Management of Adult Patients Receiving Intraventricular Chemotherapy for the Treatment of Leptomeningeal Metastasis

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Cancer in the central nervous system can arise from a primary brain tumor and metastasize to the brain or to the leptomeninges, leading to leptomeningeal metastasis (LM). LM also is called leptomeningeal carcinomatosis and carcinomatous meningitis. When LM occurs, signs and symptoms include headache, nausea, vomiting, lumbar back pain, and stiff or painful neck; LM also may lead to mental disturbances and seizures. Nursing care of patients with LM requires an understanding of neurologic anatomy and physiology, along with associated treatments and complications. Treatment of LM may involve intrathecal or, more likely, intraventricular chemotherapy. Very little has been written about appropriate care of patients with LM. The purpose of this article is to review the literature, summarize clinical care recommendations, and construct evidence-based guidelines for the administration of intraventricular chemotherapy and the care and monitoring of patients with LM.

At a Glance

❖ Leptomeningeal metastasis is a complex condition with multiple neurologic sequelae. It occurs primarily with leukemia and lymphoma but also is associated with solid tumor cancers.

❖ Treatment of leptomeningeal metastasis often involves intrathecal or intraventricular chemotherapy.

❖ Use of evidence-based guidelines for the care and management of patients receiving intraventricular chemotherapy will promote safe use of the infrequent treatment.

A 42-year-old man with AIDS and B-cell lymphoma was admitted to the inpatient mixed medical-surgical-oncology unit. He had been treated as an outpatient. He presented with severe lumbar back pain, right-eye ptosis, lower-extremity weakness, and anal “numbness.” The physician performed a lumbar puncture (LP) but could not collect enough fluid, so a second LP was performed. Multiple diagnostic tests were run; the patient’s pain worsened, as did his lower-extremity weakness. He eventually required an indwelling catheter for urinary incontinence. Five to seven days later, leptomeningeal metastasis (LM) was confirmed. An intraventricular (IVt) reservoir (e.g., Ommaya port) was placed, and chemotherapy (CTX) agent cytarabine was administered.

Staff required substantial guidance regarding assessment and management of the patient, particularly regarding his IVt CTX. This is a type of IT administration, which also can be given via LP. The institution had no policies for nursing care of patients receiving IVt CTX, pharmacy preparation of IVt CTX, or proper administration techniques.

The patient received CTX through the IVt port for one cycle. His lumbar pain worsened, and his neurologic status deteriorated. He exhibited symptoms of cauda equina syndrome, characterized by dull pain in the lower back and upper buttocks along with lack of feeling in the buttocks, genital area, and upper thighs. Bowel and bladder function often are impaired by LM, caused by nerve impairment in the spinal root nerves. He began spinal radiation but died within the week. Unfortunately, the man spent his last month of life in the hospital, in pain, with worsening neurologic status.

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Leptomeningeal Metastasis

Leptomeningeal metastasis (LM) can occur from the spread of leukemia, lymphoma, or a solid tumor such as breast, lung, gastrointestinal tract, or brain (Demopoulos & Posner, 2006a). Primary central nervous system lymphoma is an aggressive form of non-Hodgkin lymphoma that arises in the brain, eyes, leptomeninges, or spinal cord and often involves LM (Abrey, Yahalom, & DeAngelis, 2000). Approximately 5%–20% of patients with metastatic cancer develop LM (Chamberlain, Kormanik, & Barba, 1997). LM is increasing in frequency, with an overall incidence as high as 8% in patients with cancer (Belford, 2004).

The leptomeninges are two tissue linings that cover the brain and spinal cord. The layers, the arachnoid and the pia mater, encase the arachnoid space, which contains cerebrospinal fluid (CSF) (see Figure 1). Tumor cells can invade the CSF through multiple entry points, which include brain parenchyma, blood vessels, metastasis to the choroid plexus, extension from spinal metastasis, invasion along peripheral or cranial nerves, or directly from the meninges. When cancer metastasizes to the leptomeninges, it is LM, also known as meningeal carcinomatosis. Once cancer has spread to the CSF, it spreads throughout the entire neuraxis (Berg & Chamberlain, 2003), defined as “the axial unpaired part of the central nervous system, composed of the spinal cord, rhombencephalon, mesencephalon, and diencephalon” (American Heritage Stedman’s Medical Dictionary, n.d.). Because LM usually occurs with advanced disease, prognosis after diagnosis and treatment is usually less than six months. Without treatment, survival may be as short as four weeks. LM can occur in patients without evidence of systemic disease. In such cases, prognosis averages 12 weeks (Gordon & Myers, 2003). Treatment options for LM are limited but include IT CTX, systemic CTX that is usually high dose, palliative radiation, corticosteroids, and pain management (Lassman et al., 2006).

Presenting symptoms of LM are neurologic in nature and can indicate the location of pathology. Headache, nausea, vomiting, and mental status changes indicate cerebral hemisphere involvement. Cranial nerve involvement usually is exhibited as diplopia, facial weakness, hearing loss, and dysphagia. Spinal cord or nerve root involvement leads to back pain, radiculopathy, myelopathy, or paraparesis (Berg & Chamberlain, 2003). Transverse myelopathy is less common and presents as isolated spinal cord dysfunction; it may occur in patients receiving concurrent IT methotrexate and radiation. With myelopathy, patients can develop back pain, leg pain, paraplegia, sensory loss, and sphincter dysfunction (Wen & Plotkin, 2006). Other symptoms at LM presentation may include increased intracranial pressure, nuchal rigidity, dizziness, “numb chin syndrome,” radicular pain, incontinence or retention, hydrocephalus, and encephalopathy (Berg & Chamberlain; Demopoulos & Posner, 2006a; Gordon & Myers, 2003). Patients with LM often demonstrate cognitive changes such as altered mental status and confusion. Transient ischemic attacks and strokes also may develop if the vasculature of the brain is compromised (Gordon & Myers).

Until the cause of symptoms is established, patients may require multiple diagnostic tests, including cranial imaging, gadolinium-enhanced magnetic resonance imaging (MRI with contrast), CSF cytology by LP, and CSF flow studies (Gordon & Myers, 2003). Because an LP can cause spot enhancement on an MRI, MRI should be obtained prior to any procedure involving LP. Unfortunately, cytology specimens may not be conclusive, leading to repetitive LPs for diagnostic confirmation. Because of low sensitivity, cytology is negative in 20% of patients with LM (Demopoulos & Posner, 2006a). Even with negative imaging and negative CSF cytology, if a patient with cancer exhibits multiple neurologic symptoms, a diagnosis of LM often is assumed (Berg & Chamberlain, 2003).

Treatment

Systemic CTX, IT or IVt CTX, cranial and spinal radiation, and corticosteroids are the mainstays of medical management.
Because a typical LM prognosis is six months, the focus of LM treatment is palliative (Berg & Chamberlain, 2003; Demopoulos & Posner, 2006b). For patients with multiple comorbidities and poor performance status, supportive services may be provided without treatment. Because of LM diffuseness, treatment involves the entire neuraxis (brain and spinal cord) (Berg & Chamberlain). People with increased intracranial pressure may need shunt placement and are not candidates for CTX (Sandberg, Bilsky, Souweidane, Bzdil, & Gutin, 2000).

Radiation provides symptom relief more quickly than CTX. It may be given concurrently with CTX (IT or systemic). External beam radiation can be delivered to the entire neuraxis, to symptomatic sites, or to sites with bulky disease (Demopoulos & Posner, 2006b). For patients with bilateral lower-extremity weakness, the lumbosacral area can be irradiated. Major side effects of radiation for LM are myelosuppression, mucositis, esophagitis, and leukoencephalopathy, a condition affecting the brain’s white matter. Leukoencephalopathy is more likely when patients receive concurrent CTX (IT or systemic), particularly methotrexate. Patients who have received central nervous system CTX followed by brain radiation are at risk for late neurotoxicities, which occur months after completion of therapy (DeAngelis, 2001).

Chemotherapeutic agents typically used for LM include methotrexate and cytarabine. Monoclonal antibodies and biologic agents are under investigation for such use. Vinca alkaloids (e.g., vincristine) are never administered into CSF because they can cause paralysis or death.

IT CTX can be given via LP; however, because patients with LM often have had multiple invasions into the spinal fluid, this is not the desired method of treatment. LP access can lead to leakage of CTX into the epidural space or surrounding tissue (Berg & Chamberlain, 2003), pain from repeated LPs, difficulty with repeated insertion because of scar tissue formation, and unreliable drug concentrations in the ventricles of the brain. To avoid such complications, an IVt approach is preferred. A ventricular reservoir (e.g., Ommaya) is surgically placed under the skin of the scalp into the ventricle of the brain. This provides continuous access to the CSF, ensuring drug delivery.

Unfortunately, current literature regarding care of patients with LM predominately relates to medical management. No published guidelines are available on the clinical monitoring of patients with LM. Guidelines on IT administration for pain medications exist (Camp-Sorrell, 2004) but none specific to IT CTX. Safety guidelines were developed in the United Kingdom following several fatal errors with IT administration of vinca alkaloids (Health Services Council, 2003), but the recommendations do not direct nursing care.

**Nursing Care of Patients Receiving Intraventricular Chemotherapy**

**Preprocedural Patient Assessment**

Oncology nurses play a key role in the care of patients with LM. Primarily, care involves education and support. Patients and families need to understand what is happening, why patients may be confused, and the treatments and types of procedures involved in treatment. They need information to make informed decisions about how to proceed with a diagnosis of LM.

Before administration of IVt CTX, patients must be made comfortable. This involves toileting and administration of appropriate pain medications. Although specific premedications are not required for the procedure, patients may benefit from anti-anxiety medications. Some patients also require an antiemetic. Nurses should complete and document a neurologic assessment prior to administration of IVt CTX (Sandberg et al., 2000).

**Drug Preparation and Administration**

IT and IVt CTX agents must be prepared in a pharmacy, under a biologic safety cabinet, and in sterile conditions. Sterile, preservative-free saline should be used to decrease neurotoxicity (Berg & Chamberlain, 2003). When preservatives have been used, some patients have experienced transient paresis (Dunkelman, Earl, & Twelves, 1991).

Definitive guidelines on preparation of IT and IVt CTX syringes do not exist. An informal survey of nurses indicates that some facilities place the sterile syringe in a sterile bag under a biologic safety cabinet, then affix the drug label to the outside of the bag, which becomes the unsterile surface. In that procedure, a label is not placed on the syringe itself, which remains sterile. Other facilities prepare the syringe under sterile conditions and affix an unsterile label on the syringe, making the syringe unsterile.


- Prepare IT or IVt medication in the pharmacy as close to administration time as possible, then deliver the drug to a separate designated area (separate from other CTX medications).
- Wrap IT or IVt drugs in a sterile bag, then wrap again in a sterile towel or another bag labeled “FOR INTRATHECAL USE ONLY.” Wraps or packages should be removed immediately prior to administration by the person administering the drug.
- Prior to the start of CTX administration (an invasive procedure), conduct a final verification to confirm correct patient, procedure, site, and availability of appropriate documents. Verification uses active—not passive—communication techniques.
- The 2006 National Patient Safety Goals included a new requirement: Label all medications, medication containers (e.g., syringes, medicine cups, basins), and other solutions on and off the sterile field in perioperative and other procedural settings (“JCAHO Announces 2006 Patient Safety Goals for Ambulatory Care Facilities,” 2005).

IT or IVt CTX typically is administered by an oncologist. In some states, specially trained nurses can obtain privileges to administer such medications (Camp-Sorrell, 2004). Providers should always wear sterile gloves, a gown, and mask during administration.

**Preparation of Equipment and the Sterile Field**

Prior to the actual administration of IVt CTX, all equipment should be gathered and a sterile field prepared. Staff and fam-
ily should be instructed not to disturb providers while CTX is being administered because it is crucial to patient safety that the medications are delivered correctly via the right route and because the risk of meningitis is increased when people without masks are in the room. Those involved should wear masks that cover the nose and mouth; this decreases the risk of transfer of *Streptococcus salivarius* to the treatment field (Baer, 2000; Laurila, Kostamovaara, & Alahuhta, 1998; Schneeberger, Jansen, & Voss, 1996).

Preparing the skin prior to accessing the Ommaya reservoir is a controversial topic. Based on animal studies from the 1950s–1980s indicating neurotoxicity from the use of chlorhexidine, the U.S. Food and Drug Administration (FDA) has required a label warning stating, “Avoid contact with meninges.” However, the American Society of Regional Anesthesia and Pain Medicine’s 2006 published guidelines recommend that alcohol-based chlorhexidine should be considered the antiseptic of choice before regional anesthesia procedures, which is epidural, performed by LP. Based on at least one randomized, controlled trial, chlorhexidine solutions significantly reduced the likelihood of catheter and site colonization. This does not address IVt site preparation (Hebl, 2006). Therefore, following the FDA’s warning seems the most prudent practice. 10 percent povidone-iodine is the current recommendation for IVt and IT chemotherapy administration.

Figure 2 offers a recommended standardized procedure for accessing an IVt reservoir and administering CTX (Blaney & Poplack, 1996; Camp-Sorrell, 2004; Demopoulos & Posner, 2006b).

**Patient Safety**

IT and IVt CTX errors related to the wrong drug or wrong route have been reported (Health Services Council, 2003). Vincristine is a vesicant intended for IV administration. It has been inadvertently confused with central nervous system CTX. When vincristine is given IT or IVt, it is fatal. Errors may be caused by mislabeling, mixed-up syringes, or failure to label syringes (Health Services Council). Figure 3 lists recommendations that can contribute to patient safety with IT or IVt CTX.

**Complications and Monitoring**

Patients who have received IT or IVt CTX have had their CSF tapped. As with any patient who has received an LP, they should be encouraged to drink fluids to replenish CSF and decrease the chance of headache (Franges, 1996). Because reports suggest that iatrogenic meningitis may occur following access to the CSF (Johnson & Sexton, 2006), face masks are recommended during procedures that access CSF, especially if procedures may be prolonged or during instillation or removal of fluids such as with CTX administration (Baer, 2000; Franges).

Potential adverse results of a ventricular reservoir include infection, catheter malposition, and intracranial hemorrhage (Sandberg et al., 2000). The most common complications from IVt CTX include aseptic meningitis (inflammation of the lining of the brain [meninges] where bacteria do not grow in cultures of the cerebrospinal fluid) and myelosuppression (Chamberlain et al., 1997). In fact, aseptic meningitis can affect 10% of patients. Presenting symptoms may include headache, nuchal rigidity, back pain, nausea and vomiting, fever, and lethargy. Corticosteroids administered either orally or with IT CTX may decrease the incidence of aseptic meningitis.

Cognitive complications related to IT or IVt CTX administration include reversible posterior leukencephalopathy syndrome (see Figure 4), confusion, hallucinations, delusions, transient aphasia depression, suicidal ideation and behavior, irritability, and changes in mental status. Patients with a psychiatric history are more likely to develop psychiatric symptoms. If symptoms are not reversed, patients can develop permanent dementia or go into a persistent vegetative state (Wen & Plotkin,

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1. As with all chemotherapy (CTX) administration, patient is informed and consent is signed. If substantial mental status changes exist, a guardian or person with power of attorney must provide consent.
2. Initial assessment of patient’s vital signs and neurologic status is documented.
3. The patient is made comfortable; he or she can be supine, semirecumbent, or seated; the patient’s head should be supported on a pillow.
4. Instillation is a sterile procedure, so a sterile field is prepared and maintained.
5. A healthcare professional palpates the reservoir by gently depressing, leaving fingers in place. The reservoir will fill with cerebrospinal fluid (CSF).
6. The intraventricular reservoir is cleansed with alcohol swabsticks and 10% povidone-iodine; allow betadine to dry for 30 seconds.
7. 25-gauge or smaller noncoring butterfly needle or scalp vein needle with extension tubing attached is inserted into the reservoir at a 45° angle.
8. Two syringes are needed for the procedure: one to withdraw CSF, one with CTX medication to be infused. The withdrawal syringe size can be the same as the medication syringe size because the amount of CSF fluid withdrawn will be equivalent to the amount of CTX infused.
9. Attach the empty syringe to the extension tubing and allow CSF to flow freely into the syringe.
10. Slowly withdraw CSF (equaling volume to be infused) over two to five minutes. Reserve 2–3 ml to use as a flush after the drug is instilled. Any CSF remaining in the syringe can be sent for cytology.
11. The syringe containing the drug should be at room temperature to prevent headache.
12. Administer CTX slowly over two to three minutes (approximately 2 ml per minute). This can be slowed if the patient experiences headache.
13. The remaining CSF is injected into the reservoir over two to three minutes (or 2 ml per minute); intermittently aspirate to ensure placement.
14. The needle is removed from the reservoir, and light pressure is applied with a sterile 4 x 4 gauze pad.
15. Gently pump the reservoir three to five times to assist in distribution of drug. The patient may hear the sound of the fluid filling the reservoir. The patient also may experience headache, nausea, or dizziness.
16. Patient remains supine or semirecumbent for 30 minutes after procedure is completed.

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**Figure 2. Procedure for Accessing an Intraventricular Reservoir for Chemotherapy Administration**
Cytarabine as an IT agent for meningeal disease is given in IT or IVt CTX concurrently with radiation and typically presents with back or leg pain, paraplegia, sensory loss, and sphincter dysfunction. It can occur 30 minutes, 48 hours, or occasionally two weeks after treatment.

Patients diagnosed with LM may be prescribed medications with neurologic side effects, such as corticosteroids and anticonvulsants. The medications may mask the exact etiology of complications. Complications often are associated with a specific chemotherapeutic agent. IT methotrexate (MTX) is conventionally given 15 mg per week but can be given in daily serial dosages in high-dose regimens (Fizazi et al., 1996). It can cause the following side effects: headache, nuchal rigidity, back pain, nausea, vomiting, fever, and lethargy. Symptoms can begin 2–4 hours after treatment and last as long as 12–72 hours (Demopoulos & Posner, 2006b). Leukoencephalopathy can be a delayed complication related to MTX that is worsened by radiation (past or current) and may be more likely in patients older than 60 years (Schlegel et al., 2001). Systemic high-dose MTX can cause neurotoxicity and may produce a stroke-like syndrome (Lassman et al., 2006).

Accidental overdose with IT MTX (up to 600 mg compared to the usual dose of 10–12 mg) can cause acute myelopathy, encephalopathy, even death. Symptoms include seizures, coma, confusion, tachycardia, and hypertension (Blaney & Poplack, 1996; Demopoulos & Posner, 2006b). The antidote to MTX overdose is carboxypeptidase G2 (CPDG2), which is given via the IT route to metabolize the MTX. CPDG2 is available for compassionate use from the Pharmaceutical Management Branch at the Cancer Therapy Evaluation Program of the National Institutes of Health; call +1-301-496-5725. Ventriculostomy with ventriculolumbar perfusion (flushing of the CSF), corticosteroids, and systemic leucovorin also are recommended.

Cytarabine as an IT agent for meningeal disease is given in doses ranging from 30–100 mg/m² (Blaney & Poplack, 1996). IT cytarabine can cause chemical arachnoiditis, headaches, encephalopathy, transient paraplegia and seizures, transverse myelitis, and, rarely, aseptic meningitis. Liposomal cytarabine, a sustained-release cytarabine, may be used; the agent maintains a therapeutic drug level in the CSF for as long as 28 days (Demopoulos & Posner, 2006b).

In rare circumstances, high doses of systemic cytarabine can cause acute cerebellar syndrome, characterized by somnolence, encephalopathy, and ataxia and often beginning two to five days after treatment (Blaney & Poplack, 1996). Onset of acute cerebellar syndrome indicates toxicity and may resolve in some patients. Cytarabine treatment must be stopped immediately.

IT interferon has been studied to treat LM, brain tumors, and progressive multifocal leukoencephalopathy. Neurologic symptoms such as headache, vomiting, fever, and nausea can occur within hours of initial treatment. Encephalopathic symptoms can develop within several days. Again, cranial irradiation tends to worsen the symptoms (Wen & Plotkin, 2006).

### Care of Patients

Knowledge of the pathophysiology and treatment of LM should assist nurses in caring for patients and their families. Underlying care is the premise that LM is a devastating condition in patients with cancer who will not live long. Neurologic symptoms from the disease may be exacerbated by treatments. Comfort care and palliation of symptoms should be primary goals.

Specific guidelines do not exist for the preparation, administration, and monitoring of IT or IVt CTX and the management of patients receiving it. British guidelines regarding IT chemotherapy (Health Services Council, 2003) contain many important safety recommendations but do not specify nursing implica-

### Figure 4. Reversible Posterior Leukoencephalopathy Syndrome (RPLS)

**Note:** Based on information from Hinchey et al., 1996; Kuker et al., 2005; Tam et al., 2004; Wen & Plotkin, 2006. The exact cause of RPLS is unknown, although causative factors include metastatic carcinoma, leptomeningeal metastases, radiation, inflammatory conditions, alcoholic encephalopathy, and sepsis.

- **Uncommon clinical syndrome with distinctive symmetrical posterior cerebral white matter edema shown upon magnetic resonance imaging**
- **Clinical symptoms of acute neurotoxicity: confusion, disorientation, seizures, headache, visual disturbances, altered mental status, and focal deficits**
- **With appropriate management (especially of blood pressure), reversible in majority of cases**
- **Risk factors: significant fluid overload (> 10% baseline weight), mean blood pressure > 25% of baseline, creatinine > 0.16 mmol/L, requiring more than 3 L of IV fluid per day**
- **Monitoring is recommended to assess for changes in weight and/or blood pressure.**
- **Potential etiology: vasogenic edema caused by brain capillary leak syndrome, hypertension, fluid retention, or cytotoxic effects on vascular endothelium**
- **RPLS can be caused by other syndromes and treatments, in addition to intrathecal chemotherapy and cranial radiation, including but not limited to encephalopathy, eclampsia, bevacizumab, and interferon-α**
Case Study Revisited

Care of the patient could have been handled differently. With more knowledge of the low likelihood of cure of LM, staff would have been stronger advocates for the patient in palliation of symptoms, rather than active treatment. The patient would have had more in-depth counseling, and attention to his psychosocial needs in the terminal phase of his care would have been preeminent. Administration of IVt CTX would have been according to the guidelines in Figure 5.

Oncology nursing needs to continue to develop the evidence related to this patient population. The population is a low-volume, high-risk group. Errors related to care can be fatal. Safety features must be included in all care, and patients’ short-term prognoses should be taken into consideration.

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