

## FEATURE ARTICLE

# Intra-Arterial Chemotherapy for Limb Preservation in Patients With Osteosarcoma: Nursing Implications

Ellyn Matthews, PhD, RN, AOCN<sup>®</sup>, CRNI, Katie Snell, RN, BSN, OCN<sup>®</sup>,  
and Heather Coats, RN, MS, APN, OCN<sup>®</sup>

Osteosarcoma is an aggressive tumor found in children and young adults, originating primarily in the legs or arms. The high-grade tumor grows in a circular, ball-like mass in the bone tissue. Before the 1970s and the advent of chemotherapy use in osteosarcoma, treatment consisted solely of amputation. More recently, a preoperative regimen of intra-arterial (IA) cisplatin and infusional doxorubicin with limb-sparing procedures has provided an effective treatment option and improved survival for many patients with osteosarcoma. IA chemotherapy is administered through a small, temporary, external catheter that rests in the arterial vessel that supplies the tumor. The primary advantage of IA chemotherapy administration is the delivery of a higher chemotherapy concentration directly to the tumor site. Nursing management of patients with IA chemotherapy requires knowledge of treatment side effects and procedure-related assessments. Further implications for practice include instructing patients and families before and after the insertion of the IA line and giving discharge and long-term follow-up education. Oncology nurses are well positioned to assist children and young adult patients through difficulties with adjustment after treatment is completed and a response has been achieved, owing to advanced communication skills and knowledge of developmental stages and survivorship issues.

### At a Glance

- ◆ Osteosarcoma is a bone tumor that occurs predominantly in adolescents and young adults, most often in areas of active growth plates such as the distal femur.
- ◆ Effective treatment for localized, resectable, high-grade tumors consists of a combination of preoperative chemotherapy (systemic or intra-arterial), followed by resection of detectable disease (e.g., amputation, limb-sparing procedure) and postoperative adjuvant chemotherapy as indicated.
- ◆ As key members of the multidisciplinary care team, oncology nurses ease the treatment journey with skilled nursing interventions based on physical and psychosocial assessments, specialized knowledge of systemic and intra-arterial chemotherapy administration, and expertise in patient and family teaching.

**S**ince the late 1970s, numerous advances have been made in delivering increasingly complex, curative therapy to children and young adults with osteosarcoma. The advances are largely the result of findings of randomized clinical trials and advances in pharmacology, surgical techniques, and imaging technology. Although clinical trial

protocols and new treatments include details of the medical treatment, they often do not adequately describe nursing care procedures and guidelines (Gilger, Groben, & Hinds, 2002). Oncology nurses consistently incorporate new information and skills related to evolving technology, chemotherapy administration methods, communication facilitation in the healthcare team, assessment of treatment response, and patient education into their evidence-based practice. One institution in Denver, CO, offers a promising treatment for osteosarcoma, and as a result, oncology nurses are educated about the care of patients

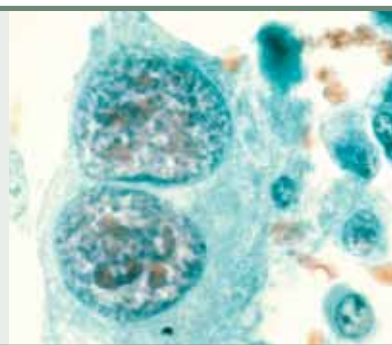
---

Ellyn Matthews, PhD, RN, AOCN<sup>®</sup>, CRNI, is an assistant professor in the School of Nursing at the University of Colorado in Denver; at the time this article was written, Katie Snell, RN, BSN, OCN<sup>®</sup>, was a bone marrow transplantation unit nurse and clinical educator in the bone marrow transplantation and oncology units and currently is a staff nurse in the bone marrow transplantation unit, both at Presbyterian St. Luke's Medical Center in Denver; and at the time this article was written, Heather Coats, RN, MS, APN, OCN<sup>®</sup>, was a staff nurse in the oncology unit at Presbyterian St. Luke's Medical Center and currently is an oncology clinical nurse coordinator at Rose Medical Center in Denver. No significant financial relationship to disclose. (Submitted October 2005. Accepted for publication December 18, 2005.)

Digital Object Identifier: 10.1188/06.CJON.581-589

receiving intra-arterial (IA) administration of chemotherapy. The purpose of this article is to provide background information and describe the treatment for osteosarcoma with IA chemotherapy in addition to essential nursing assessments, care guidelines, patient education, and psychological concerns. A case study will help to illustrate a typical course of treatment and care.

With approximately 2,500 new cases diagnosed in the United States each year, osteosarcoma is the most frequent primary bone cancer in children and young adults.



## Background

With approximately 2,500 new cases diagnosed in the United States each year, osteosarcoma is the most frequent primary bone cancer in children and young adults (Jemal et al., 2006). Most osteosarcomas are high-grade tumors commonly found in the legs or arms and are characterized by the formation of bone tissue that grows in a circular, ball-like mass that eventually penetrates the bony cortex to form a reactive zone. Surgical resections of the tumor must be wide to include microextensions or satellite nodules that grow in the reactive zone. Tumor nodules growing outside the reactive zone but in the same bone or across a neighboring joint are termed *skip lesions* (Wittig et al., 2002).

Two main histologic classes of osteosarcomas exist, with a number of subtypes in each group: (a) central (medullary) tumors, the most common type, and (b) surface or peripheral tumors (Antonescu & Huvos, 2000). In children and young adults, 50% of tumors arise in the femur; of these, most are in the distal femur adjacent to the knee. Additional primary sites of localized osteosarcoma, in descending order of frequency, are the tibia, humerus, pelvis, jaw, fibula, and ribs (Longhi et al., 2001). Dull, aching pain at night, which increases in severity in the affected site, is a frequent presenting complaint and often is attributed mistakenly to growing pains. The etiology of osteosarcoma is unclear, but a relationship appears to exist between the growth spurt of adolescence and the development of osteosarcoma. Rapid skeletal growth may account for the development of primary osteosarcoma in the distal femur and proximal tibia, areas with active growth plates (Sumner, 2005).

Following imaging studies, a biopsy is required to confirm the diagnosis of osteosarcoma. Magnetic resonance imaging (MRI) and computed tomography (CT) scans of the affected bone provide information about the extent of the disease and the presence of skip lesions. Bone scans and chest x-rays determine the extent of disease and areas of metastasis, particularly lung metastasis. Since the 1980s, substantial progress has been made in the treatment of osteosarcoma, which has greatly improved long-term disease-free survival. Neoadjuvant (i.e., preoperative) and adjuvant (i.e., postoperative) chemotherapy regimens have given rise to safe limb-sparing surgical resections. Currently, 90%–95% of patients with osteosarcoma are treated safely with limb-sparing surgery and 60%–80% become long-term survivors (Bacci et al., 2000; Fuchs et al., 1998).

## Prognosis and Psychosocial Alterations

As with all cancers, patients with localized osteosarcoma have a much better prognosis than those with metastatic disease. At diagnosis, as many as 20% of patients have radiographically de-

tectable metastases; the lung is the most common site (Sumner, 2005). Distal sites have a more favorable prognosis than proximal sites; primary axial skeleton tumors (e.g., rib, spine, pelvis) have the greatest risk of progression and death (Donati et al., 2004; Ozaki et al., 2003; Patel et al., 2002; Smith et al., 2003). Prognostic features for patients with localized, high-grade osteosarcoma that predict a poorer prognosis include age younger than 10 years, increased tumor diameter, multifocal lesions, involvement of the femur or humerus, increased lactate dehydrogenase level (proxy for tumor volume), alkaline phosphatase level, and histologic subtype (Bacci et al., 2006; Bielack et al., 2002; Ferrari et al., 2001; Longhi et al., 2001). Tumor response to preoperative chemotherapy is the most important factor in overall prognosis of nonmetastatic osteosarcoma. Patients with greater than 95% necrosis in the primary tumor after induction chemotherapy have a better prognosis than those with lesser percentages of necrosis (Bielack et al.; Reddick et al., 2001). In the authors' personal experience, a 90% correlation exists between the results of tumor necrosis during IA chemotherapy treatment, monitored by angiogram and pathologic response, as assessed at the time of surgery.

An osteosarcoma diagnosis may be delayed because of a lack of routine medical care or insurance coverage or because of low suspicion of cancer on the part of the public and healthcare providers (Adams, 2003). Active young adults may ignore symptoms and put off seeking medical attention because pain and swelling in the limbs can be attributed to many nonmalignant causes. Adolescents and young adults with osteosarcoma have unique concerns related to their developmental stage, such as feelings of powerlessness in an overwhelming healthcare system, isolation from peers, insecurity about the future, and vulnerability in addition to multiple losses related to body image, unique information needs, concerns about reproductive potential, and an endangered sense of personal control (Bello & McIntire, 1995; Bradlyn, Kato, Beale, & Cole, 2004; Dealy, Pazola, & Heislein, 1995; Eiser, Darlington, Stride, & Grimer, 2001; Haase, 2004).

## Treatment of Osteogenic Sarcoma: Historic Perspectives

Before the 1970s and the advent of chemotherapy, treatment of osteogenic sarcoma consisted solely of amputation. More than half of patients with the aggressive tumor developed metastases within six months, and overall, 90% developed recurrent disease within two years (Link et al., 1986, 1991). Mortality usually was a result of pulmonary metastatic disease that was undetected at

diagnosis but appeared six to nine months after surgical resection of the primary tumor (Derstappen, Roessner, Muller, & Grundmann, 1987). Randomized trials documenting the response of pulmonary metastases to multiagent chemotherapy (e.g., high-dose methotrexate, doxorubicin, cisplatin) led to the routine use of preoperative and postoperative chemotherapy in the mid-1970s for patients with newly diagnosed osteosarcoma.

Numerous subsequent studies concluded that surgery and chemotherapy provide the best chance of limb preservation and long-term disease-free survival. Eighty percent of patients with extremity osteosarcomas can be treated with limb preservation when staging indicates that achieving wide surgical margins is possible (Bacci et al., 2000). Limb-sparing surgery involves the removal of the malignant bone tumor without amputation as well as replacement of bones or joints with allografts (from bone procured from deceased donors) or prosthetic devices. Metallic prostheses often are used for reconstruction because they provide joint stability, early ambulation, and weight bearing with minimal early postoperative complications (Henshaw, Bickels, & Malawer, 1999; Kawai, Muschler, Lane, Otis, & Healey, 1998).

## Treatment With Intra-Arterial Chemotherapy and Limb-Sparing Surgery

Mavligit et al. (1981) first reported significant response to the use of IA cisplatin in 15 patients with advanced osteosarcoma. Subsequently, several studies reported improved survival in children and adults with preoperative doxorubicin as a continuous high-dose infusion followed by IA cisplatin (Benjamin et al., 1986; Jaffe et al., 1985, 1989; Pathak et al., 1993; Souhami et al., 1997; Uchida, Myoui, Araki, Yoshikawa, Shinto, & Ueda, 1997). Wilkins et al. (2003) treated 47 patients with primary, high-grade, non-metastatic osteosarcoma (median age of 15 years) with an average of four cycles of IA cisplatin and infusional doxorubicin preoperatively. They reported that 41 of the study participants had 90% or greater tumor cell necrosis at the time of surgical resection and 43 underwent limb-preservation surgery. Postoperatively, good responders ( $\geq 90\%$  reduction in tumor neovascularity) received the same agents for four months, whereas poor responders ( $< 90\%$  necrosis) were treated with a variety of alternative agents. At an average of 92 months, 39 of the participants were disease free, three had died from the disease, one had died from other causes, and four had no evidence of disease at 11–51 months. The findings demonstrated improved survival with the preoperative regimen of IA cisplatin and infusional doxorubicin, and the regimen, together with limb-sparing procedures, has provided an effective treatment option for many patients with osteosarcoma.

## Intra-Arterial Chemotherapy Administration and Protocol Description

IA chemotherapy is administered through a small, temporary, external catheter that rests in the arterial vessel supplying the tumor and usually is placed by an interventional radiologist. The primary advantage of IA administration is the ability to achieve a higher chemotherapy concentration directly at the tumor site. With IA administration, cisplatin levels are two to five times higher in the draining vein of the arterially infused

area, yet concentration of cisplatin in peripheral blood does not exceed levels seen with systemic administration. Protocol eligibility criteria, design, procedure, and nursing care related to IA chemotherapy are discussed in the following sections, and nursing assessments before and after the procedure are summarized in Figures 1 and 2.

The primary objectives of the IA chemotherapy protocol described in this article are (a) ongoing evaluation of the response of the primary tumor to the infusion of preoperative IA cisplatin and infusional doxorubicin, (b) assessment of the response by radiologic imaging studies, and (c) determination of histologic response. As previously mentioned, studies have shown that IA administration of cisplatin increases tumor necrosis by delivering a high concentration of the drug to the tumor. Reducing the tumor burden preoperatively with IA chemotherapy enhances limb salvage techniques and increases long-term disease-free survival (Benjamin et al., 1986; Jaffe et al., 1985; Sumner, 2005).

## Eligibility for Intra-Arterial Chemotherapy for Limb Preservation

Children and young adults with previously untreated primary osteogenic sarcoma are eligible to enter the doxorubicin plus IA cisplatin trial. Patients with unresectable tumors or pathologic fractures are included; however, low-grade and parosteal osteosarcomas (i.e., tumors of the outmost layer of the periosteum) are excluded. Before treatment begins, patients must have a complete workup, including radiographic studies of the primary tumor, an MRI scan of the entire involved bone, a bone scan of the entire skeleton, a CT scan of the chest, and laboratory tests. Potential participants receive an audiogram and echocardiogram for baseline data because a known complication of cisplatin is hearing loss and because cumulative doses of anthracyclines such as doxorubicin directly damage myocardial tissue (Polovich, White, & Kelleher, 2005). Patients with serious documented past contrast media reactions or impaired renal status are not eligible. To avoid the risk of renal failure, metformin is stopped for 48 hours following IA line placement to prevent possible interactions with the contrast media. Coagulopathies and the inability to lie flat because of cardiac or respiratory compromise also are exclusion criteria.

1. Assess physical and emotional status; ascertain patients' and families' understanding of the treatment and ability to follow directions (e.g., lying flat because of intra-arterial [IA] catheter insertion).
2. For repeat treatments, assess previous chemotherapy-induced symptoms.
3. Begin IV hydration the night before the procedure.
4. Two RNs should verify height and weight.
5. Check to verify laboratory values are within normal limits for chemotherapy administration.
6. Evaluate peripheral pulses, mark the site, and obtain a Doppler ultrasound, if necessary.
7. Insert a Foley catheter the morning of IA line placement.
8. Send the necessary equipment to interventional radiology with patients (i.e., pump, chemotherapy IV administration set, 500 ml 5% dextrose solution with 3,000 units of heparin).
9. Educate patients preprocedure regarding the importance of lying flat after line insertion.

Figure 1. Preprocedure Assessment and Preparation

On arrival to the floor following intra-arterial (IA) line placement,

1. Immediately assess patients' level of consciousness, vital signs, IA line insertion site, and peripheral pulses; the check includes evaluation of the warmth and color of extremities and signs of bleeding or hematoma at the IA catheter site.
2. Vital signs, insertion site, and peripheral pulses are monitored every 30 minutes for one hour, then every hour for two hours, then every two hours until completion.
3. IA chemotherapy is started within 60 minutes of patients' return to the oncology unit; before cisplatin administration, premedications, including lorazepam, furosemide, dexamethasone, aprepitant, and ondansetron, are given.
4. Chemotherapy is checked by two RNs and administered per Oncology Nursing Society guidelines (Polovich et al., 2005); the pulsatile pump is turned on, and triple-channel infusion pump programming is verified.
5. Patient education is reinforced regarding lying flat while the IA line is in place.
6. Fifteen to 20 minutes before cisplatin is scheduled to finish, an interventional radiologist is notified; on completion, the chemotherapy line is flushed with the heparin solution to prevent thrombus formation.
7. A radiologist removes the line and applies pressure for 10 minutes until hemostasis is obtained, and a pressure dressing is applied.
8. Patients remain on bed rest for an additional four hours; the pressure dressing and peripheral pulse sites are checked hourly for four hours.
9. When bed rest is no longer necessary, the Foley catheter can be removed; IV fluid continues for another 24 hours; intake and output are monitored strictly.

**Figure 2. Postprocedure Nursing Assessment**

## Protocol Treatment Description

Participants in the protocol receive three to six courses of preoperative chemotherapy until a complete or maximum response is observed by arteriogram. A response is considered a greater than 90% decrease in the neovascularity of the tumor. In addition, participants proceed to surgery in two other circumstances: (a) if the decrease in neovascularity has reached a plateau and no longer is showing improvement, and (b) if progressive disease is present.

Doxorubicin 90 mg/m<sup>2</sup> is administered on days 1 to 2 or 3. Patients younger than age 18 receive 48 hours and adults receive as many as 72 hours of continuous infusion. On day 3, cisplatin 120 mg/m<sup>2</sup> is administered over six hours via arterial infusion. If the tumor is larger than 10 cm in diameter at diagnosis, patients receive 24 hours of IA cisplatin at 160 mg/m<sup>2</sup>. Prior to and following cisplatin administration, patients receive vigorous IV hydration, diuresis therapy, and close monitoring of intake and output. Treatment is repeated every three to four weeks, depending on hematologic recovery. Postoperative chemotherapy for good responders (> 90% tumor cell necrosis) includes two to three additional courses of infusional doxorubicin and IV cisplatin administered at the same dose; poor responders receive alternative chemotherapy. If patients reach the maximum cumulative dose of doxorubicin, etoposide may be used as a substitute, and if grade III or IV ototoxicity results, cisplatin should be discontinued and replaced with carboplatin.

## Preprocedure Assessment and Preparation

Patients are instructed to arrive on the nursing unit the night before their scheduled IA line placement for evaluation and prehydration. In addition to the standard admission procedures, two nurses obtain and verify an accurate height and weight to ensure

a correct chemotherapy dose calculation the following day. A complete blood count (CBC) and comprehensive metabolic panel are obtained to confirm that current laboratory results are within normal limits for chemotherapy. Bilateral peripheral pulses are evaluated and marked to provide baseline information on function. If patients have pulses that are weak or difficult to palpate, a Doppler ultrasound is used to demonstrate adequate blood flow.

IV hydration of dextrose 5% and half-normal saline with potassium, magnesium, and calcium additives at 250 ml per hour is started the evening of admission via a large-gauge peripheral line or central venous device. Patients receive instructions about the need for strict monitoring of intake and output. On the morning of line placement, a nurse inserts a Foley catheter in adult patients; pediatric patients have the Foley catheter inserted in interventional radiology (IR) under conscious sedation. Because patients lie flat for 6–24 hours after the procedure, using the bathroom is not feasible. Patients should remove all undergarments and wear a hospital gown for the procedure.

A nurse ensures that necessary equipment for the procedure is sent to IR with patients. Equipment includes a triple-channel infusion pump, a chemotherapy IV administration set, and a 500 ml bag of dextrose 5% in water with 3,000 units of heparin added. The IR department supplies and maintains the pulsator pumps (see Figure 3). The infusion line used for IA chemotherapy administration is primed carefully through the pulsator pump in the IR department to prevent any air bubbles in the tubing (see Figure 4).

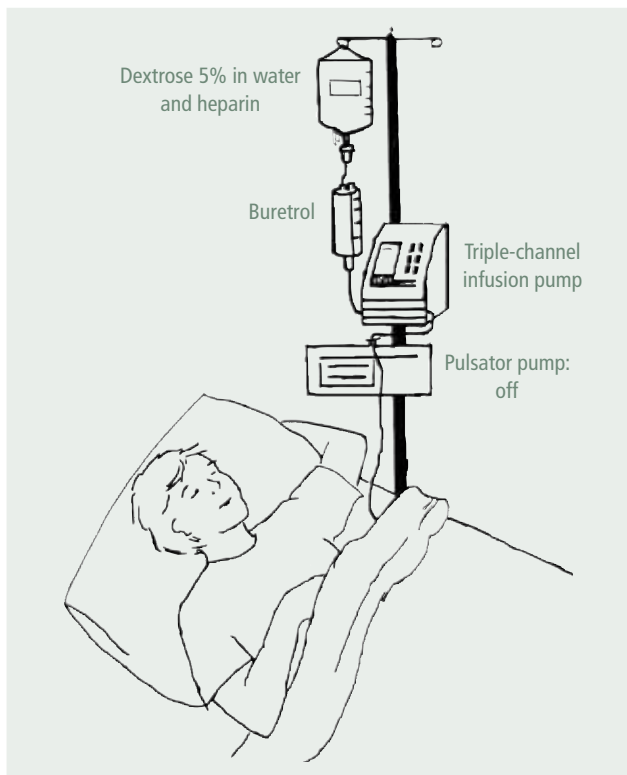
Patient teaching regarding the line placement procedure and potential complications is provided before the procedure. Before commencement of the procedure and in accordance with facility policy, a nurse confirms that informed consent for the procedure has been obtained. Instructions regarding lying flat and keeping the affected limb immobile following the procedure are reinforced, and a sign is posted in patients' rooms as a reminder.

## Intra-Arterial Catheter Placement Procedure

The IA catheter line placement procedure is performed under conscious sedation (using versed and fentanyl). Patients' electrocardiogram, vital signs, and oxygen saturation levels are monitored continuously throughout the procedure. The artery is accessed



**Figure 3. Pulsator Pump**



**Figure 4. Dextrose 5% in Water and Heparin Administration After Insertion of Intra-Arterial Catheter in Interventional Radiology Before Intra-Arterial Cisplatin Administration**

via the groin following routine surgical sterile preparation, and a 21-gauge needle guide is inserted, followed by a 4.1 French end-hole catheter. The catheter then is threaded through the artery until it reaches the tumor to be treated. During the catheter placement procedure, an angiogram is performed to provide baseline information on the extent of the tumor and assess the response to prior IA chemotherapy and tumor necrosis. The catheter is fixed in place with an occlusive dressing (see Figure 5). Immediately after the IA catheter is positioned properly, the tubing primed with dextrose 5% in water and heparin is connected and the heparin solution is infused to prevent thrombus formation. The rate of IA heparin is controlled by programming the triple-channel infusion pump. The IR staff verifies continuous tubing connections from the heparin solution to the triple-channel infusion pump, through the pulsator pump, and to the patient.

The pulsator pump allows cisplatin to be delivered in a pulsing, spraying motion to increase effective delivery to the tumor. However, clinicians should note that the pulsator pump is not turned on during the heparin infusion. The pulsator pump is turned on only when cisplatin is infusing. The heparin infusion continues until the IA cisplatin is ready to be administered after patients return to their hospital rooms.

## Postprocedure Assessment

On return to their room, patients are assessed immediately by a nurse for level of consciousness, vital signs, peripheral pulses,

warmth and color of extremities, pain level, and IA catheter insertion site and dressing. Any evidence of bleeding, hematoma, absent pulses, sensation, or coldness in the extremities is urgent and must be reported immediately to an interventional radiologist.

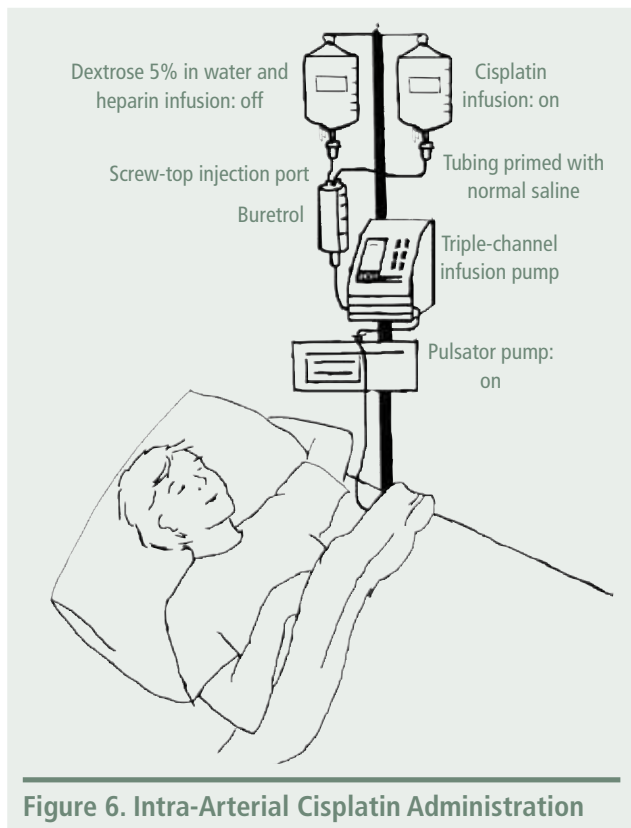
An oncology nurse then prepares patients for chemotherapy according to policy. The IA chemotherapy is administered within 60 minutes of patients' return to their room to prevent any complications occurring with the IA line and to reduce the time patients have to spend lying flat. Chemotherapy premedications include aprepitant, ondansetron, and dexamethasone as anti-nausea coverage (National Comprehensive Cancer Network, 2005). Lorazepam also is given to help relax patients. Furosemide is ordered as a premedication to protect the kidneys from the nephrotoxic effects of cisplatin (Polovich et al., 2005). Cisplatin is started 20 minutes after premedications are given.

Chemotherapy is verified by two chemotherapy-certified nurses and administered following the standard Oncology Nursing Society chemotherapy guidelines (Polovich et al., 2005). The cisplatin bag and tubing are attached to the volume chamber of the buretrol via a screw-top injection port. Cisplatin is instilled into the volume chamber, and the heparin solution is clamped for the duration of the cisplatin infusion (see Figure 6). The cisplatin line is labeled to ensure that the line is not confused with fluid concurrently infusing through a peripheral or central line. The pharmacy primes the tubing with normal saline before it is attached to the cisplatin bag to prevent chemotherapy spills and then ensures that the system is a closed system free of chemotherapy. A chemotherapy-certified nurse completes the medication checks, verifies the triple-channel infusion pump programming, and turns on the pulsator pump. For the first 15 minutes of the infusion, a nurse stays with patients to monitor for untoward reactions to cisplatin. Extension tubing may be used, and a nurse must ensure that all connections are taped securely to prevent any disconnection or leakage.

Reinforcing education regarding lying flat while the IA line is in place is essential. Nurses may need to assist patients with eating and drinking. Nurses should advise patients to order finger foods or meals that are easy to eat while supine. A sign should be placed above patients' beds indicating which limb needs to be kept immobile. Vital signs, IA catheter site checks, and peripheral pulse



**Figure 5. Intra-Arterial Catheter Occlusive Groin Dressing**



**Figure 6. Intra-Arterial Cisplatin Administration**

assessments are conducted every 30 minutes for one hour, every hour for two hours, then every two hours. Output is monitored closely, and furosemide is used to increase diuresis as needed.

### Nursing Care Following Completion of Intra-Arterial Cisplatin

Fifteen to 20 minutes before cisplatin is scheduled to finish, a nurse informs an interventional radiologist, who removes the IA catheter (in patients' rooms) soon after the cisplatin is completely infused. When the cisplatin administration is completed, a nurse immediately restarts the heparin infusion to prevent clotting in the IA line. An interventional radiologist removes the line and applies pressure to the catheter site for at least 10 minutes, until hemostasis is obtained. A pressure dressing is applied, and patients are instructed to stay on bed rest with the affected limb extended for four to six hours. A nurse assesses for bleeding or swelling at the site and monitors patients' pulses, movement, and sensation of the extremity distal to the site. IV fluids are continued for 24 hours, and patients are encouraged to take oral fluids if possible. Four to six hours after catheter removal, the Foley catheter is removed when patients are no longer on bed rest. However, intake and output continue to be monitored strictly.

Few cases have been reported of inflammatory changes and necrosis of the skin and muscle during the first week after the first or second infusion of IA chemotherapy (Tsuchiya et al., 2001). Signs and symptoms include skin induration, ulceration, and flares; muscle edema and weakness; and severe pain with gait disturbance. Although myocutaneous changes are rare, oncology nurses need to assess carefully any complaints of severe pain in the area near the tip of the catheter and report the find-

ings so that the catheter can be repositioned under angiography. Muscle necrosis is treated best by surgical resection, which can be done at the time of the limb-salvage surgery to mitigate pain (Tsuchiya et al.). In the authors' experience at Presbyterian St. Luke's Medical Center in Denver, CO, the symptoms are very rare and self-limiting. Patients do not require any therapeutic interventions other than temporary use of analgesics to control pain, and the symptoms do not appear to recur with subsequent IA chemotherapy infusions.

### Discharge Education After Each Cycle of Chemotherapy

Patients should be given discharge education after each cycle of chemotherapy (see Figure 7). Following IA line removal, patients are advised to avoid any strenuous lifting or exercise. Patients are instructed to remove the site dressing after 24 hours and immediately report to the radiologist or oncologist any bleeding or swelling or the development of a hematoma. Patients are taught to identify signs of infection and report drainage at the exit site, redness along the tract of the IA catheter, or altered sensations such as numbness or tingling in the affected limb. Educating patients about signs and symptoms of thrombus in the affected extremity from possible shearing with placement of the catheter or tumor breakdown products is important.

The chemotherapy regimen of IV doxorubicin and IA cisplatin causes several side effects. Patients are expected to lose all of their hair and develop chemotherapy-related fatigue. Nausea can be a distressing problem with cisplatin, so patients are discharged with appropriate antiemetic medication instructions. Neutropenia is a serious concern approximately 10 days following treatment, and patients are educated regarding the need for prompt treatment with antibiotics if their temperature reaches 100.5°F or higher. Patients' CBC is monitored closely at weekly ambulatory care visits. Growth factors routinely are administered to prevent or reduce the neutropenic nadir. Regular audiograms and echocardiograms are performed throughout treatment to assess for toxicities. Renal function is monitored by regular blood tests; a

1. If discharged within 48 hours of chemotherapy administration, patients are instructed on guidelines for safe management of body fluids in the home setting (Polovich et al., 2005).
2. Patients should not do strenuous lifting or exercise following IA line removal.
3. The dressing should be removed after 24 hours and a bandage applied.
4. Patients are instructed to notify the oncologist immediately of burning, swelling, pain, drainage, redness, or development of hematoma at the catheter site; also, patients are educated to inform doctors of any loss of sensation in the affected limb as well as how to identify thrombus formation (e.g., pain, redness, swelling, discoloration, engorged veins).
5. Patients should be taught identification and management of chemotherapy side effects (e.g., hair loss, fatigue, neutropenia, nausea and vomiting).
6. Instructions are given to patients to schedule weekly visits to the ambulatory care office for symptom and laboratory-value monitoring (e.g., complete blood count, metabolic panel).

**Figure 7. Patient and Family Teaching Essentials After Intra-Arterial Chemotherapy**

significant rise in blood urea nitrogen and creatinine levels are investigated, and, if necessary, a lower dose of cisplatin or replacement with carboplatin may be ordered for the next cycle.

## Postoperative and Long-Term Care After Limb-Sparing Surgery

Limb-sparing surgery is scheduled after hematologic recovery and sufficient cycles of chemotherapy achieve an optimal response, confirmed by reduction in tumor neovascularity per angiogram (Wilkins et al., 2003). Typical immediate follow-up care by an orthopedic surgeon focuses on monitoring and care of the incision, early identification of surgical complications, and evaluation of physical therapy progress (e.g., ability to rebuild strength in the affected extremity). Monitoring includes regular CBC, serum chemistries, chest CTs, plain-film radiography of the reconstructed extremity, and regular physical examinations every three months for the first two years, every six months for a total of five years, then on a yearly basis (Wittig et al., 2002). Repeat audiograms and echocardiograms are suggested during the first year after treatment (Wilkins et al.).

Patients are monitored annually for life for local and systemic recurrence. Maintaining lifetime surveillance is a challenge with younger individuals, who move frequently and do not remember details of their treatments or maintain a good record of their previous health history. Oncology nurses need to ensure that patients receive a complete treatment summary and information about the risk for late complications. Bashore (2004) reported that the majority of childhood and adolescent cancer survivors lack essential knowledge of their diseases, specific therapies, and effects of treatment. Prior treatment with doxorubicin is especially important to follow because of the lifetime dose limit of 550 mg/m<sup>2</sup> or less to prevent cardiotoxicity. Musculoskeletal abnormalities are reported immediately to ensure a proper workup with scans and x-rays to rule out recurrence. The lungs and bones are frequent sites of metastases; therefore, prompt attention and evaluation of any respiratory or musculoskeletal symptoms are essential.

Long-term psychosocial issues are related to feelings of isolation, reentering the role of a young adult, and forming relationships (Adams, 2003). During and after treatment, patients with osteosarcoma need ongoing explanations of their treatment, side effects, and symptoms. Keeping them informed of any treatment or disease status changes is important and addresses the developmental need for autonomy (Dealy et al., 1995). Fertility is often an unstated or poorly communicated concern in this population of patients. Along with the improved survival for patients with osteosarcoma of the extremities, common misconceptions exist regarding probable infertility. Several recent studies have reported that patients with osteosarcoma treated preoperatively and postoperatively with multiple chemotherapy agents (e.g., doxorubicin, floxuridine, methotrexate, IA cisplatin) can have high expectations of conceiving healthy offspring. However, Longhi, Macchiagodena, Vitali, and Bacci (2003) confirmed the potential risk of sterility from ifosfamide-based chemotherapy in males treated for osteosarcoma. Therefore, counseling should include the possibility of infertility and information about fertility options (e.g., sperm banking), but patients also should be aware of a high success rate of normal conception and childbirth with most treatment options (Hosalkar, Henderson, Weiss, Donthineni, & Lackman, 2004; Longhi et al., 2003; Yonemoto, Tatezaki, Ishii, & Hagiwara, 2003).

After going through treatment, adolescents and young adults find reentering a previously “normal” life difficult as a result of new and different priorities and outlooks on life. The bewildering change of outlook may lead to difficulties in dating, finding new jobs, and making new friends. Because of their communication skills and knowledge of developmental stages and survivorship issues, oncology nurses are well positioned to assist patients through difficulties with adjustment after treatment is completed and a response has been achieved.

## Psychosocial Aspects

Because adolescents and young adults are typically Internet savvy, referring them to respected Internet sites, such as [www](#)

### Mr. J: A Case Study

Mr. J is a 20-year-old man recently diagnosed with a high-grade osteosarcoma of the right leg. He presents to a primary care provider with dull, aching pain (particularly at night) of two months' duration. Recently, his increasing pain has been accompanied by swelling in the lower outer aspect of his right thigh, which he attributes to a minor work injury three weeks previously. Mr. J reports no other significant medical or surgical history. After initial x-rays of the femur, he immediately is referred to an orthopedic oncologist, who orders a complete workup, including computed tomography scans, bone scans, magnetic resonance imaging (MRI) of the extremity, and blood tests. The bone scan shows an increased uptake in the area of his lower right femur. The MRI shows a bony destructive lesion with a soft tissue component. His chest, abdomen, and pelvis show no evidence of metastatic disease. Following evaluation, an orthopedic surgeon performs the initial biopsy. Mr. J makes plans to begin treatment consisting of three to six cycles of intra-arterial cisplatin and systemic doxorubicin followed by limb-sparing surgery to remove the tumor. An angiogram of the vessels feeding the tumor provides baseline information before treatment. During his first chemotherapy treatment in the hospital, he confides to an oncology nurse. “I keep having this recurring dream that I had my surgery, and when I wake up in the recovery room, my leg is gone.” Mr. J lives with his fiancée nearly four hours from the urban cancer center where he receives treatment. He is a construction worker with insurance coverage through his employer.

Mr. J was treated with four cycles of systemic doxorubicin and IA cisplatin, resulting in a 90% necrosis and reduction in vascularity around the tumor. Limb-sparing surgery was performed with “good margins” per the operative report, and no amputation was needed. Mr. J continued regular follow-up with the surgical oncologist until the incision healed and he progressed satisfactorily with physical therapy. Postoperative chemotherapy consisted of two additional cycles of doxorubicin and cisplatin, both given via IV. To date, he is free of metastasis and continues with surveillance clinic visits with medical oncologists every six months. Mr. J confided to an oncology nurse that he had difficulty believing that his leg still worked. He stated that he sometimes was overwhelmed by “all I have learned and how all the nurses and doctors helped me and my family through such a difficult time in my life.”

.cancer.org or www.cancer.gov, to learn more about their disease process provides time to discover and work through their feelings and gives them a sense of control over their situation. A specialized and popular Web site that deals with the concerns of young adults is www.youngadultswithcancer.org. When adolescents and young adults are more knowledgeable about their disease process, they are better able to communicate their needs to healthcare providers and often reach out to other patients with osteosarcoma.

The ultimate goal for osteosarcoma treatment is cure, and the aim of IA and systemic chemotherapy is limb-sparing surgery when possible; therefore, keeping the focus on these outcomes may help alleviate some of the fears of disfigurement. If amputation is necessary, it should not be viewed as a failure of treatment but rather as the best-informed choice for a patient's particular situation.

## Conclusion

Coordination of care among the intradisciplinary team is important to young patients. As key members of the care team, oncology nurses facilitate collaboration and communication among various physicians, other professionals, and patients. In addition, oncology nurses coordinate referral and follow-up visits, address problems identified through test results, perform physical and emotional assessments, and educate patients throughout the cancer trajectory. The entire intradisciplinary team is necessary to assist patients with various aspects of care (e.g., physical, psychological, financial).

**Author Contact:** Ellyn Matthews, PhD, RN, AOCN®, CRNI, can be reached at [ellyn.matthews@uchsc.edu](mailto:ellyn.matthews@uchsc.edu), with copy to editor at [CJONEditor@ons.org](mailto:CJONEditor@ons.org).

## References

- Adams, H.S. (2003). Young adults with cancer. *Cure, 2*(2), 36–41.
- Antonescu, C.R., & Huvos, A.G. (2000). Low-grade osteogenic sarcoma arising in medullary and surface osseous locations. *American Journal of Clinical Pathology, 114*(Suppl.), S90–S103.
- Bacci, G., Ferrari, S., Bertoni, F., Ruggieri, P., Picci, R., Longhi, A., et al. (2000). Long-term outcome for patients with nonmetastatic osteosarcoma of the extremity treated at the Istituto Ortopedico Rizzoli according to the Istituto Ortopedico Rizzoli/Osteosarcoma-2 protocol: An updated report. *Journal of Clinical Oncology, 18*, 4016–4027.
- Bacci, G., Longhi, A., Versari, M., Mercuri, M., Briccoli, A., & Picci, P. (2006). Prognostic factors for osteosarcoma of the extremity treated with neoadjuvant chemotherapy: 15-year experience in 789 patients treated at a single institution. *Cancer, 106*, 1154–1161.
- Bashore, L. (2004). Childhood and adolescent cancer survivors' knowledge of their disease and effects of treatment. *Journal of Pediatric Oncology Nursing, 21*, 98–102.
- Bello, L.K., & McIntire, S.N. (1995). Body image disturbances in young adults with cancer. Implications for the oncology clinical nurse specialist. *Cancer Nursing, 18*, 138–143.
- Benjamin, R.S., Chawla, S.P., Carrasco, C.H., Raymond, A.K., Wallace, S., Murray, J., et al. (1986). Primary chemotherapy of patients with osteosarcoma of an extremity [Abstract 541]. *Proceedings of the American Society of Clinical Oncology, 5*, 139.
- Bielack, S.S., Kempf-Bielack, B., Delling, G., Exner, G.U., Flège, S., Helmke, K., et al. (2002). Prognostic factors in high-grade osteosarcoma of the extremities or trunk: An analysis of 1,702 patients treated on Neoadjuvant Cooperative Osteosarcoma Study Group protocols. *Journal of Clinical Oncology, 20*, 776–790.
- Bradlyn, A.S., Kato, P.M., Beale, I.L., & Cole, S. (2004). Pediatric oncology professionals' perceptions of information needs of adolescent patients with cancer. *Journal of Pediatric Oncology Nursing, 21*, 335–342.
- Dealy, M.F., Pazola, K., & Heislein, D.M. (1995). Care of the adolescent undergoing an allograft procedure. *Cancer Nursing, 18*, 130–137.
- Derstappen, T., Roessner, A., Muller, K.M., & Grundmann, E. (1987). Morphology of pulmonary metastases from osteosarcoma during chemotherapy. *Journal of Cancer Research and Clinical Oncology, 113*, 241–248.
- Donati, D., Giacomini, S., Gozzi, E., Ferrari, S., Sangiorgi, L., Tienghi, A., et al. (2004). Osteosarcoma of the pelvis. *European Journal of Surgical Oncology, 30*, 332–340.
- Eiser, C., Darlington, A.E., Stride, C.B., & Grimer, R. (2001). Quality of life implications as a consequence of surgery: Limb salvage, primary and secondary amputation. *Sarcoma, 5*, 189–195.
- Ferrari, S., Bertoni, F., Mercuri, M., Picci, P., Giacomini, S., Longhi, A., et al. (2001). Predictive factors of disease-free survival for nonmetastatic osteosarcoma of the extremity: An analysis of 300 patients at the Rizzoli Institute. *Annals of Oncology, 12*, 1145–1150.
- Fuchs, N., Bielack, S.S., Epler, D., Bieling, P., Delling, G., Korholz, D., et al. (1998). Long-term results of the co-operative German-Austrian-Swiss Osteosarcoma Study Group's protocol COSS-86 of intensive multidrug chemotherapy and surgery for osteosarcoma of the limbs. *Annals of Oncology, 9*, 893–899.
- Gilger, E.A., Groben, V.J., & Hinds, P.S. (2002). Osteosarcoma nursing care guidelines: A tool to enhance the nursing care of children and adolescents enrolled on a medical research protocol. *Journal of Pediatric Oncology Nursing, 19*, 172–181.
- Haase, J.E. (2004). The adolescent resilience model as a guide to interventions. *Journal of Pediatric Oncology Nursing, 21*, 289–299.
- Henshaw, R.M., Bickels, J., & Malawer, M.M. (1999). Modular endoprosthesis reconstruction for lower extremity skeletal defects: Oncologic and reconstructive indications. *Seminars in Arthroplasty, 10*, 180–187.
- Hosalkar, H.S., Henderson, K.M., Weiss, A., Donthineni, R., & Lackman, R.D. (2004). Chemotherapy for bone sarcoma does not affect fertility rates or childbirth. *Clinical Orthopaedics and Related Research, 428*, 256–260.
- Jaffe, N., Raymond, A.K., Ayala, A., Carrasco, C.H., Wallace, S., Robertson, R., et al. (1989). Effect of cumulative courses of intra-arterial cis-diamminedichloroplatin-II on the primary tumor in osteosarcoma. *Cancer, 63*, 63–67.
- Jaffe, N., Robertson, R., Ayala, A., Wallace, S., Chuang, V., Anzai, T., et al. (1985). Comparison of intra-arterial cis-diamminedichloroplatinum II with high-dose methotrexate and citrovorum factor rescue in the treatment of primary osteosarcoma. *Journal of Clinical Oncology, 3*, 1101–1104.
- Jemal, A., Siegel, R., Ward, E., Murray, T., Xu, J., Smigal, C., et al. (2006). Cancer statistics, 2006. *CA: A Cancer Journal for Clinicians, 56*, 106–130.
- Kawai, A., Muschler, G.F., Lane, J.M., Otis, J.C., & Healey, J.H. (1998). Prosthetic knee replacement after resection of a malignant tumor of the distal part of the femur: Medium to long-term results. *Journal of Bone and Joint Surgery, 80*, 636–647.
- Link, M.P., Goorin, A.M., Horowitz, M., Meyer, W.H., Belasco, J., Baker, A., et al. (1991). Adjuvant chemotherapy of high-grade osteosarcoma of the extremity. Updated results of the Multi-Institutional Osteosarcoma Study. *Clinical Orthopaedics and Related Research, 270*, 8–14.
- Link, M.P., Goorin, A.M., Miser, A.W., Green, A.A., Pratt, C.B., Be-



- lasco, J.B., et al. (1986). The effect of adjuvant chemotherapy on relapse-free survival in patients with osteosarcoma of the extremity. *New England Journal of Medicine*, *314*, 1600-1606.
- Longhi, A., Fabbri, N., Donati, D., Capanna, R., Briccoli, A., Biagini, R., et al. (2001). Neoadjuvant chemotherapy for patients with synchronous multifocal osteosarcoma: Results in eleven cases. *Journal of Chemotherapy*, *13*, 324-330.
- Longhi, A., Macchiagodena, M., Vitali, G., & Bacci, G. (2003). Fertility in male patients treated with neoadjuvant chemotherapy for osteosarcoma. *Journal of Pediatric Hematology/Oncology*, *25*, 292-296.
- Mavligit, G.M., Benjamin, R.S., Patt, Y.Z., Jaffe, N., Chuang, V., Wallace, S., et al. (1981). Intra-arterial cis-platinum for patients with inoperable skeletal tumors. *Cancer*, *48*, 1-4.
- National Comprehensive Cancer Network. (2005). *Practice guidelines in oncology—v.1.2005: Antiemesis*. Jenkintown, PA: Author.
- Ozaki, T., Flege, S., Kevric, M., Lindner, N., Maas, R., Dellling, G., et al. (2003). Osteosarcoma of the pelvis: Experience of the Cooperative Osteosarcoma Study Group. *Journal of Clinical Oncology*, *21*, 334-341.
- Patel, S.G., Meyers, P., Huvos, A.G., Wolden, S., Singh, B., Shaha, A.R., et al. (2002). Improved outcomes in patients with osteogenic sarcoma of the head and neck. *Cancer*, *95*, 1495-1503.
- Pathak, A.B., Advani, S.H., Iyer, R.S., Pai, S.K., Gopal, R., Nadkarni, K.S., et al. (1993). Adjuvant chemotherapy for osteogenic sarcoma of the extremity with sequential adrimycin and cisplatin. *Journal of Surgical Oncology*, *52*, 181-184.
- Polovich, M., White, J.M., & Kelleher, L.O. (2005). *Chemotherapy and biotherapy guidelines and recommendations for practice* (2nd ed.). Pittsburgh, PA: Oncology Nursing Society.
- Reddick, W.E., Wang, S., Xiong, X., Glass, J.O., Wu, S., Kaste, S.C., et al. (2001). Dynamic magnetic resonance imaging of regional contrast access as an additional prognostic factor in pediatric osteosarcoma. *Cancer*, *91*, 2230-2237.
- Smith, R.B., Apostolakis, L.W., Karnell, L.H., Koch, B.B., Robinson, R.A., Zhen, W., et al. (2003). National Cancer Data Base report on osteosarcoma of the head and neck. *Cancer*, *98*, 1670-1680.
- Souhami, R.L., Craft, A.W., Van der Eijken, J.W., Nooij, M., Spooner, D., Bramwell, V.H., et al. (1997). Randomized trial of two regimens of chemotherapy in operable osteosarcoma: A study of the European Osteosarcoma Intergroup. *Lancet*, *350*, 911-917.
- Sumner, M.J. (2005). Bone and soft-tissue sarcomas. In C.H. Yarbro, M.H. Frogge, & M. Goodman (Eds.), *Cancer nursing: Principles and practice* (6th ed., pp. 979-1004). Sudbury, MA: Jones and Bartlett.
- Tsuchiya, H., Morinaga, T., Taki, J., Sumiya, H., Matsui, O., & Tomita, K. (2001). Effect of myocutaneous changes caused by intra-arterial chemotherapy on the outcome of patients who undergo limb-saving surgery. *Cancer*, *91*, 2447-2453.
- Uchida, A., Myoui, A., Araki, N., Yoshikawa, H., Shinto, Y., & Ueda, T. (1997). Neoadjuvant chemotherapy for pediatric osteosarcoma patients. *Cancer*, *79*, 411-415.
- Wilkins, R.M., Cullen, J.W., Odom, L., Jamroz, B.A., Cullen, P.M., Fink, K., et al. (2003). Superior survival in treatment of primary nonmetastatic pediatric osteosarcoma of the extremity. *Annals of Surgical Oncology*, *10*, 498-507.
- Wittig, J.C., Bickels, J., Priebat, D., Jelinek, J., Kellar-Graney, K., Shmookler, B., et al. (2002). Osteosarcoma: A multidisciplinary approach to diagnosis and treatment. *American Family Physician*, *65*, 1123-1132.
- Yonemoto, T., Tatzaki, S., Ishii, T., & Hagiwara, Y. (2003). Marriage and fertility in long-term survivors of high-grade osteosarcoma. *American Journal of Clinical Oncology*, *26*, 513-516.