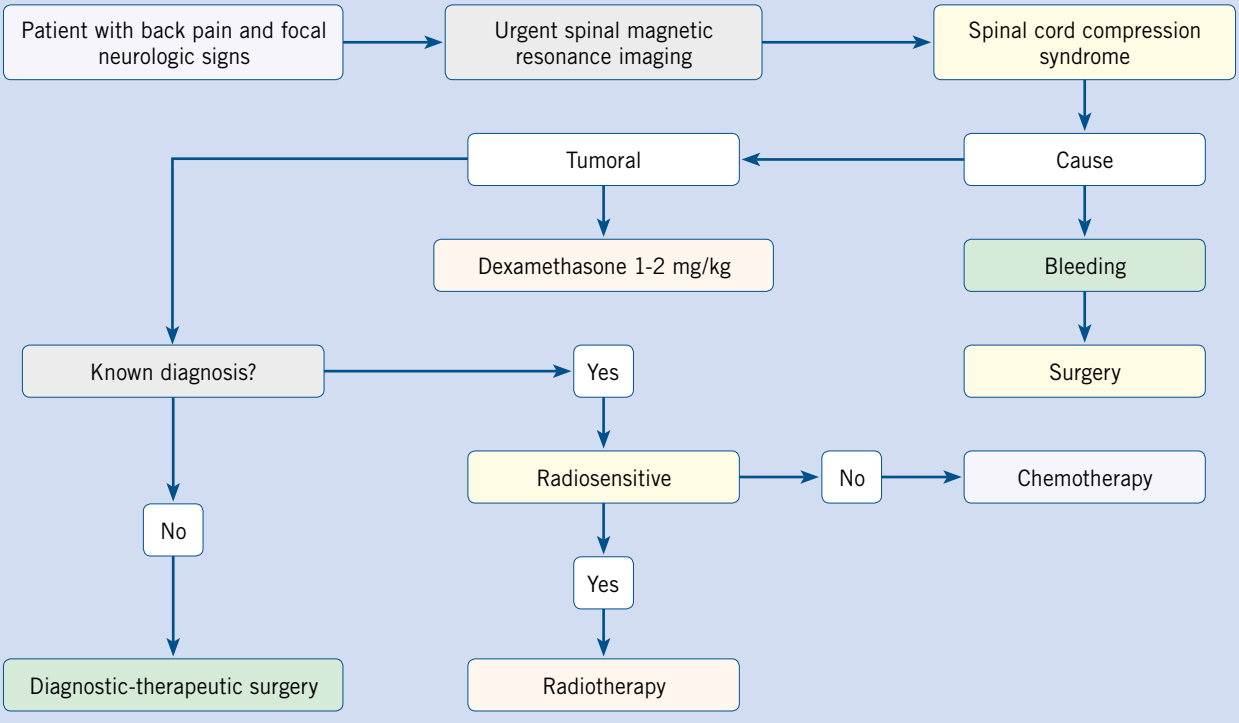
Given this situation, blood cultures are drawn and empiric antibiotic treatment with cefepime is started. The workup is expanded, adding: uric acid (3.4 mg/dL; 2.3-6.6), calcium (10.1 mg/dL; 9.5-10.8), and phosphorus (4.4 mg/dL; 4.2-6.4). Coagulation study (normal, except for elevated fibrinogen) and chest x-ray (normal). The patient is admitted under the care of pediatric hematology-oncology for diagnosis and treatment.

Algorithm 1. Initial management of fever and neutropenia in the emergency department

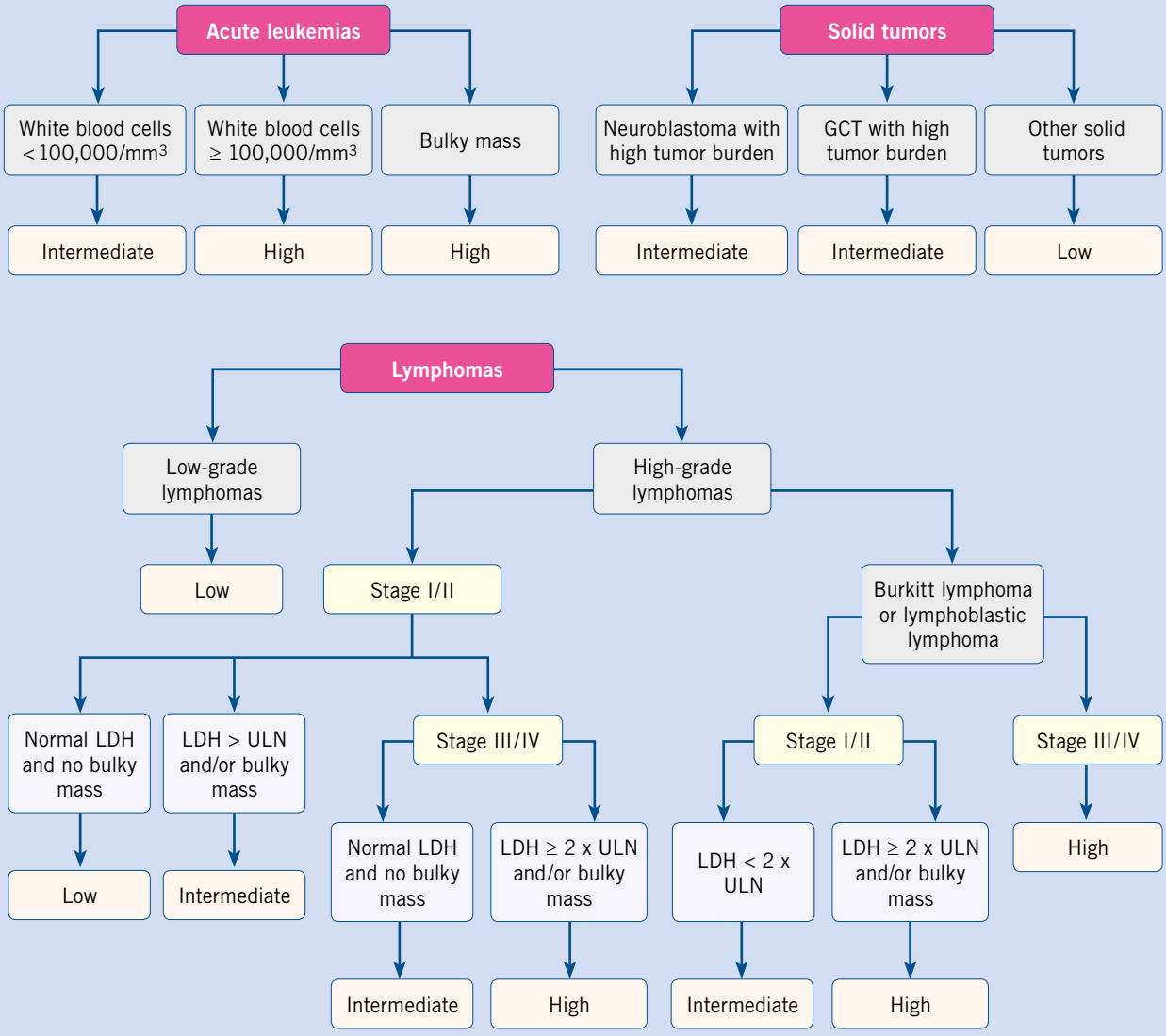


CVC: central venous catheter; PAT: Pediatric Assessment Triangle; UTI: urinary tract infection.

Algorithm 3. Diagnosis and treatment of spinal cord compression syndrome



Algorithm 2. Risk stratification of tumor lysis syndrome



Bulky mass: in general, a mass or nodal conglomerate more than 10 cm in diameter, although the size of the child must be taken into account. – GCT: germ cell tumor; Low-grade lymphoma: Hodgkin lymphoma and follicular lymphoma; ULN: upper limit of normal. – High-grade lymphomas: diffuse large B-cell lymphoma and anaplastic large-cell lymphoma.
Burkitt lymphoma and lymphoblastic lymphoma are high-grade, but their risk is stratified differently in this classification.

Accreditation quiz

The accreditation questionnaires for continuing education topics will be administered online via the website: www.sepeap.org and www.pediatriaintegral.es. To obtain continuing medical education credits (CEP-DPC/ECMECs) endorsed by SEAFORMEC, participants must be members of SEPEAP, ***complete 100% of the minimum required time, score at least 80% on the assessment test, and complete the satisfaction survey within the deadline set by the accrediting body****. The accreditation questionnaires for the various issues of the journal may be completed during the period indicated in the online questionnaire. Continuing education credits do not apply to professionals currently training as specialists in Health Sciences.*

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Oncologic Emergencies in Pediatrics

33. Which of the following clinical manifestations is NOT frequent in leukostasis?

a. Dyspnea.
b. Headache.
c. Fever.
d. Hypoxemia.
e. Acute kidney injury.

34. Which pathogen or group of pathogens is ESSENTIAL to cover empirically in all oncology patients with fever and neutropenia?

a. *Pneumocystis jirovecii.*
b. Fungi.
c. *Pseudomonas aeruginosa.*
d. Anaerobes.
e. *Staphylococcus aureus.*

35. Regarding the extravasation of cytostatic drugs, indicate the CORRECT answer:

a. It is a medical emergency with serious consequences, such as tissue necrosis.
b. The lesions remain stable a few hours after the extravasation.
c. Irritant drugs do not cause necrosis.
d. Local cold compression of the area should be started as soon as possible to minimize tissue damage.
e. The damage produced is independent of the drug's concentration and its excipients.

36. Which of the following can be a CAUSE of gross hematuria in oncology patients?

a. BK virus infection.
b. Tumor infiltration.
c. Recent treatment with cyclophosphamide.
d. Recent treatment with abdominal radiotherapy.
e. All of the above options are correct.

37. Regarding superior vena cava syndrome, indicate the INCORRECT option:

a. It is essential that the patient is not in the supine position.
b. A chest CT should always be performed as part of the diagnostic workup.
c. The most frequent cause in pediatrics is a tumor mass.
d. It is caused by an obstruction of the superior vena cava and the trachea.
e. b and d are false.

Clinical case

38. Which measure would you NOT start in this patient?

a. Hydration with potassium-free fluid at 95 mL/h.
b. Allopurinol at 78 mg every 8 hours orally.
c. Ensure a urine output of at least 60% of intake.
d. Hydration with potassium-free fluid at 130 mL/h.
e. Clinical and laboratory monitoring at least every 8 hours.

39. Which factors allow us to stratify this patient's risk of tumor lysis syndrome (TLS), and in which risk group does he fall? Indicate the CORRECT option:

a. White blood cell count, low risk.
b. White blood cell count, intermediate risk.
c. White blood cell count and LDH values, high risk.
d. White blood cell count and creatinine value, intermediate risk.
e. White blood cell count and creatinine and uric acid values, high risk.

40. 24 hours after admission, a temperature of 38.5°C is noted, with the rest of the vital signs within range except for mild tachycardia that resolves when the fever spike does. Which of the following measures is INDICATED?

a. Watchful waiting.
b. A urine culture should be obtained.
c. A glycopeptide should be added, after drawing blood cultures.
d. Treatment with granulocyte colony-stimulating factor should be started.
e. Escalate to triple therapy (addition of a glycopeptide and an aminoglycoside).

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