# I.V. infil

BY LYNN C. HADAWAY, RN,C, CRNI, MED

PETE TUCKER, 55, spent 3 days in the intensive care unit following a colon resection for cancer. He was transferred to your unit this morning with a nontunneled triple-lumen catheter inserted in the left subclavian area. Examining the catheter and dressing, you notice an excessive amount of moisture under the transparent dressing. Mr. Tucker tells you he feels some burning in the area around the catheter insertion site. The fluid infusing (at 83 ml/hour) is 5% dextrose in 0.45% sodium chloride with 40 mEq potassium chloride added to the liter.

You may be all too familiar with the clinical signs and symptoms of infiltration at a peripheral catheter insertion site: swelling or leaking at the site, pain, and skin coolness and blanching. But what about a central catheter insertion site? Can infiltration be a problem?

Unfortunately, yes. Also known as extravasation, infiltration isn't just a peripheral problem. It can occur with any type of vascular access device (VAD), including nontunneled and tunneled central vascular catheters, implanted ports, and even intraosseous and epidural infusion devices.

Although the terms *infiltration* and *extravasation* are often used interchangeably, the *Infusion Nursing Standards of Practice* published by the Infusion Nurses Society defines infiltration as the inadvertent administration of a *nonvesicant* solution into surrounding tissue; extravasation is the inadvertent administration of a *vesicant* solution into surrounding tissue. Vesicants are solutions capable of causing tissue injury or destruction if they escape into surrounding tissue. Examples include chemotherapy agents, certain electrolyte solutions, radiographic contrast media, and vasopressors (see *Recognizing Vesicant Medications*).

In this article, I'll discuss how to recognize and treat infiltration or extravasation at various peripheral and central intravenous (I.V.) sites. To thoroughly examine the clinical picture, let's first examine the mechanisms that cause fluid to escape from the catheter and the processes that injure subcutaneous tissue.

## Precipitating events

Factors leading to infiltration include mechanical forces that displace the VAD, obstructions to blood flow around or through the catheter, and the inflammatory process. Once subcutaneous tissue is exposed to the escaping fluid, damage is caused by osmotic and pH differences, ischemia, compression, and direct toxicity.

Complications of infiltration fall into three categories:

• *ulceration and possible tissue necrosis.* The severity of tissue damage depends on many variables, including the drug's vesicant potential, the amount of drug extravasated, and the venipuncture site. Contrary to popular assumptions, ulceration isn't immediately apparent. The patient may initially complain of burning at the site, as Mr. Tucker did, or may state that the infusion "feels different now." The ulcer may actually take days or weeks to develop. Treatment for ulceration may include debridement, skin grafting, or other surgical reconstruction.

• *compartment syndrome.* Compartments are areas of the body where muscles, nerves, and vessels are confined in relatively inflexible spaces bounded by skin, fascia, and bone. When fluid inside a compartment increases, the venous end of the capillary bed becomes compressed. If vessels can't carry away the excessive fluid, hydrostatic pressure rises, leading to compartment syndrome: arteriolar compression, vascular spasm, pain, and muscle necrosis inside the compartment. Functional muscular changes can occur within 4 to 12 hours of injury. Within 24

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Not just a peripheral problem

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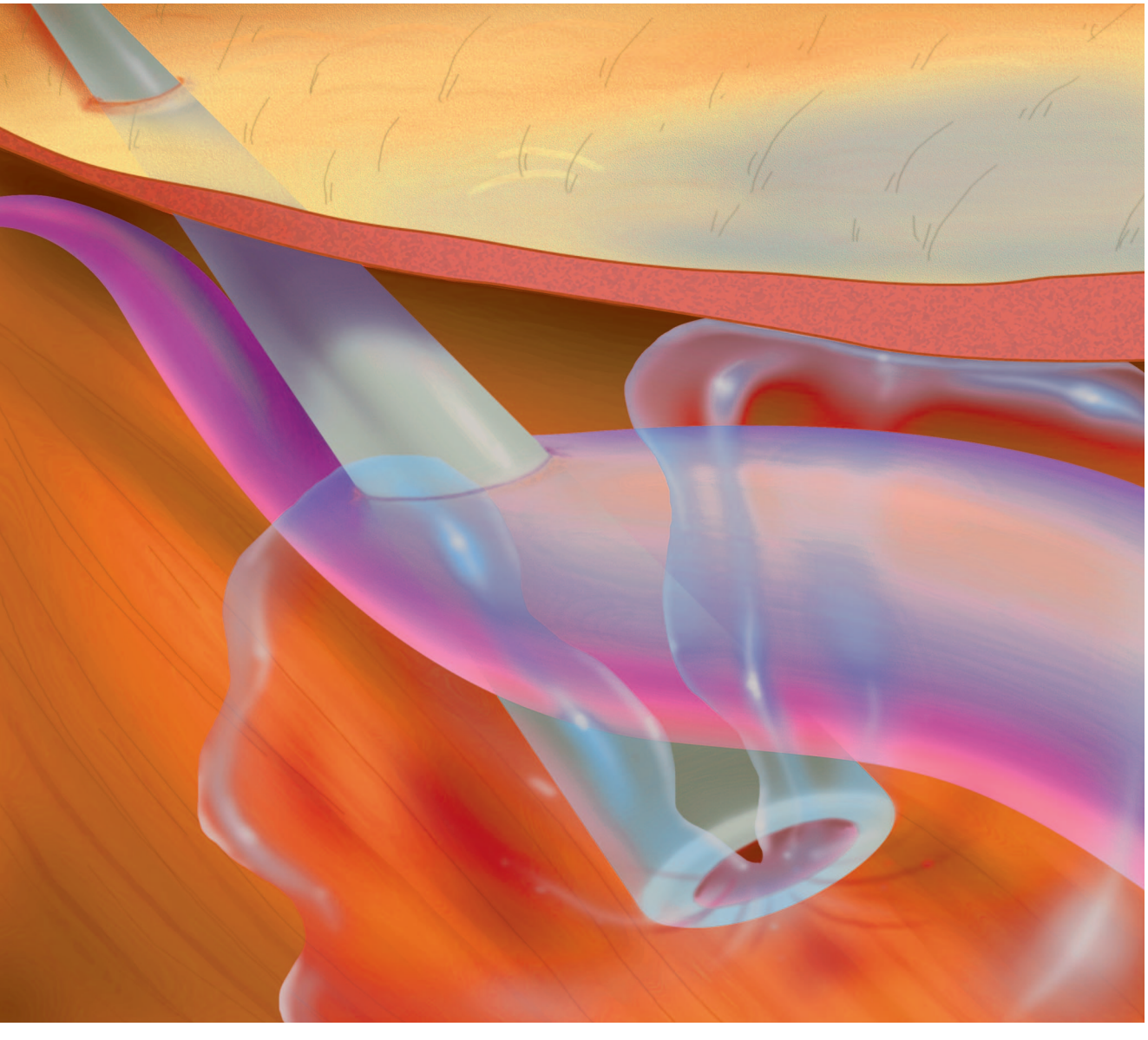

hours, ischemic nerve damage can result in functional loss of the extremity. The extremities contain many compartments, increasing the possibility of compartment syndrome from infiltration at a peripheral site.

• *reflex sympathetic dystrophy syndrome.* Although the exact pathogenesis is unknown, this chronic pain syndrome is caused by trauma to nerve complexes or soft tissue. When severe infiltration occurs, a chronic and exaggerated inflammatory process begins, leaving the patient with limited function in the affected extremity.

## Not always obvious

Classic signs and symptoms of infiltration include edema and changes in the site's appearance and temperature, such as swelling, blanching, and coolness. The patient may complain of pain or discomfort and a feeling of tightness around the site.

But not all patients experience discomfort. In fact, clinical research demonstrates that pain, edema, and induration are unreliable indicators of infiltration, which isn't always easy to spot.

The greatest discomfort and best-defined borders of infiltrated fluid tend to occur immediately. Depending on the fluid type, infiltrated fluid may then dissipate, relieving signs and symptoms.

The type and amount of fluid that infiltrates dictates the total amount of fluid in the infiltrated area. A hypertonic fluid draws fluid out of cells, increasing the amount of fluid in tissue. A hypotonic fluid will quickly be absorbed by surrounding cells; however, depending on the volume of infiltrated fluid, the cells may swell and rupture, spilling fluid back into the tissue.

Different I.V. solutions produce differing pain intensity. In one study, infiltrated hypertonic solutions such as 3% sodium chloride were most painful, followed by hypotonic 0.45% sodium chloride. In a test performed with an isotonic solution, pain began immediately after infiltration started, then subsided quickly even if infiltration continued.

In addition, the administration method influences the amount of fluid that escapes into tissue. Compared with a pump-controlled infusion, a gravity infusion creates less pressure on the catheter and vein wall. If infiltration occurs, the infusion will generally slow down. In an elderly patient, however, loose skin may allow the infiltration to progress with little effect on the flow rate.

If a pump-controlled infusion infiltrates, the pump will continue to force solution into the tissue. This is more likely to produce a large infiltration in a short time.

Fluid manually injected by a syringe can also cause great pressure in tissues and veins—maybe even more than fluid infused by a pump.

To complicate assessment, problems associated with infiltration may not always appear at the insertion site. Think not only about where the catheter enters the body, but also about where the medication enters the vein. Assess the entire catheter and adjacent structures, including, for example, the vein entry site, the catheter tip location, and the venous pathway in between those two points. With central lines, check the subcutaneous tunnel or port pocket and the neck, jaw, arm, and chest wall ipsilateral to the catheter. Engorged chest wall veins and difficulty in moving the neck or jaw indicate an obstruction to venous blood return and possible thrombosis. By obstructing blood flow, thrombosis causes back pressure in the vein, which may lead to an overflow of fluid from the puncture site.

Unexplained areas of swelling around the venotomy end of a tunneled catheter or an implanted port may indicate catheter fracture with subsequent fluid leakage into the surrounding tissue.

## Launching an investigation

If you suspect infiltration, take these steps to investigate:

• If the patient has a peripheral catheter, carefully assess both arms and compare them, looking for differences.

• Ask him to describe any discomfort or tightness and when he first noticed it.

• Review his medical history. Conditions other than infiltration, such as heart failure, renal failure, or the presence of an arteriovenous fistula, can also cause edema.

• Assess for other factors, such as positioning, that could impair blood flow or cause edema and swelling. For example, was he lying on his arm, constricting it mechanically? Could tight clothing or restraints be a factor? Does repositioning change the resistance to flushing or lack of blood flow? If so, the catheter tip may have simply been pressed against the vein wall.

• Check the I.V. line for patency. Do you find resistance to flushing with a syringe or gravity flow? Has the pump started to beep with an occlusion alarm? Can you easily obtain blood flow from the catheter?

## Checking catheter patency

A traditional way to assess catheter function is to attach a syringe and slowly draw back to obtain a blood return. You should obtain a blood return

before giving any medication—especially a vesicant. First, gently flush the catheter with 0.9% sodium chloride solution and check for any resistance to flushing, changes at the insertion site (such as edema or leaking), and patient complaints of discomfort. If you encounter no problems, gently aspirate for blood.

Keep in mind, however, that this method can also be misleading. You can't assume that a free-flowing blood return rules out infiltration. You could obtain a free-flowing blood return even when infiltration is present under these circumstances:

- the catheter tip has eroded through the vessel wall, yet the tip remains partially inside the lumen
- blood flow is obstructed, forcing blood to flow out of the vein
- an inflammatory process is causing endothelial cells to retract and fluid to leak.

Similarly, the absence of blood return doesn't necessarily confirm infiltration. A blood return is usually absent when:

- fibrin occludes the catheter tip
- the tip is pressed against the vein wall
- you attempt to aspirate too aggressively (pulling back on the syringe plunger too quickly and forcefully can cause soft catheters, such as peripherally inserted central catheters, to temporarily collapse)
- blood flow is impeded by a large catheter in a small vein.

Another way to check for patency of a gravity-flow peripheral I.V. line is by using the tourniquet test. While the I.V. solution is infusing, place the tourniquet on the patient's arm well above the site. Then observe the gravity drip of the fluid. If the drip rate isn't affected by venous constriction from the tourniquet, the test is positive for infiltration. If the infusion were running properly, the venous compression from the tourniquet would dramatically slow the drip rate. Keep in mind, however, that because obstruction of blood and fluid flow can cause infiltration, the tourniquet test could contribute to problems. If you use it, apply the tourniquet gently and for only a brief time.

## Central-line considerations

When a central vascular catheter doesn't yield a blood return, you may attempt to salvage the line by instilling a thrombolytic agent to dissolve fibrin inside the lumen. Drugs being used for this purpose include alteplase and reteplase. At present, catheter clearance is a labeled indication only for alteplase (Cathflo Activase). Other drugs may have this indication added to their label in the future. Or the primary care provider may order a cathetergram to determine the fluid pathway through the catheter. Performed under fluoroscopy, the procedure involves injecting a dye through the catheter and watching to see if it flows into the vein or backflows along a fibrin sheath and out the insertion site.

If a fibrin sheath has formed outside the catheter, thrombolytic agents instilled in the catheter lumen may not clear the obstruction; an interventional radiologist may use a stripping procedure to pull the sheath off the catheter and preserve the line.

With a subclavian line, another possible reason for obstruction of fluid flow is that the catheter is pinched between the clavicle and first rib, a situation that can lead to catheter fracture, emboli, and fluid escaping into the tissue from the fractured section.

If you find pain and edema in the subclavian area, stop the infusion and attempt to flush the line with heparinized saline. Prepare the patient for X-ray studies to confirm catheter fracture and retrieve the fragment.

## Elevate or not?

Suppose you've identified infiltration at a peripheral site, stopped the infusion, and removed the catheter. What's next? Elevating the affected arm is a time-honored nursing intervention, but research shows it isn't as effective as you may think.

In one study, small quantities of infiltrated I.V. solutions were followed by magnetic resonance imaging. Hypotonic solutions decreased in volume and hypertonic solutions increased in volume. But a 4-inch (10-cm) elevation of the extremity made no difference in the rate of fluid reabsorption for either solution.

### Recognizing vesicant medications

**Antibiotics**
Doxycycline
Nafcillin
Piperacillin
Piperacillin/tazobactam (Zosyn)
Vancomycin

**Antineoplastic drugs**
Carmustine
Dacarbazine
Dactinomycin
Daunorubicin
Doxorubicin
Epirubicin
Idarubicin
Mechlorethamine
Mitomycin C
Paclitaxel
Plicamycin
Streptozocin
Vinblastine
Vincristine
Vinorelbine

**Electrolyte solutions**
Calcium chloride
Calcium gluconate
Potassium chloride
Sodium bicarbonate

**Vasopressors**
Dopamine
Epinephrine
Metaraminol
Norepinephrine

**Miscellaneous**
Dextrose > 10%
Doxapram
Lorazepam
Phenytoin
Promethazine
Radiocontrast media

Elevating the arm may be uncomfortable for some patients, so let them decide what position is most comfortable.

What about applying warm or cold compresses to the site? That depends on the type of I.V. solution. To limit contact of the medication with subcutaneous tissue, local hypothermia is the recommended treatment for infiltration of all fluids with one exception: Warmth is still recommended for vinca alkaloids (vinblastine, vincristine, and vinorelbine). Unlike other vesicant drugs that lodge in tissue and produce prolonged effects, vinca alkaloids don't bind to cellular DNA and are quickly metabolized. Applying heat helps reduce pain and swelling associated with the acute phase following extravasation.

Warming a site infiltrated with a hypotonic solution would have no effect on local induration or reabsorption. But warming a site infiltrated with a hypertonic solution would increase the indurated area and slow reabsorption.

## Answers about antidotes

Because research on antidote use in humans has been limited for ethical reasons, many questions about antidotes are unsettled and some treatments are controversial. In the past year or so, two drugs used as antidotes have been removed from the market—hyaluronidase and phentolamine. At present, no drugs have been identified as replacement antidotes. For extravasation of antineoplastic agents, the Oncology Nursing Society continues to recommend applying cold or warm compresses, depending on the extravasated drug. Terbutaline injection and topical nitroglycerin ointment have been suggested as alternatives for extravasation of constrictor agents, although there are no clear protocols for their use.

Some facility policies permit experienced RNs who've demonstrated competency in this area to administer an antidote for an extravasated peripheral site. Following are some typical antidotes and treatment protocols currently used in practice:

- ***alkylating agents***—Inject 1 to 4 ml (⅙ molar) of sodium thiosulfate, giving 1 ml for each milliliter of extravasated drug. Or apply topical dimethyl sulfoxide (DMSO).
- ***antitumor antibiotics***—Apply topical DMSO. Or inject 20 to 90 ml of 0.9% sodium chloride into the site daily for 3 to 6 days, followed by topical corticosteroids.
- ***plant alkaloids***—Inject 20 to 90 ml of 0.9% sodium chloride into the site daily for 3 to 6 days, followed by topical corticosteroids.

If you're qualified to administer antidotes, you can use the peripheral catheter to carry the antidote into extravasated subcutaneous tissue. First, detach the tubing, connect an empty syringe to the catheter hub, and aspirate residual medication from the catheter. Then, disconnect this syringe, attach the syringe containing the antidote, and inject the antidote.

But suppose you can't aspirate any residual drug from the catheter. In this case, using the catheter to deliver the antidote may force more medication into the tissue. As directed by facility procedure, remove the catheter immediately and inject the antidote percutaneously around the extravasated area with a small-gauge needle. The disadvantage of this technique is that it causes additional breaks in the skin, making the procedure more painful and increasing the risk of infection.

After treatment, apply a sterile dressing to the area. Avoid pressure dressings, which would force the extravasated fluid into contact with a larger area.

The use of antidotes with central lines is controversial. If ordered or permitted by facility policy, you may treat extravasation at most central venous sites by injecting an antidote subcutaneously rather than through the catheter. If extravasation has occurred at an implanted port site, however, aspirate the drug through the needle, if possible, and inject the antidote through the needle. If you can't aspirate through the needle, remove it and aspirate the subcutaneously pooled drug.

## Documentation tips

When documenting assessments and interventions, include the VAD type, insertion site, name of the medication, and how it was infused (I.V. bolus or infusion, with or without pump). Describe how you assessed catheter patency, such as by flushing or checking for blood return, and note when you stopped the infusion.

Assess the status of circulation at, above, and below, the insertion site—including skin color, capillary refill, and circumference of both extremities at the site. Estimate how much solution entered the subcutaneous tissue by noting the time of the first complaint, the time the infusion was stopped, and the rate of the infusion. Multiply the length of time by the hourly rate.

Also document how you treated the infiltrated site. For example, did you apply cold or warm compresses? Did you elevate the extremity? If so, by how much and for how long? If you injected an antidote, did you use the catheter or a needle and syringe? How frequently have you reassessed

## Why fluid escapes from the vein

| Type of problem | Possible reasons |
|---|---|
| **Mechanical**<br>Needle or catheter punctures vein wall | • Traumatic insertion of peripheral catheter<br>• Inadequate stabilization of catheter or site<br>• Patient movement (head, neck, extremity, or diaphragm during respiration) leads to catheter impinging on vein wall; over time, catheter tip works through the vessel wall |
| Needle dislodged from implanted port | • Poor port location<br>• Inadequate stabilization of port or access needle |
| Vascular access device broken, damaged, or separated | • Access needle too short<br>• Catheter separates from port, possibly because of unsuccessful connection at time of insertion<br>• Subclavian catheter fracture related to compression between clavicle and first rib<br>• Catheter rupture from excessive force applied during manual injection via syringe<br>• Puncture of catheter during port access procedure or during blood sampling in area of peripherally inserted central catheter insertion |
| **Obstructed blood flow**<br>Normal venous flow impeded above puncture site; pressure in vein causes fluid to spill from puncture site into subcutaneous tissue | • Thrombosis<br>• Vessel narrowing from scarring, sclerosis, accidents, surgery, or radiation<br>• Pressure on veins from lymphedema or enlarged axillary nodes |
| **Obstructed fluid flow**<br>Infused fluid flows retrograde and leaks from insertion site into subcutaneous tissue | • Fibrin sheath encases catheter from puncture site to tip |
| **Inflammatory reaction**<br>Cellular injury triggers release of chemical mediators, causing capillary endothelial cells to retract and fluid to leak | • Physical trauma from venipuncture, catheter advancement, or high-pressure injection<br>• Chemical irritation from medications<br>• Microorganisms<br>• Temperature extremes |

the site and what was its condition at each check?

To keep a record of the condition of the site before and after treatment, take a picture at the time of infiltration for the chart according to facility policy. Subsequent pictures will clearly document the degree of tissue damage and the results of treatment.

Notify the patient's primary care provider of the incident and obtain additional instructions about treatment. File an incident report according to facility policy.

### An ounce of prevention…

Because vesicant drugs can be so damaging if they extravasate, they should be administered only by experienced practitioners with high-caliber venipuncture skills. Your facility should have a competency assessment program to identify and document staff skill. Nurses with less-than-expert skills shouldn't be expected to give high-risk drugs.

The following techniques help minimize vein trauma during catheter insertion and advancement into the vein:

- Maintain skin traction below the site to keep the vein straight as you perform venipuncture and advance the catheter.
- Stabilize the catheter after insertion to prevent movement and decrease the possibility of vein erosion. For a peripheral catheter, use a taping technique that holds the catheter securely and allows good visualization of the site. If the site is located in an area of joint flexion, such as the wrist, use an armboard or handboard. Don't use the hand to administer known vesicant medications because of the close proximity of tendons and ligaments that control its function.

### Securing central lines

Peripherally inserted central catheters and midline catheters may be taped or sutured in place. Central vascular catheters inserted via the jugular or subclavian veins must be adequately secured. Sutures remain the most common method, although other securement devices may be used. Inadequate taping

or suturing, improper dressing removal techniques, and patient activity may dislodge the catheter, increasing the possibility of inflammation, thrombosis, and infiltration. Support, secure, and protect port access needles to prevent leakage into the port pocket.

### Treating Mr. Tucker

Now let's consider Mr. Tucker, who was introduced at the beginning of this article. To determine the pathway of the fluid infusing through Mr. Tucker's central venous catheter, the primary care provider orders a cathetergram, which reveals that the fluid is leaking out of the insertion site. The physician removes the catheter.

If Mr. Tucker needs only a few more days of fluids and antibiotics, a short peripheral catheter may be sufficient to complete his therapy. However, he'll need another central vascular catheter if he'll receive therapy for more than a few days, the medications and solutions have irritating properties, or the availability of peripheral venous sites is limited.

### Be prepared

No treatment can take the place of good assessment skills and problem prevention. But in instances when infiltration occurs despite your best efforts, you're prepared to act correctly and rapidly to minimize tissue damage.


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SELECTED WEB SITES

Infusion Nurses Society: **http://www.ins1.org**

League of I.V. Therapy Education: **http://www.lite.org**

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# I.V. infiltration: Not just a peripheral problem

**PURPOSE** To improve nursing practice and the quality of care by providing a learning opportunity that enhances a participant's understanding of I.V. infiltration and extravasation. **OBJECTIVES** After reading the preceding article and taking this test, you should be able to: **1.** Differentiate between I.V. infiltration and extravasation. **2.** Identify three categories of complications associated with I.V. infiltration and extravasation. **3.** Identify how to assess for and manage signs and symptoms associated with I.V. infiltration and extravasation.

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CE TEST **1.5** ANCC/AACN CONTACT HOURS

**1. In contrast to extravasation, infiltration is defined as the inadvertent administration of which of the following into surrounding tissue?**
1. nonvesicant solutions
2. vesicant solutions
3. solutions capable of causing tissue injury
4. dopamine infusions

**2. Which of the following is a chronic pain condition caused by trauma to nerve complexes or soft tissue?**
1. compartment syndrome
2. tissue necrosis
3. reflex sympathetic dystrophy syndrome
4. ulceration

**3. If it infiltrates, which of the following draws fluid out of cells and into the tissue?**
1. isotonic solution
2. hypotonic solution
3. 0.45% sodium chloride
4. hypertonic solution

**4. Which of the following statements comparing gravity and pump-controlled infusions is correct?**
1. Pump-controlled infusions produce a larger infiltration in a shorter time.
2. Gravity infusions produce a larger infiltration in a shorter time.
3. Gravity infusions produce more pressure on the vein wall.
4. Pump-controlled infusions produce less pressure on the vein wall.

**5. In a patient with a central line, engorged chest wall veins and difficulty moving the neck or jaw indicate**
1. compartment syndrome.
2. chronic pain syndrome.
3. thrombosis.
4. reflex sympathetic dystrophy syndrome.

**6. Which of the following is correct about a blood return?**
1. It rules out infiltration.
2. It's not important before administration of a vesicant.
3. It doesn't rule out infiltration.
4. It may signify occlusive fibrin at the catheter tip.

**7. Which of the following is used to dissolve fibrin inside a central venous catheter?**
1. vesicant solutions
2. nonvesicant solutions
3. thrombolytics
4. radiocontrast media

**8. Which is the best intervention following extravasation of vincristine?**
1. Elevate the extremity 4 inches (10 cm).
2. Apply a warm compress.
3. Inject phentolamine.
4. Apply a cold compress.

**9. Applying a warm compress to a site infiltrated with 3% sodium chloride would**
1. limit the fluid's contact with subcutaneous tissue.
2. reduce pain and swelling.
3. increase the area of induration.
4. increase the rate of reabsorption.

**10. Which of the following statements regarding antidote administration is correct?**
1. Always administer an antidote via the peripheral catheter.
2. After treatment, apply a sterile dressing.
3. After treatment, apply a pressure dressing.
4. Injecting an antidote percutaneously reduces infection risks.

**11. Interventions that help prevent tissue trauma from extravasation include**
1. restricting administration of vesicant drugs to practitioners with high-caliber venipuncture skills.
2. making the hand the preferred site for vesicant drugs.
3. avoiding skin traction when performing venipuncture.
4. avoiding suture of central lines inserted in the jugular or subclavian vein.

**12. Which may be used as an antidote to treat extravasation of an alkylating agent?**
1. DMSO
2. topical corticosteroids
3. phentolamine
4. hyaluronidase

**13. Pressure on veins from lymphedema or enlarged axillary nodes may cause**
1. obstructed fluid flow.
2. obstructed blood flow.
3. an inflammatory reaction.
4. VAD separation.

Carefully cut along dotted line.

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| 2. I met objective 2. | 1 | 2 | 3 | 4 |
| 3. I met objective 3. | 1 | 2 | 3 | 4 |
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