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.

Since 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...
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Humerus, pelvis, jaw, fibula, and ribs (Longhi et al., 2001). Dull, osteosarcoma, in descending order of frequency, are the tibia, femur adjacent to the knee. Additional primary sites of localized 50% of tumors arise in the femur; of these, most are in the distal mors (Antonescu & Huvos, 2000). In children and young adults, mors, the most common type, and (b) surface or peripheral tu-

number of subtypes in each group: (a) central (medullary) tu-

60%–80% become long-term survivors. Currently, and adjuvant (i.e., postoperative) chemotherapy regimens have long-term disease-free survival. Neoadjuvant (i.e., preoperative) chemotherapy has 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
Intra-Arterial Chemotherapy in 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 periosseum) 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
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/m² 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/m² 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/m². 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
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 antinausea 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
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 re-inserted. 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

![Diagram of Intra-Arterial Cisplatin Administration](image)

**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 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.

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/m² 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 unspoken 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, fluorouridine, 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, Henders, 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...
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).

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