IV Infiltration: Be Alarmed Even When Your Infusion Pump Isn’t

Between June 2004 and August 2007, PA-PSRS received 10 reports of events involving fluid infiltration or extravasation in patients during intravenous (IV) therapy via infusion pumps that specifically mentioned the infusion pumps’ occlusion alarms. Five of the reports indicated that the infusion pumps did not alarm for the infiltration or extravasation, and five reports indicated that the pumps did alarm during the infusion therapy. The 10 PA-PSRS reports, as described below, indicate that some clinicians may misunderstand the role of occlusion alarms of infusion pumps.

The terms infiltration and extravasation are often used interchangeably; however, they do have different meanings. The Infusion Nurses Society (INS) defines infiltration as the inadvertent administration of a nonvesicant solution into surrounding tissue, instead of into the intended vascular pathway.1 INS defines extravasation as the inadvertent administration of a vesicant solution into surrounding tissue, instead of into the intended vascular pathway.1 A vesicant is an agent that has the potential to cause blistering or tissue necrosis.2 Common vesicants include chemotherapy/antineoplastic medications, certain vasodilators and vasopressors, parenteral nutrition, certain antibiotics, and certain electrolyte solutions.3 For more information on extravasation and vesicant solutions, see the article “Extravasation of Radiologic Contrast” in the September 2004 issue of the PA-PSRS Patient Safety Advisory.

PA-PSRS Reports

The 10 PA-PSRS reports on IV infiltration and extravasation are described below:

Intravenous antibiotic infused via a heparin well that had recently been inserted into patient’s left hand. Upon routine check of the patient, her left hand was swollen, and the heparin lock was infiltrated with half the dose of antibiotic having been infused. The [brand omitted] pump did not alarm for elevated pressure.

Patient’s left forearm IV (dopamine) infiltrated. The machine never alarmed. Infiltration was found only when checking site.

IV started at right antecubital site at 12:05 a.m. with 20-gauge catheter. IV access with excellent blood return and running on gravity.

IV placed on the [brand omitted] pump on minimum setting for 30 minutes. Setting was changed to moderate. IV site assessed at 1 a.m., and there were no signs of infiltration. IV site assessed at 2 a.m., and some soft tissue edema was noted. IV access was discontinued and dressing applied. IV pump did not alarm due to occlusion, and when IV access was determined to be no longer patent, the pump was indicating there was no occlusion. IV pump was removed from service.

The pump did not alarm for occlusion. The IV site infiltrated. The [physician] was aware. A warm compress was applied.

Found right arm edematous from IV infiltration; pump never alarmed.

Dopamine 400 mg/250 cc D5W at 5 mcg/kg/min running through 22 g in left wrist, found Dopamine just beginning to infiltrate when the [brand omitted] pump began alarming. IV was removed, and site was infused with Regitine as per protocol.

During transfusion of packed red cells, pump alarmed occlusion. Staff found site infiltrated. Infusion discontinued and warm compress applied.

Patient admitted and requiring IV dopamine. When nurse answered alarm from IV pump, it was noted that the patient’s IV site in the left AC was infiltrated. Catheter removed intact and Regitine used at site. Site was edematous.

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IV infusing with vancomycin at 100 cc/hr via IV in left bicep. Bicep became infiltrated. Patient used call bell to notify nurse when the [brand omitted] pump alarmed. Patient complained of discomfort. Vancomycin infusing for 60 minutes. Infusion stopped; heparin lock removed. Warm compresses applied. IV team called to place new HL. Old IV site in left bicep was reddened and tender, slightly firmness to palpation. Heat pad ordered.

Patient arrived from another hospital’s ER with IV infusing with heparin. Staff noted infiltration, and IV catheter was kinked. Patient stated the IV pump had been alarming throughout the night, and it was just reset by the staff. Patient requested this be reported. Patient also had heparin drip started at about 9 p.m. and did not have partial thromboplastin line monitored per protocol.

FDA IV Infiltration Reports
A search of the U.S. Food and Drug Administration’s (FDA’s) Manufacturer and User Facility Device Experience (MAUDE) database using the search terms “infiltration” and “infusion pump” revealed 28 reports between 1992 and 2006 describing patients who experienced fluid infiltrations during intravenous infusion therapy. Some of the MAUDE reports indicated that the infusion pumps’ occlusion alarm did not activate to alert staff of an infiltration condition. Many of the reports also included statements from the implicated infusion pump manufacturers indicating that the respective infusion pumps do incorporate downstream occlusion detection circuitry, but that they are not capable of detecting infiltration conditions.

The Misconception of Infusion Pump Occlusion Alarms
Occlusion alarms on infusion pumps do not detect or prevent infiltration or extravasation. Infusion pumps are equipped with downstream occlusion (pressure) sensor circuitry used to detect elevated pressures in the IV administration set between the infusion pump mechanism and the patient. When the sensor circuitry detects an elevated pressure that equals the pump’s preset occlusion alarm limit (e.g., 10 psi), the infusion pump will initiate an audible and a visual alarm and stop the IV flow.

Infiltration and extravasation pressures are typically much lower than pumps’ downstream occlusion alarm limit settings and therefore will not trigger the occlusion alarm. Setting an infusion pump’s maximum downstream occlusion alarm limit to a very low value (greater sensitivity) would still not reliably detect infiltration or extravasation pressures but would, instead, create nuisance alarm situations, which would only inconvenience the patient and caregiver. In some cases, an infusion pump may alarm for a downstream occlusion during an infiltration or extravasation; however, the occlusion condition would most likely be for reasons other than infiltration or extravasation (e.g., kinked IV tubing between the pump mechanism and the patient, a blocked IV port site).

Infusion pumps play an ancillary role in infiltration or extravasation events, and the belief that the pumps themselves produce the infiltration or extravasation is inaccurate. Infiltration or extravasation may be caused by mechanical means, such as the needle puncturing the vein wall or the needle dislodging from the implanted port, obstructed blood flow, obstructed fluid flow, or an inflammatory reaction (e.g., chemical irritation from medications).

Identifying Infiltration
Relying on an infusion pump’s downstream occlusion alarm to identify an infiltration condition is not good practice. To avoid infiltrations or reduce their likelihood, monitor the IV sites of patients receiving infusion therapy via an infusion pump as frequently as possible to ensure that the catheter or needle has not dislodged. Being aware of the signs and symptoms of infiltration is also a good risk reduction strategy. INS has published an infiltration scale that can be used to document an infiltration condition. According to INS, infiltrations are graded according to the most severe presenting indicator and extravasations should always be rated as Grade 4, as follows:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Clinical Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No symptoms</td>
</tr>
<tr>
<td>1</td>
<td>Skin blanched</td>
</tr>
<tr>
<td></td>
<td>Edema less than 1 inch in any direction</td>
</tr>
<tr>
<td></td>
<td>Cool to touch</td>
</tr>
<tr>
<td></td>
<td>With or without pain</td>
</tr>
<tr>
<td>2</td>
<td>Skin blanched</td>
</tr>
<tr>
<td></td>
<td>Edema 1 to 6 inches in any direction</td>
</tr>
<tr>
<td></td>
<td>Cool to touch</td>
</tr>
<tr>
<td></td>
<td>With or without pain</td>
</tr>
<tr>
<td>3</td>
<td>Skin blanched, translucent</td>
</tr>
<tr>
<td></td>
<td>Gross edema greater than 6 inches in any direction</td>
</tr>
<tr>
<td></td>
<td>Cool to touch</td>
</tr>
<tr>
<td></td>
<td>Mild to moderate pain</td>
</tr>
<tr>
<td></td>
<td>Possible numbness</td>
</tr>
</tbody>
</table>
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4 Skin blanched, translucent
Skin tight, leaking
Skin discolored, bruised, swollen
Gross edema greater than 6 inches in any
direction
Deep pitting tissue edema
Circulatory impairment
Moderate to severe pain
Infiltration of any amount of blood product, irritant, or vesicant

The following questions about this article may be useful for internal education and assessment. You may use the following examples or come up with your own.

1. The difference between infiltration and extravasation is which one of the following?
   A. Nonexistent; the terms are interchangeable.
   B. Extravasations are larger, involving all the fluid.
   C. Extravasations are reserved for infiltration of agents that can cause local tissue necrosis.
   D. Extravasations are infiltrations caused by pressure injectors.

2. Infusion pump occlusion alarms do not detect or prevent infiltration or extravasation conditions.
   A. True
   B. False

3. Infiltration may be caused by mechanical means, such as the needle puncturing the vein wall or the needle dislodging from the implanted port, obstructed blood flow, obstructed fluid flow, or an inflammatory reaction (e.g., chemical irritation from medications).
   A. True
   B. False

4. According to Infusion Nurses Society’s infiltration scale, grade 2 clinical criteria for assessing infiltration includes all EXCEPT which one of the following?
   A. Skin blanched
   B. Edema 1 to 6 inches in any direction
   C. Cool to touch
   D. Possible numbness
   E. With or without pain

Notes

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The Institute for Safe Medication Practices (ISMP) is an independent, nonprofit organization dedicated solely to medication error prevention and safe medication use. ISMP provides recommendations for the safe use of medications to the healthcare community including healthcare professionals, government agencies, accrediting organizations, and consumers. ISMP’s efforts are built on a non-punitive approach and systems-based solutions.