

## Infiltration and Extravasation

*Preventing a complication of IV catheterization.*

**Overview:** The Infusion Nurses Society's national standards of practice require that a nurse who administers IV medication or fluid know its adverse effects and appropriate interventions to take before starting the infusion. A serious complication is the inadvertent administration of a solution or medication into the tissue surrounding the IV catheter—when it is a nonvesicant solution or medication, it is called infiltration; when it is a vesicant medication, it is called extravasation. Both infiltration and extravasation can have serious consequences: the patient may need surgical intervention resulting in large scars, experience limitation of function, or even require amputation. Another long-term effect is complex regional pain syndrome, a neurologic syndrome that requires long-term pain management. These outcomes can be prevented by using appropriate nursing interventions during IV catheter insertion and early recognition and intervention upon the first signs and symptoms of infiltration and extravasation. Nursing interventions include early recognition, prevention, and treatment (including the controversial use of antidotes, and heat and cold therapy). Steps to manage infiltration and extravasation are presented.

*vesicant* refers to any medication or fluid with the potential for causing blisters, severe tissue injury, or necrosis if it escapes from the venous pathway. Table 1 (page 65) lists vesicants that can cause extravasation injuries. Tissue damage may occur from direct contact with vesicant medication, from compression of surrounding tissues by a large volume of fluid in the case of infiltration, or from severe vasoconstriction.

These local complications frequently have serious consequences. The patient may need surgical intervention, which could result in large scars; experience limitation of function; or even require amputation. Another long-term effect of infiltration or extravasation is complex regional pain syndrome (CRPS), a neurologic syndrome requiring long-term pain management. These serious, life-altering outcomes can be prevented.

**I**nfiltration and extravasation are known complications of IV infusion therapy. The Infusion Nurses Society (INS) and the Oncology Nursing Society have set the definitions of infiltration and extravasation. Both complications involve accidental leakage of an IV solution into surrounding tissue, but the type of IV solution differs. Infiltration is the inadvertent administration of a nonvesicant solution or medication into the tissue surrounding the IV catheter, whereas extravasation is the inadvertent administration of a vesicant medication into the surrounding tissue.<sup>1,2</sup> The term

The national standards established by the INS require that a nurse who administers IV medication or fluid know the possible adverse effects and the interventions to undertake before starting the infusion. Before administering the infusion the nurse must assess the patency of the vein and the catheter. This is done by checking for lack of resistance when flushing the catheter, brisk blood return from the catheter, and a free-flowing gravity infusion. In addition, the nurse should palpate the area above the insertion site, assess the length of dwell time for the catheter (older catheters are more likely to be associated with complications), and compare the appearance of the two extremities. The nurse should confirm the absence of all signs and symptoms of complications, such as<sup>1</sup>:

- pain, tenderness, or discomfort
- edema at, above, or below the insertion site
- erythema at or above the insertion site

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- blanching of the area around the insertion site
- changes in the temperature of the surrounding skin
- numbness, tingling, or a feeling of “pins and needles”
- burning at the insertion site or along the venous pathway
- fluid leaking from the insertion site
- feeling of skin tightness around the insertion site or tightness below the site (such as in the fingers)
- bruising
- palpable cording of the vein

Decisions made about the insertion site, catheter size, methods of catheter stabilization, and drug administration techniques influence the clinical outcome for the patient (as well as the legal liability of the nurse). When infiltration or extravasation occurs, the nurse who inserted the catheter rarely knows about loss of function, surgical procedures, amputation, and CRPS, unless a lawsuit is filed.

The incidence of infiltration and extravasation is hard to determine because of limited reporting. Extravasation injury from cancer chemotherapy is reported to be 11% in children and 22% in adults.<sup>3</sup> Jacobs reported a rate of 0.6% (41 events out of 6,600 injections) for extravasation of contrast agents given with high-pressure injector pumps.<sup>4</sup> Although pumps do not cause infiltration or extravasation, their use forces fluid into the subcutaneous tissue and so could make the situation worse if the complication is not detected quickly. Rates of extravasation with cancer chemotherapy infused through implanted ports range from 0.3% to 6%.<sup>5,6</sup>

Ethical considerations limit evidence for clinical management to case reports and animal studies. The following case study, a composite based on clinical experience, demonstrates decisions that nurses can make during IV catheter insertion to prevent infiltration and extravasation.

### CASE STUDY

Greta Henderson, age 58, arrives at the ED by ambulance, reporting severe epigastric pain of sudden onset, weakness, and nausea. The nausea has resulted in limited oral intake and a moderate fluid volume deficit. The emergency medical technician has inserted a 16-gauge, 1-in., peripheral IV catheter in her left antecubital fossa, through which Ms. Henderson is receiving an infusion of 5% dextrose and 0.45% sodium chloride at a rate of 125 mL per hour. During transfer from the ambulance stretcher to the ED stretcher, the IV catheter is accidentally pulled out. After three attempts to reinsert it, a 20-gauge catheter is inserted in the left wrist area.

The physician orders the continuation of 5%

**Table 1. Vesicant Medications and Solutions Reported to Cause Extravasation Injuries**

<b>Antimicrobials</b>
Fluoroquinolones Gentamicin Nafcillin Penicillin Vancomycin
<b>Electrolytes</b>
Calcium chloride Calcium gluconate Potassium chloride Sodium bicarbonate
<b>Cytotoxic agents</b>
Cisplatin (Platinol-AQ) Dactinomycin (Cosmegen) Daunorubicin (Cerubidine) Doxorubicin (Adriamycin, Doxil) Epirubicin (Ellence) Idarubicin (Idamycin PFS) Mechlorethamine (Mustargen) Mitomycin (Mitomycin-C) Paclitaxel (Taxol) Plicamycin (Mithracin) Streptozocin (Zanosar) Vinblastine (Velban) Vincristine (Oncovin) Vinorelbine (Navelbine)
<b>Dextrose</b>
<b>Diazepam (Valium)</b>
<b>Dobutamine (Dobutrex)</b>
<b>Dopamine</b>
<b>Fat emulsion</b>
<b>Human immunoglobulin</b>
<b>Norepinephrine (Levophed)</b>
<b>Parenteral nutrition formulas, hypertonic</b>
<b>Phenytoin (Dilantin)</b>
<b>Promethazine (Phenergan)</b>
<b>Propofol (Diprivan)</b>
<b>Radiographic contrast agents</b>
<b>Vasopressin (Pitressin)</b>

dextrose and 0.45% sodium chloride with 20 mEq potassium chloride at 125 mL per hour. The following medications are ordered: imipenem–cilastatin (Primaxin) 500 mg every eight hours by intermittent

iv infusion, diluted in 100 mL of normal saline and infused over 30 minutes; meperidine (Demerol) 25 mg iv every three hours as need for pain; and promethazine (Phenergan) 12.5 mg iv every three hours as needed for nausea and vomiting. An electrocardiogram (ECG), complete blood count and chemistry panel, abdominal X-rays and ultrasound, and pancreatic computed tomography are ordered.

**A variety of taping techniques have been used to stabilize catheters, but they're all inadequate and increase the risk of complications.**

In the ED, Ms. Henderson receives two doses of meperidine and promethazine by iv push through the catheter site in the left wrist and one dose of imipenem–cilastatin over 30 minutes. To ensure correct flow rates, an electronic iv pump is used. During the imipenem–cilastatin infusion, Ms. Henderson complains that her hand feels tight and that she cannot flex her fingers completely. When she reports a severe burning pain in her arm with each dose of promethazine, the nurse tells her this is normal for that drug.

The ECG is normal. The white blood cell count is elevated, and the blood glucose level is 235 mg/dL. An ultrasound is negative for gallstones. The patient is admitted to the medical unit to rule out pancreatitis.

During the initial assessment on the medical unit, Ms. Henderson complains of pain at the iv site. The primary care nurse notices moderate edema in the hand and the area around the iv catheter. She immediately removes it and inserts a new catheter in the right forearm. The nurse applies a heating pad to the left wrist and elevates the left arm on a pillow.

Six hours later Ms. Henderson continues to report severe pain in her left hand and arm and has great difficulty extending the fingers of that hand. The edema has dramatically increased, making the skin look tight. Capillary refill in the left fingers is much slower than in the right hand, and it's difficult to feel the left radial pulse. The primary care nurse notifies the physician, who orders continuation of the heat application and a surgical consultation.

Fifteen hours after removal of the catheter from

the left wrist, the surgeon examines the arm and decides that Ms. Henderson has compartment syndrome. She is taken to the operating room for a fasciotomy of the left arm. The fasciotomy incision extends from the volar aspect of the left wrist to the antecubital fossa.

Elevated serum amylase and lipase levels and an enlarged pancreas on computed tomography confirm the diagnosis of acute pancreatitis. Ms. Henderson responds well to bed rest and no oral intake. She is discharged on day 5.

Ms. Henderson requires physical therapy for months to improve the function of her arm. The pain in the arm continues. Three months after the incident, a neurologic examination confirms CRPS type I (previously known as reflex sympathetic dystrophy).

## CLINICAL OUTCOMES

A more rapid response from the surgical consultant might have altered the outcome in this case. Compartment syndrome lasting longer than 12 hours leads to additional complications.<sup>7</sup> It occurs when fluid collects in tight spaces bound by fascia, bone, muscle, and skin. The increasing pressure decreases capillary perfusion in the area. The outcome may be irreversible nerve damage and permanent loss of function.<sup>7,8</sup> Irreversible damage can occur after as little as four hours.<sup>9</sup> Fasciotomy decompresses the compartment and relieves the pressure.

Ms. Henderson was diagnosed with CRPS type I, a neurologic pain disorder that most often occurs after trauma. Burning pain is the most common symptom. Other signs and symptoms include color and temperature differences in the two extremities, edema, and hyperhidrosis (excessive perspiration). Long-term effects include skin and nail changes, osteoporosis, weakness, and tremor.<sup>10</sup> Although the pathophysiology remains unclear, research reveals involvement of an inflammatory process.<sup>10</sup> The complexity of signs and symptoms indicates, in addition to inflammatory processes, sensory, autonomic, trophic, and motor processes.<sup>10</sup>

Although Ms. Henderson did not experience a necrotic ulcer, potassium chloride and promethazine have the potential to cause tissue destruction if they enter the subcutaneous area. Extravasation of a vesicant medication produces immediate pain, but blisters may not appear for several days. Necrosis is seen within weeks.<sup>2,11</sup>

The photographs on pages 68 and 69 show the outcomes of extravasation and infiltration in actual patients (not Ms. Henderson).

## CAUSES OF INFILTRATION AND EXTRAVASATION

Ms. Henderson was receiving IV fluids through an infusion pump at a rate of 125 mL per hour. Although the infusion pump didn't cause the extravasation injury, it compounded the problem because it continued to pump fluid into the subcutaneous space. Five doses of IV medications were infused or injected, adding to the fluid that could escape into the tissue. Computed tomography involved an injection of a contrast agent at a fast rate with a high-pressure injector, which also could have driven more fluid into the tissue.

There are three basic causes of infiltration and extravasation: mechanical, obstructive, and inflammatory. Two of these problems could be present in Ms. Henderson's case.

**Mechanical problems** with the catheter can occur during the initial venipuncture or while the catheter is in place. During venipuncture, the nurse could have pierced the posterior wall of the vein, pulled the catheter back into the vein lumen, obtained a brisk blood return, and completed the procedure. Although everything might have appeared normal at the time, fluid could have been leaking unseen into the subcutaneous tissue from the puncture site in the vein wall.

The nursing documentation indicates that the catheter was placed in the left wrist; however, the exact location was not specified. Veins are located on the radial, ulnar, and volar aspects of the wrist. Each of these sites is in an area of joint flexion. Kagel and Rayan reported that more than half of major IV-associated complications occur in the hand, and more than half of minor complications occur in the hand and wrist.<sup>12</sup>

Many sites at which catheters are inserted in the hand, wrist, and antecubital fossa are areas of joint flexion and require stabilization of the joint. Movement of the joint will occur naturally as the patient moves in bed, transfers or is transferred in and out of bed or to a wheelchair, and performs activities of daily living such as dressing, eating, and toileting. As the joint moves, the catheter will move inside the vein, and the catheter tip can pierce the vein wall. Instructing a patient not to use the hand, for example, or supporting the hand with a pillow doesn't prevent joint movement. The best preventive measure is the use of a hand board, which prohibits a flexible catheter from bending (cutting off flow).<sup>1</sup>

**Venous obstruction** may also be involved in this case. The first catheter was placed in the left antecubital fossa; there is no documentation of the specific vein used. After three unsuccessful venipuncture

attempts, the catheter was then successfully placed in the left wrist. The medical record does not specify the exact location of the unsuccessful venipuncture sites.

During all venipuncture procedures, a clot forms inside the vein lumen from disruption of the tunica intima, the vein's internal layer. Disruption of this one-cell-thick layer allows blood to make contact with the basement membrane between the vein layers, which immediately begins the clotting process. The final, successful site of cannulation was distal to the original antecubital site and possibly distal to the unsuccessful sites as well. Those sites did not have sufficient time to heal. Fluid flowing to those sites could have met resistance from the clots, resulting in fluid leaking into the subcutaneous tissue at the successful site of catheterization.

**Inflammatory processes** sometimes play a part in infiltration, although that was probably not so in the present case. Inflammatory processes are usually associated with drugs such as cytotoxic medications that promote venous inflammation. After infusion of irritating fluids and medications, biochemical substances such as histamine, serotonin, leukotrienes, prostaglandins, and bradykinins cause gap junctions to open in the walls of capillaries. These openings allow the passage of fluid from the intravascular space to the interstitial space. The result is edema, redness, and pain.<sup>13</sup>

## NURSING INTERVENTIONS

The nurse is responsible for ensuring that all measures have been taken to prevent infiltration or extravasation, that signs and symptoms are rapidly recognized, and that proper treatment measures are used (see Table 2, page 70). Hospitals should establish written protocols that nurses can follow quickly and easily without waiting for instructions from a physician.

**Prevention.** Measures to prevent infiltration and extravasation include selection of an appropriate site for catheter insertion, selection of an appropriate-size catheter, use of appropriate fluids, stabilization of the catheter, and use of proper administration techniques.

*Site selection* is the first step. Areas of joint flexion such as the hand, wrist, and antecubital fossa are never the best place for an IV catheter.

Palpating the veins can be difficult; sharpen your skills. Always use the same finger of your nondominant hand. With repeated use of the same finger for palpation, you'll be able to find veins more successfully and develop a better sense of how good and bad choices for IV catheter placement feel. Veins





Surgical scars after a fasciotomy necessitated by compartment syndrome from a severe infiltration.

that can be palpated but not seen are usually larger than veins that appear as superficial blue lines under the patient's skin. Veins that feel hard or cordlike should be avoided. Press down on a vein, and you'll notice the elasticity of a healthy vein as you release the pressure on the site.

In Ms. Henderson's case, after the initial 16-gauge catheter was accidentally dislodged, the opposite arm should have been used for subsequent insertion of a catheter. The first site had not had time to heal prop-

erly, and the large catheter probably created a thrombosis that prevented adequate blood flow through the vein; a standard 20-gauge catheter would have been a better choice. The normal fibrinolytic system had not had time to break down the clot. Four attempts were made to obtain a second iv site, but the number of nurses making these attempts was not documented. The INS standards of practice call for only two attempts per nurse, as well as documentation of the site of each attempt.<sup>1</sup>

**Catheter size.** The smallest-gauge catheter for delivering the prescribed therapy should be used. Catheters are now made with thinner yet stronger walls, resulting in a larger lumen. As a result, it's now possible to achieve required flow rates using smaller gauges. A 20-gauge catheter is easily capable of infusing about 3,900 mL per hour, a 22-gauge catheter can infuse about 2,200 mL per hour, and a 24-gauge catheter can deliver about 1,400 mL per hour.

Flow rate depends not just on the catheter gauge size, but also on the size of the vein, its condition, and whether vasospasm or valves are present. Use of a catheter that is too large for the vein will result in obstruction of blood flow and possible thrombosis distal to the site. Mechanical phlebitis occurs if the catheter makes contact with the endothelial vein lining.

**Osmolarity and pH.** Many iv therapies should not be infused through peripheral veins because of their osmolarity and pH; chemical phlebitis can result.<sup>14</sup> Fluids and medications with an osmolarity greater than 350 mOsm/L are considered hypertonic. Those with an osmolarity greater than 600 mOsm/L

should not be infused through a peripheral vein. Animal and human studies have demonstrated that these fluids are associated with the highest risk of endothelial damage.<sup>15-17</sup> Medications with a pH lower than 5 or higher than 9 should not be infused through a peripheral vein, as similar endothelial damage results.<sup>18</sup> Such fluids and medications require infusion through a central venous catheter.

In a busy ED, however, trauma patients may be the only ones to receive a central venous catheter.

The nurse therefore needs to be particularly careful about choosing sites and catheters to minimize the patient's risk. Having a close working relationship with the hospital pharmacy and an iv-drug handbook available will ensure that nurses have the necessary information about the pH and osmolarity of iv solutions and medications.

**Stabilization.** Using a manufactured catheter stabilization device, which has a mechanism that anchors the catheter and prevents unnecessary movement within the vein, is the best way to stabilize the catheter. Numerous studies have reported greatly reduced complications when such devices are used,<sup>19,23</sup> and they're now preferred, according to the INS standards of practice.<sup>1</sup>

The use of hand boards may have decreased in the recent past because the Joint Commission has stressed the importance of reducing the use of restraints.<sup>24</sup> This concern is unfounded because hand boards are not a form of physical restraint.<sup>1</sup>

A variety of taping techniques have been used to stabilize catheters, but they're all inadequate and increase the risk of complications.<sup>23</sup> Tape doesn't adhere well to the plastic cannula. In 74% of tape specimens tested in one hospital, pathogenic bacteria contaminated the tape.<sup>25</sup> Complex taping techniques require nursing time that would be better spent in other ways. In addition, tape may obscure the iv site, preventing early detection of complications. The catheter dressing should be a transparent membrane dressing, without excessive tape obscuring the insertion site and venous pathway.

**Administration techniques.** The patency of the catheter and vein should be assessed frequently so that infiltration or extravasation can be prevented. Before administering each dose of medication, the nurse should visually inspect and palpate the site, checking for vein cording, edema, skin temperature, and tenderness or discomfort. During drug administration, the nurse should check the gravity drip; slowing indicates possible infiltration.

Each drug should be diluted in a separate syringe. When dilution is done either in a syringe or by slow injection through an infusing, compatible iv fluid, according to recommendations from the drug manufacturer, the injection can be stopped if the patient complains of any problems.

Check for a positive blood return using gentle aspiration from the vein into the syringe. Slow or inadequate blood return could indicate a problem with the location of the catheter, although a small vein with a large catheter may not produce adequate blood return—that is, brisk, free-flowing return of blood rather than pink-tinged fluid.



A promethazine extravasation about five weeks after the event.

Flushing the catheter with normal saline while palpating the site also makes detection of swelling at the catheter tip easier.

**Early recognition.** Assessment of the site and the venous pathway up the arm is critical to recognizing problems with catheterization.

An iv infusion should not be painful if the drug is diluted and slowly injected through a catheter that has been properly selected, inserted, and secured. Pain on injection is an immediate indication to stop. Most severe complications occur because the infusion continues while staff consider other explanations for the pain.

It's the nurse's responsibility to know the adverse effects associated with each iv drug. Severe burning such as Ms. Henderson reported with each infusion of promethazine is a classic sign that the drug is escaping into the subcutaneous tissue. The nurse should assess the neurovascular condition of the extremity as often as dictated by hospital policy, by checking for sensation, range of motion, capillary refill, and pain. A rating scale, such as the one published in the INS standards of practice,<sup>1</sup> should be used to document the severity of the problem. Extravasation is the most severe level of the scale.

When comparing the appearance and circumference of the two extremities, conduct the tourniquet test if there is edema or any other reason to suspect possible infiltration. Place a tourniquet several inches proximal to the iv site and observe for changes in the gravity flow rate. Compression of the vein by the tourniquet will slow or stop the infusion when infiltration is not present. An unaltered flow rate upon compression by the tourniquet indicates that fluid is leaking into the subcutaneous tissue.<sup>14</sup>

When infiltration or extravasation occurs, it's important to estimate the volume of infiltrated fluid.

**Table 2. Steps in the Management of Infiltration and Extravasation**

1. Know your facility's policy and procedure for infiltration and extravasation. If your facility doesn't have a detailed policy and procedure, work to establish one.
2. Teach the patient and family the signs and symptoms of infiltration and extravasation.
3. Pay close attention to all patient complaints, and be prepared to act.
4. Know the location of all supplies or assembled kits needed to treat an infiltration or extravasation.
5. Use a transparent membrane dressing to ensure visibility of insertion sites and venous pathways.
6. Assess the condition of a site, the patient's reports of problems related to the catheter, and catheter dwell time before administering each dose of a vesicant medication.
7. Aspirate until there is a brisk blood return before, during, and after administration of each vesicant medication.
8. At the very first sign or symptom of infiltration or extravasation, immediately stop the infusion or injection.
9. Disconnect the administration set from the catheter hub and attach an empty 3- or 5-mL syringe. Attempt to aspirate fluid from the catheter lumen.
10. Photograph the site to document the condition if that is in accordance with your facility's policies and procedures.
11. For a problem involving a short peripheral catheter:
  - Remove the dressing and withdraw the catheter.
  - Use a dry gauze pad to control bleeding. Apply a dry dressing to the puncture site, but avoid applying excessive pressure on the area.
  - Do *not* insert a new peripheral IV catheter distal to a site of infiltration or extravasation.
12. For a problem involving a central venous catheter:
  - Do not remove the catheter. Clamp and cap the catheter hub.
  - Follow your facility's procedure for flushing the catheter when infiltration or extravasation is suspected.
  - When there is an implanted port, remove the port access needle after aspiration and apply a dressing.
  - Consult the physician about the need for a radiographic study of the catheter to determine the cause of the infiltration or extravasation. Assess the need for continuing IV therapy and plans for another central venous catheter.
13. Assess motion, sensation, and capillary refill distal to the injury. Measure the circumference of the extremity and compare it with the opposite extremity.
14. Apply warm or cold compresses as appropriate for the fluid or medication that has escaped into the subcutaneous tissue:
  - Use heat for vinca alkaloids such as vinblastine (Velban) or vincristine (Oncovin) and for epipodophylotoxins such as etoposide (VePesid).
  - Use cold for hypertonic fluids and medications.
  - Choose either heat or cold, based on patient comfort, for isotonic or hypotonic fluids and medications.
  - Reapply compresses for 15 to 30 minutes every four to six hours for 24 to 48 hours.
15. Estimate the volume of fluid or medication that escaped into the subcutaneous tissue according to the flow rate, the condition of the site in comparison with the previous observation, and the length of time between observations.
16. Notify the physician. Provide background information such as additional risk factors, as well as your assessment of the problem and recommendations for care.
17. If indicated by the patient's condition and the estimated volume of escaped fluid, obtain physician orders for a surgical consultation.
18. If indicated by your facility's policy, obtain physician orders for the appropriate antidote. Administer the antidote, if indicated.
19. Advise the patient to rest and elevate the extremity if it increases comfort.
20. Provide the patient and family with written instructions on symptoms to report to the clinician, caring for the site, managing pain, and the plan for follow-up care.
21. Document all of the following:
  - all fluids and medications involved
  - estimated volume of fluids and medications that escaped from the vein
  - the types of infusion methods used, such as manual injection from a syringe, gravity infusion, or an infusion pump
  - the type, size, and length of the catheter involved
  - a complete description of the site, including anatomic location, size, color, and texture of the surrounding area; the Infusion Nursing Standards of Practice recommend using a grading scale
  - the methods used to assess the site before administering vesicant medications (for example, the presence of blood return, the tourniquet test when using a gravity drip)
  - all signs and symptoms
  - initial interventions (such as aspiration, catheter removal, application of heat or cold)
  - notification of the physician and other consultations
  - use of antidotes, their dosages, and how they were administered
  - patient education regarding the event and follow-up care
22. Complete an unusual occurrence, incident, or sentinel event report, as required by your facility's policy and procedure.

Polovich M, et al., editors. Chemotherapy and biotherapy guidelines and recommendations for practice. 2nd ed. Pittsburgh, PA: Oncology Nursing Society; 2005; *J Infus Nurs* 2006;29(1 Suppl):S1-S92.

Base the estimate on the hourly flow rate and the length of time the patient has had the problem.

**Treatment.** Immediate removal of the catheter is essential when infiltration occurs. Often the nurse is hesitant to remove a questionable catheter, fearing that removal will take away venous access. This rationale is not appropriate, because a questionable catheter site makes that vein unusable anyway. Catheters allowed to remain in the vein could accidentally be used for infusion of another drug by another nurse, increasing the risk to the patient.

**Antidotes.** The use of antidotes is controversial. The evidence is limited to case reports and animal studies, and there are no reports at all for many drugs. When it's a hospital's policy and procedure to administer an antidote, the questionable catheter usually has been the preferred route to inject it, on the theory that the antidote will follow the path of the extravasated fluid.<sup>3,26</sup> The most recent guidelines of the Oncology Nursing Society in general do not recommend antidotes for extravasation.<sup>2</sup> A pressure dressing on the site should be avoided, because it could spread the fluid, causing contact with more tissue.<sup>27</sup>

Sodium bicarbonate has been used as an antidote, but unsuccessfully; it actually destroys tissue. Steroids have also been tried without success, probably because there is no inflammatory response in the subcutaneous tissue. Rather, tissue compression is related to the volume of infiltrated fluid. Some cancer chemotherapy agents cause direct cellular destruction, and several vasopressors cause vasoconstriction, not inflammation.<sup>3,28,29</sup>

Phentolamine (Regitine) is indicated for extravasation of vasopressors, because it reduces local vasoconstriction and ischemia. A dose of 5 to 10 mg is diluted in 10 mL of normal saline and injected subcutaneously around the area after catheter removal. It's best when this is done immediately, but it should be done at least within 12 hours after extravasation. One problem is the limited availability of the drug from the manufacturer. It is available only on an allocation basis, and a hospital is allowed to keep two boxes on hand.<sup>30</sup>

Hyaluronidase (Vitrase and others) has been used for the treatment of infiltration and extravasation of many drugs. This protein enzyme breaks down the cellular cement in the subcutaneous tissue.<sup>3,29,31,32</sup> Several brands are available, including one recombinant product (Hylenex), which has not been studied for use with infiltrations.

**Heat and cold.** The application of heat is based on the theory that vasodilation increases drug distribution and decreases drug accumulation in the local tissue. The application of cold is based on the theory

that vasoconstriction localizes the drug to a limited area.<sup>3,29,32</sup> Heat application is indicated for extravasation of two types of cancer chemotherapy: vinca alkaloids such as vinblastine (Velban) and vincristine (Oncovin) and epipodophyllotoxins such as etoposide (VePesid). Cold application is indicated for infiltration or extravasation of hyperosmolar fluids.

The use of heat in the management of infiltration has been the subject of several studies. After infiltration of small amounts of 0.45% sodium chloride (hyposmolar) and 3% sodium chloride (hyperosmolar) in healthy volunteers, the subcutaneous tissue was examined using magnetic resonance imaging at 30-minute intervals.<sup>34</sup> When applied to an infiltration of hyperosmolar fluid, heat increased the area of induration and slowed reabsorption of the subcutaneous fluid. Heat had no impact on induration and reabsorption of the hyposmolar infiltration.<sup>33</sup> A similar test evaluated the effect of elevating the extremity by 4 in. Although hyposmolar fluid infiltrates decreased in size and hyperosmolar fluid infiltrates increased in size, elevation caused no change in the rate of fluid reabsorption or symptoms such as pain and volume of fluid in the subcutaneous tissue.

In Ms. Henderson's case, applying heat to her arm where hyperosmolar fluid had extravasated, a treatment that was continued under a physician's order, made the problem worse.

## POLICY AND PROCEDURE IMPROVEMENTS

All health care facilities should establish policies and procedures for preventing and managing infiltration and extravasation. There is no time to learn the best methods once the complication occurs. The INS standards of practice recommend developing an extravasation prevention plan that defines the skills of nurses giving vesicant medications.<sup>1</sup>

Following the INS national standards of practice would have created a better outcome for Ms. Henderson.

Complete documentation—including the exact location of each successful and unsuccessful venipuncture site, the method of stabilization, and the methods used to assess the site before each drug administration—provides evidence that appropriate measures are taken. Without this documentation, many questions about safe practices are left unanswered, and the nurse's liability increases.

Most readily available drug references do not contain complete information about iv administration. Drug handbooks specific to iv administration must be available and used to ensure that all the correct steps are taken.

Nurses must stay current on recommendations from advisory organizations such as the Institute for



Safe Medication Practices (ISMP). For example, the August 2006 issue of the ISMP *Medical Safety Alert* focused on actions needed to prevent serious injury from IV promethazine.<sup>11</sup> Recommendations included the use of alternative antiemetic medications such as ondansetron (Zofran), the removal of promethazine from hospital formularies, and collaboration between the Food and Drug Administration and drug manufacturers to change the labeling of this drug.

## Sodium bicarbonate has been used as an antidote, but it actually destroys tissue.

Ms. Henderson experienced a serious injury that resulted in loss of limb function and long-term pain. This meets the definition of a sentinel event. Such events require root-cause analysis to identify the factors that led to the problem, followed by changes in practice to prevent future episodes.<sup>35</sup> ▼

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