Peripheral Intravenous Access: Applying Infusion Therapy Standards of Practice to Improve Patient Safety

Barb Nickel, APRN-CNS, NP-C, CCRN, CRNI

The most common invasive procedure performed in the hospital setting worldwide is the insertion of a peripheral intravenous catheter. Although use of peripheral intravenous access is common, its presence is far from benign, with a reported 35% to 50% failure rate, even in facilities with a dedicated infusion team. Significant complications related to the presence of a peripheral intravenous site include localized infection, bacteremia, phlebitis, and infiltration or extravasation. Consistent application of evidence-based standards of practice in all aspects of peripheral intravenous catheter care is essential to provide infusion therapy that delivers safe and quality care. Management of peripheral intravenous access in the complex setting of critical care is examined in this article. A case study approach is used to illustrate application of infusion therapy standards of practice in peripheral intravenous catheter insertion, indications for catheter placement, and assessment parameters to enhance early recognition of peripheral intravenous access–related complications. (*Critical Care Nurse*. 2019;39[1]:61-71)

The Institute of Medicine defines quality relative to health care as "the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge."[1] Consistent delivery of quality care is essential in all segments of nursing, from the highly complex to the more fundamental areas of practice, such as management of the peripheral intravenous (PIV) route for solution and medication administration. It is alarming, however, to consider that the most common procedure performed in the hospital setting, the insertion of the PIV catheter, has a reported overall failure rate of 35% to 50%, including complications such as phlebitis, infiltration, occlusion, infection,

CE 1.0 hour, CERP A

This article has been designated for CE contact hour(s). The evaluation tests your knowledge of the following objectives:
1. Describe strategies to promote successful short peripheral intravenous (PIV) catheter insertion
2. Identify interventions to prevent patient injury resulting from a PIV site extravasation
3. Describe interventions to provide evidence-based management of PIV access in older adults

To complete evaluation for CE contact hour(s) for test C1912, visit www.ccnonline.org and click the "CE Articles" button. No CE fee for AACN members. This test expires on February 1, 2022.

The American Association of Critical-Care Nurses is an accredited provider of continuing nursing education by the American Nurses Credentialing Center's Commission on Accreditation. AACN has been approved as a provider of continuing education in nursing by the State Boards of Registered Nursing of California (#01036) and Louisiana (#LSBN12).

 doi: https://doi.org/10.4037/ccn2019790

Table 1 Severe sepsis criteria and metrics[4]

Presentation time: the time at which the patient has met all 3 criteria within an identified time frame	
Suspected infection Presence of ° 2 systemic inflammatory response syndrome criteria Heart rate >90/min Respiratory rate >20/min Temperature <36.0°C (96.8°F) or >38.3°C (100.9°F) White blood cell count <4000 or > 12.0 × 10^3 mm^3 or >10% bands Presence of ° 1 indication of organ system dysfunction	
Examples in case study: Hypotension (systolic blood pressure <90 mm Hg, mean arterial pressure <65 mm Hg); elevated lactic acid (>2 mmol/L)	
Initial interventions within 3 hours of presentation time	Obtain blood cultures, serum lactic acid Administer broad-spectrum antibiotic appropriate to suspected source of infection Provide 30 mL/kg fluid resuscitation if indications are met (ie, hypotension, lactic acid ° 4 mmol/L)
Secondary interventions within 6 h of presentation	Repeat lactic acid measurement if initial result is >2 mmol/L Tissue perfusion reevaluation Vasopressor use, if indicated

and catheter dislodgement.[2] This failure rate is likely even higher in the critical care setting, considering added variables such as complex patient risk factors, multiple concurrent therapies, and an increased level of urgency for intravenous administration of high-risk medications. A case study approach is used in this article to examine the delivery of quality PIV-access care through the application of related infusion therapy standards of practice[3] and evidence-based guidelines in the complex critical care environment.

PIV Catheter Insertion Risks

Case Study 1

A 66-year-old woman was emergently transferred to the intensive care unit from the medical surgical floor with acute abdominal pain, hypotension, and newly elevated white blood cell count of 16.3 × 10^3 mm^3 with 12% bands. The patient had been admitted 2 days prior with a small-bowel obstruction. Conservative treatment had been unsuccessful, and the patient had increasing nausea, pain, and abdominal distension. Before transfer to the intensive care unit, her vital signs were as follows: blood pressure, 88/48 mm Hg; mean arterial pressure, 61 mm Hg; heart rate, 134/min; respiratory rate, 28/min; temperature, 35.4°C (95.8°F).

The primary nurse on the medical surgical floor had notified the primary physician that the patient's signs met systemic inflammatory response syndrome criteria and she had new hypotension. The sepsis protocol was ordered, including a 30 mL/kg bolus of normal saline and broad-spectrum antibiotics to be administered immediately. Table 1 lists severe sepsis criteria and metrics. A blood sample was collected for culture before the patient was transported to the intensive care unit, but the phlebotomist struggled to get the minimum amount. The initial lactic acid level was elevated at 3.8 mmol/L. In her right upper arm, the patient had a single-lumen, midline peripheral catheter that had been placed on admission. The midline catheter did not have blood return but flushed easily. The dressing was intact, and the site was without redness, tenderness, or edema.

With 75% of the bolus infused, the patient's blood pressure was 76/44 mm Hg and mean arterial pressure was 55 mm Hg. The physician ordered a norepinephrine infusion, titrated to keep the mean arterial pressure above 65 mm Hg. A provider was not immediately available to place a central catheter, so a second nurse offered to place a second PIV catheter to initiate the norepinephrine infusion. The second nurse washed her hands, donned

Author

Barb Nickel is the critical care clinical nurse specialist for CHI Health St. Francis, a rural community hospital in Grand Island, Nebraska. She has served as chair/lead nurse planner for the Infusion Nurses Society's National Council on Education and is a member of the Infusion Nurses Society Standards Practice Committee.

Corresponding author: Barb Nickel, APRN-CNS, NP-C, CCRN, CRNI, CHI Health St. Francis, 2620 W. Faidley Ave, Grand Island, NE 68801 (email: bnickel@sfmc-gi.org).

clean gloves, applied the tourniquet to the left arm, and began to assess the antecubital space. Using the PIV-site cleanser, she wiped the area quickly, then tore off the right index finger of her glove and again palpated the vein. The phlebotomist arrived at bedside to collect the second blood sample for culture and noted the nurse was about to access a second PIV site. The phlebotomist requested that the second blood sample be collected from this new site once the catheter was placed. With an 18-gauge, short PIV catheter in hand, the second nurse was about to insert the catheter when the primary nurse asked her to pause. Although initiating the second site was urgently needed, he knew this vulnerable patient deserved excellent care that adhered to evidence-based infusion therapy standards of practice. The primary nurse advised that the antecubital site be used by the phlebotomist for collecting the blood sample for culture. He indicated to the assisting nurse that a 20-gauge PIV catheter placed in the forearm would be optimal and that there was time to use careful site preparation and a no-touch technique to protect the patient.

To rapidly identify deviations in care, a ready knowledge of relevant evidence-based standards of practice is crucial. The primary nurse's willingness to intervene to ensure that quality care was provided not only required an organizational culture of patient safety but also a ready knowledge of how deviations from the standard of practice can cause patient harm.

Providing quality care, however, is more easily said than done. Although use of the most current evidence-based recommendations is an expectation within health care, there are multiple barriers between creation of new knowledge and its direct application to patient care[5]—barriers illustrated in the case studies in this article. To bridge some of these barriers, organizations such as the Infusion Nurses Society have developed evidence-based guidelines[3] that promote positive patient outcomes and eliminate practices that may have a negative affect on the patient.[6] The 2016 Infusion Nurses Society Infusion Therapy Standards of Practice[3] is a comprehensive examination of the current evidence regarding infusion therapy. Effective application of those standards of practice then falls to health care organizations and individual health care professionals who practice infusion therapy. To positively influence patient outcomes, these standards must be fully integrated into the education, competencies,[3] and daily workflows of clinicians. In addition, infusion-related adverse events and quality metrics must be monitored and analyzed to identify variations from the standard of practice and to form action plans to improve care.[3]

In the competing priorities involved in this patient's care, the insertion of a PIV catheter may seem to be a simple task. However, there were multiple areas where the care about to be delivered by the second nurse could be improved and, if allowed to continue, could contribute to significant patient harm. The variations that increased the potential of harm included site contamination caused by improper insertion technique, increased risk of PIV catheter–related complications due to the chosen insertion site and catheter size, and probable contamination of the blood sample for culture that was collected from a PIV site. The second nurse may have felt justified in bypassing critical aspects of initiating PIV access, such as proper cleansing of the site, because of the urgent need for additional venous access. However, a careful review of actual infusion-related complications and their potential causes clearly illustrates a correlation between insertion technique and patient harm. The realization of the true patient cost of these complications may be an effective method to motivate nurses to alter fundamental practice patterns to align with current standards of practice.[7] Table 2 presents key points from case study 1.

Realizing the significant patient cost of PIV-related complications can motivate nurses to alter fundamental practice patterns to align with standards of practice.

Risks of Site Contamination During Insertion

The patient-related costs attributed to catheter-related bloodstream infections are estimated to add 7 to 20 days of hospitalization and up to $56 000 in costs per case.[2] Bacteremia from PIV access has been considered rare; however, studies have indicated that it is likely more prevalent than originally thought. In a retrospective study of 445 patients with *Staphylococcus aureus* bacteremia, 7.6% of these cases were related to PIV catheters.[8] In an Australian prospective study of 583 patients with *S aureus* bacteremia, 23.5% cases were associated with PIV catheters, with a high incidence of PIV catheters inserted in emergency situations.[9] In a retrospective study of 293 patients with candidemia, researchers in Japan found

Table 2 Key points from case study 1

Topic	Key points
Choice of PIV insertion site	Preferential placement in forearm vessels; avoid areas that increase risk of complications (eg, areas of flexion or altered sensation). If an area of increased risk must be used, the site monitoring frequency should be increased.
Size of PIV catheter	Use smallest gauge catheter that will perform needed therapy. Consider 20 gauge as standard for most therapies (22 gauge in fragile, smaller veins).
Cleansing of PIV insertion site	Clean with >0.5% chlorhexidine in alcohol (unless contraindicated); allow to fully dry. If a provider needs to retouch the insertion site after cleansing to palpate the vessel, then sterile gloves should be used. Do not alter the integrity of gloves during insertion process.
Blood cultures drawn from PIV start	Practice is not recommended. Blood samples for culture should be collected by a dedicated phlebotomy team.
Culture of safety	Staff should be empowered to coach and correct deviations from standard of practice. A standard reporting process should be used to facilitate reporting.

Abbreviation: PIV, peripheral intravenous.

that the PIV route was an important source of candidemia, with associated risk factors including recent consultation with infectious disease specialists, concurrent presence of polymicrobial bacteremia or fungemia, and exposure to cephalosporins.[10] Bacteremia risk factors associated with the PIV route include insertion in the emergency department or outside of the hospital,[9,11] use of the proximal forearm or antecubital fossa,[8,11] and thrombophlebitis from a previous PIV site.[8]

Risks Associated With PIV Catheter Insertion

In a randomized controlled trial examining modifiable factors associated with PIV catheter failure, several important considerations for PIV insertion and assessment were identified that directly related to this case study.[12] Phlebitis risk was highest in female patients and when concurrent presence of an infection existed, use of an 18-gauge or larger catheter occurred, and PIV sites were started subsequent to the first PIV catheter placement.[12] Risk factors associated with an increase in risk for accidental removal were use of an 18-gauge or larger PIV catheter and use of the hand or antecubital fossa.[12] Increased risks of PIV occlusion were found in use of the antecubital fossa or upper arm, being female, and use of the site for antibiotics.[12] In addition, although short-term peripheral infusion of the vesicant (eg, norepinephrine) was necessary in this scenario, placement of the PIV catheter in an area of flexion increased the risk of extravasation and resultant tissue damage (see Figure).

Extravasation, the inadvertent leakage of a vesicant into the tissue surrounding the insertion site, is explored in case study 2 in this article. The Infusion Nurses Society Vesicant Taskforce recommends avoiding peripheral administration of vesicants when infusion time exceeds 30 to 60 minutes.[14] Table 3 lists PIV-catheter placement recommendations.

Figure Dermal necrosis at elbow, caused by dopamine extravasation.[13]

Used with permission. Bhosale GP, Shah VR. Extravasation injury due to dopamine leading to dermal necrosis and gangrene. *J Anaesthesiol Clin Pharmacol.* 2012;29(4):534-535. Wolters Kluwer Medknow Publications.

Risks of PIV Catheter Use for Blood Culture Collection

Bacteremia is an important source of morbidity and mortality, and requires prompt and accurate investigation to initiate effective treatment. Reported rates for

Table 3 Peripheral intravenous placement recommendations

Action	Evidence-based recommendations
Choice of insertion site for PIV catheter	"Avoid areas of flexion and areas of pain on palpation; avoid compromised areas and sites distal to these compromised areas."[3(pS54)] "Mechanical phlebitis may be related to vein wall irritation, which can come from too large a catheter for the vasculature, catheter movement, insertion trauma, or catheter material or stiffness."[3(pS95)] Avoid placement in antecubital fossa.[14] If an area of flexion is the only viable insertion site, closely observe the site (at least every 1-2 hours),[15] with prompt removal if any indication of malfunction occurs and with planning for more optimal PIV catheter placement or central venous access depending on length of therapy.[16]
Size of PIV catheter used	"Select the smallest-gauge peripheral catheter that will accommodate the prescribed therapy and patient need. . . . Consider a 20- to 24-gauge catheter for most infusion therapies. Peripheral catheters larger than 20 gauge are more likely to cause phlebitis."[3(pS51)] Consider use of 20-gauge PIV catheter as standard for most therapies. In addition, consider preferential placement in the forearm, and avoidance of the routine replacement (ie, every 72 hours) of PIVs as the first catheter placed is the least likely to fail.[12]
Preparation of site and placement of PIV catheter	"Adhere to and maintain aseptic technique with short peripheral catheter insertion: 1. Use a new pair of disposable, nonsterile gloves in conjunction with a 'no-touch' technique for peripheral IV insertion, meaning that the insertion site is not palpated after skin antisepsis."[3(pS65)] "Bacterial phlebitis may be related to emergent vascular access device . . . insertions and poor aseptic technique."[3(pS95)] "Perform skin antisepsis using the preferred skin antiseptic agent of >0.5% chlorhexidine in alcohol solution. [Unless contraindicated.] . . . Allow the antiseptic agent to fully dry before insertion."[3(pS65)]
Altering the integrity of gloves before or during PIV insertion	"Wear gloves that fit appropriately and extend to cover the wrist of an isolation gown (if worn) when there is potential contact with blood (eg, during phlebotomy), body fluids, mucous membranes, nonintact skin, or contaminated equipment."[3(pS41)] "Adhere to and maintain aseptic technique with short peripheral catheter insertion: 1. Use a new pair of disposable, nonsterile gloves in conjunction with a 'no-touch' technique for peripheral IV insertion, meaning that the insertion site is not palpated after skin antisepsis. 2. Consider increased attention to aseptic technique, including strict attention to skin antisepsis and the use of sterile gloves."[3(pS65)]
Blood culture draw from PIV start	"Sampling of blood from indwelling short peripheral catheters is reliable for many routine blood tests, including coagulations studies. Obtaining blood cultures from short peripheral catheters at insertion or during the dwell is not recommended."[3(pS87)] Thorough skin antisepsis with back and forth friction using chlorhexidine alcohol and the use of direct venipuncture over catheter blood collection as a method to decrease blood culture contamination. Additional recommendations include having blood cultures drawn by a dedicated phlebotomy team with standard workflow and standard blood culture kits.[17]
Management of potential and actual adverse events	"Establish a strong 'just culture' that continuously strengthens safety and creates an environment that raises the level of transparency, encourages reporting, empowers the clinician to identify and implement appropriate actions to prevent adverse events and near misses, and promotes quality patient outcomes."[3(pS31)]

Abbreviations: IV, intravenous; PIV, peripheral intravenous.

blood culture contamination vary from 0.6% to 12.5%, with the accepted goal of contamination rates below 3% for any method of collection.[17] Identification of the causative organism is hindered and potentially prevented by contamination of the specimen because it may yield a false-positive result or require a recollection of the specimen after antibiotics have been initiated. Inability to identify the causative pathogen has a significant impact on the quality of care because of the increased potential for administration of unnecessary antibiotics, delay in the delivery of the correct antibiotic, and need for additional testing. These factors, in turn, may increase costs to the facility and the patient, delay patient recovery, and increase the length of an inpatient hospital stay.[17]

Extravasation

Case Study 2

A poorly responsive, 52-year-old man with end-stage renal disease came to the emergency department with significant hyperkalemia. The emergency department physician ordered calcium gluconate, regular insulin, 50% dextrose, and sodium bicarbonate intravenously

for emergent treatment of the hyperkalemia. Because of the patient's vascular status and restricted extremity (with an arteriovenous fistula in the left forearm), multiple attempts were required to place 2 short PIV catheters in the right antecubital space and the right upper arm, near the shoulder. The medications were administered and the patient was stabilized for transport to the inpatient area.

On admission to the floor, there was a 2×2-cm area of redness at the now-locked right upper arm PIV site. The primary emergency department nurse did not include this in her telephone report to the admitting nurse, and the nurse who transported the patient to the inpatient area was not involved in his care and was unable to give additional information. Within 30 minutes of admission to the inpatient unit, the patient, who was now more alert, complained of burning at the PIV site. The nurse noted that the site now had a clear 3×2-cm demarcated area of redness that was firm to touch. Before removal of the PIV catheter, the nurse attached an empty sterile syringe to the catheter hub to attempt to withdraw any fluid from the tissues around the PIV site, then removed the catheter. The demarcated area was clearly outlined with a permanent marker to aid in assessment of the evolution of the area. The area was then evaluated as a stage 4 extravasation, using the infiltration staging tool included in the electronic medical record. In a single study, the Infusion Nurses Society infiltration scale (Table 4) was demonstrated to have concurrent validity and interrater reliability ($P < .05$),[19] and the scale is often used by organizations as a resource because it is easy to use by bedside clinicians and is applicable for extravasation assessment.[20,21]

The Infusion Nurses Society infiltration scale is easy to use by bedside clinicians and is applicable for extravasation assessment.

Because 3 of the agents administered in the emergency department were vesicants, the primary nurse knew that a determination of what was administered in this upper arm site was important to dictate potential treatment and to reduce the risk of tissue loss. In reviewing the emergency department nursing record, however, she was unable to determine any additional information on the PIV insertion attempts, what medications were administered in which site, or subsequent PIV site assessments. To obtain the needed information, a call was placed to the emergency department primary nurse who cared for the patient. More than 1 nurse was involved in the patient's care in the emergency department, however, and the primary nurse was unable to report how patency was ensured before and during administration. She stated she believed the calcium was administered in the upper arm site, but she was confident that the other 2 medications were administered in the antecubital fossa site. The nurse added that, because the upper arm site was covered by the patient's gown, it had not been reassessed after the medications were administered. The inpatient primary nurse then notified the attending physician of the probable peripheral extravasation of calcium gluconate and obtained an order to treat the site using the extravasation protocol. Hyaluronidase, the indicated antidote, was obtained and injected subcutaneously into the area. This agent temporarily breaks down the intracellular connective tissue, thus enabling dispersion and more rapid absorption of the extravasated agent over a larger area of tissue to prevent tissue necrosis.[20] Because of the prompt action of this nurse and the superficial nature of the intravenous site, the site gradually healed with minimal scarring.

As in case study 1, there were opportunities to improve the quality of care in case study 2, especially in a high-risk patient who was initially unable to report pain and had limited venous access options. Actions that increased risk of an extravasation injury for this patient who received

Table 4 Infiltration staging resource[18]

Grade	Clinical criteria
1	Skin blanched, edema <1 in (2.5 cm) in any direction, cool to touch, with or without pain
2	Skin blanched, edema 1-6 in (2.5-15 cm) in any direction, cool to touch, with or without pain
3	Skin blanched, translucent, gross edema >6 in (15 cm) in any direction, cool to touch, mild to moderate pain, possible numbness
4	Skin blanched, translucent; skin tight, leaking; skin discolored, bruised, swollen; gross edema >6 in (15 cm) in any direction; deep pitting tissue edema, circulatory impairment; moderate to severe pain; infiltration of any amount of blood product, irritant or vesicant

Reprinted with permission from Infusion Nurses Society (INS) 2006. Please note this scale has not been updated in the *Infusion Nursing Standards of Practice* since 2006 due to lack of studies that support its validity and reliability. This is a research priority for INS (L. Gorski, MS, HHCNS-BC, CRNI, FAAN, Chair of INS Standards of Practice Committee, written communication, December 2017).

emergent administration of several vesicant medications through the PIV route were probable inadequate assessment of patency of the PIV site before administration, inadequate monitoring during and after administration, and an inadequate description of the event in the emergency department documentation and handoff to facilitate rapid recognition and medication-specific treatment.

Risks in Administration of Vesicants Peripherally

The severity of damage from an extravasation is related directly to the type, concentration, and volume of solution or medication that infiltrated into the interstitial space.[16] In addition, vessels in areas where there is minimal underlying tissue and in areas of flexion have the highest risk of tissue damage.[20] Knowledge of the vesicant properties of the medication to be administered and the mechanisms of inadvertent delivery to tissues is important to enhance rapid recognition of an adverse event. One source of extravasation is the backflow of the vesicant from the catheter tip through the insertion site, often caused by distal obstruction from vasculopathies or mechanical obstructions,[22] such as a blood pressure cuff, tourniquet, or restraint. Another potential source is the leakage of vesicant solution through previous venipuncture sites. Thus, knowledge of the history of venous access attempts is important in recognition of risk.[14,16]

Extravasation injuries, though underrecognized and undertreated within critical care,[13,20] can cause significant inpatient morbidity, including complications such as pain, decreased function, nerve and tendon damage, soft-tissue sloughing, and even death.[22] In fact, in as many as 25% of patients with injuries related to extravasation, the burden of the complications from the extravasation are more severe than their principal admitting diagnosis.[22] Although central vascular access is preferred for delivery of these high-risk medications, it is not always possible in emergent situations,[23] such as life-threatening hyperkalemia. It is essential that health care organizations develop extravasation protocols that align with their medication formularies and that they train their staff in rapid recognition and treatment should an extravasation occur.[3] Assistance can be found in resources such the article by Gorski et al.[23] This task force of infusion experts graded noncytotoxic medications (used outside of oncology practice) on the basis of documented risks in the literature, listing them as red for high risk and yellow for intermediate risk. Of the medications received by the patient in this case study, the high-risk medications were calcium gluconate, at least 12.5% dextrose, and sodium bicarbonate.[23] Table 5 lists evidence-based guidelines for documentation of PIV administration of vesicants.

Risks of Inadequate Documentation of Vesicant Administration

Treatment recommendations for extravasation of vesicants are generally limited to animal trials and case reports describing attempted treatments, because randomized controlled trials of extravasation of vesicants in humans would carry great risk.[20] The best approach is prevention and early recognition to enable use of the best available treatment options.[20,22] Gaps in documentation of PIV catheter insertions, patency, and medication delivery can lead to delays in recognition of an extravasation when the patient transitions between caregivers or to new areas of care. It is also important to note that unrecognized extravasations are a significant source of litigation, with claims averaging $66 000 per litigation.[22] Table 6 highlights the key points of case study 2.

Infusion Therapy Competency and Special Patient Populations

Case Study 3

A nurse with 2 months of experience on a progressive care unit was assigned to care for an elderly female patient just admitted with new-onset atrial fibrillation and worsening confusion. Initial orders included initiation of infusions of heparin and diltiazem. The patient was admitted with 1 PIV catheter placed by paramedics at the nursing home before transport, through which normal saline was infusing. The PIV catheter was secured with an elastic type of rolled bandage around the forearm, because the patient was agitated en route to the hospital. The elastic bandage was removed to better visualize the PIV site. A piece of medical tape had been placed over the catheter hub, with no dressing in place. The nurse cleaned the site with an alcohol wipe, then used a transparent dressing to cover the site.

The primary nurse was not confident in his PIV catheter insertion skills. He had received limited infusion-related training in his nursing program, and his orientation did not include a meaningful review of his facility's infusion therapy policies, procedures, and resources. He researched the compatibility of diltiazem and heparin. Finding a "caution" warning in the facility's online

Table 5 Guidelines for peripheral intravenous administration of vesicants

Action	Evidence-based recommendations
Assessment of PIV site based on patient, device, and medication-related risks	"Recognize risk factors associated with infiltration and extravasation including: 1. Insertion sites in the hand, antecubital fossa, and upper arm when compared to sites in the forearm. . . . 6. Altered mental status or cognition. . . . 8. Diseases that produce changes in vasculature or impaired circulation. . . . 10. Difficulty with peripheral venous access. . . . Recognize the differences between vesicant, nonvesicant, and irritant solutions and medications. . . . Each facility should reach consensus on what medication is considered to be a vesicant and irritant based on their internal formularies."[3(pS98)] Preventative measures are the optimal strategy in high-risk situations, such as close monitoring and early recognition.[22] "As a method of public protection to ensure patient safety, the clinician is competent in the safe delivery of infusion therapy and vascular access device . . . insertion and/or management within her or his scope of practice."[3(pS18)] "The venous access device should be checked for patency before, during, and after the administration of a vesicant. Infusion of 5-10 mL of 0.9% sodium chloride before administration of a vesicant can help determine vein patency."[16(chapter23)] "When a vesicant is administered directly into a vein with a syringe, the plunger of the syringe is pulled back every 3-4 mL to note blood return. Although a good blood return [consistency of whole blood] does not guarantee that an extravasation has not occurred, any change in blood return could indicate the need to investigate the possibility of an extravasation."[16(chapter23)] "Vesicants should not be administered in areas of flexion."[16(chapter23)]
Rapid recognition and treatment of extravasation	"Limit the amount of solution that enters the tissue through early recognition of signs and symptoms of infiltration/extravasation. . . . Immediately stop the infusion when the patient reports pain, burning, stinging, and/or tightness, at or around the insertion site, catheter tip, or entire venous pathway, as this should not be considered 'normal' with any infusion."[3(pS99)] "Follow the established treatment protocol or [provider] prescription as appropriate for the solution and medication in the tissue with the goal of limiting the exposure of subcutaneous tissue to the solution or medication."[3(pS100)] With calcium extravasation, treatment with an antidote within 60 min is recommended to spread the product as fast as possible and salvage tissue.[22]
Documentation of PIV infusion therapy (specifically high-risk vesicant medications)	"Type of therapy, drug, dose, rate, time, route, and method of administration; condition of the venipuncture or access site prior to and after infusion therapy. . . . When multiple VADs or catheter lumens are used, documentation should clearly indicate what solutions and medications are being infused through each device or lumen."[3(pS29)] It is important to know history of multiple venipuncture and where those sites were located and when attempted, because previous sites and attempts can contribute to extravasation injury.[16]
Assessment and monitoring of existing PIV site extravasation	"Use a standardized tool or definition for assessing and documenting infiltration/extravasation from all types of VADs that is valid, reliable, and clinically feasible. . . . Use a standardized format to document initial and ongoing assessment and monitoring of the infiltration/ extravasation site and to document all factors involved with the event. . . . Monitor the site, as needed based on severity of the event and the venue of care."[3(pS101)]

Abbreviations: PIV, peripheral intravenous; VAD, vascular access device.

Table 6 Key points from case study 2

Topic	Key points
Extravasation prevention	Best primary management is prevention; best secondary management is early recognition.
Assessment of peripheral intravenous (PIV) site	Each caregiver should be knowledgeable of the risk factors for each medication/solution, for each patient. PIV site management should be adjusted according to identified risk factors.
PIV administration of vesicants	When necessary, careful evaluation of patency is essential before, during, and after delivery. Vesicants should not be administered in PIV catheter placed in area of flexion.
Rapid recognition of extravasation	Each facility should have an evidence-based extravasation protocol, including an identified list of vesicants and postextravasation monitoring parameters; staff should be trained in the use of this protocol; site of extravasation should be monitored using a validated assessment tool.
Documentation of PIV use	Essential items of documentation include number of and location of insertion attempts, where medications are infusing, and evidence of patency. These factors should be well communicated at handoffs.

compatibility source, he knew he needed 2 PIV sites to run both continuous infusions. As he began to investigate options for a second site, he noted the patient's age-related changes in small, tortuous vessels, loss of subcutaneous fat, and thin, fragile skin.[24] His night mentor, occupied with a new admission, advised him to attempt the PIV access, and she would join him as soon as she could. After 4 attempts, he was able to establish a 22-gauge, short PIV catheter in the patient's inner, ventral right wrist. He dressed the site, applied a new piece of elastic rolled bandage to both PIV sites for additional securement and proceeded to initiate the medications.

Competency can be defined as the knowledge and skills requisite to practice a segment of nursing practice safely.[7] Unfortunately, many schools of nursing do not include an effective review of infusion therapy in their basic curricular design.[7] And, although the standard of care may be well delineated in a facility's policy and procedure library, the application of the standard can be challenging in the setting of limited resources, inexperience, and heavy patient assignments. Without adequate training, the care delivered by this young nurse increased the potential for this patient to suffer PIV-related complications, such as pain, inadvertent removal, infiltration, mechanical phlebitis, and nerve damage. The system and individual practice variations include limited infusion-related competency development, limited resources to assist a new graduate nurse in management of a complex patient's infusion needs, and use of PIV securement that obscured the ability to assess PIV sites and increased risk for injury.

Risks of Inadequate Infusion-Related Training and Competency Assessment for New Nurses

When infusion therapy skills are obtained in such a fragmented fashion, accuracy and adherence to standards of practice are reduced. This lack of competency in a fundamental area of nursing practice can be a source of anxiety for new nurses and can be a significant source of patient dissatisfaction.[7] In addition, failed PIV catheter insertion attempts and lost PIV access sites cause vessel trauma, increase the risk of phlebitis and subsequent PIV catheter failures, and rapidly deplete future PIV site options in challenging patients such as older adults.[2,24] Therefore, nurses may decide to continue the use of a site placed in less-than-ideal conditions or that has higher risk for failure, such as the ventral wrist.[3] Table 7 lists staff training and competency recommendations, including PIV-catheter insertion in older adults.

Risks of PIV Securement in the Elderly

Securement of the PIV catheter in older adults can be especially challenging. Because of the reduction in subcutaneous tissue, inadequate securement of the PIV catheter can lead to its migration, site infection, and mechanical phlebitis.[24] Anticipation of potential complications is the key to maintenance of the site.[25] Securement devices and products should be avoided that reduce visibility, have high potential to impair skin integrity, or apply pressure to vasculature and fragile tissue (Table 7).[24]

Returning to the case study, once she was able, the new nurse's mentor met him in the patient's room to review the patient's status and his progress on initiating the medications. She removed the circumferential securement and reviewed the risks of that type of securement. She reviewed the facility policy limiting each nurse to 2 PIV-access attempts, with a total of 4 attempts, and explained the risks of a dorsal wrist PIV-catheter placement, of the PIV catheter placed outside of the hospital, and of the need for increased frequency of assessment in high-risk scenarios. She then demonstrated techniques to increase successful PIV placement in older adults, including the use of a near-infrared device. Finally, she used a full-arm sleeve to protect the PIV sites. Table 8 lists the key points of case study 3.

Lack of competency in infusion therapy can be a source of anxiety for new nurses and a significant source of patient dissatisfaction.

Conclusions

Evidence-based practice focuses on the consistent application of that validated knowledge base when making the common daily decisions inherent in nursing care, ultimately to optimize patient outcomes.[6] Peripheral intravenous–site management is an underrecognized area of patient risk within the complexity of critical care. Knowledge and close adherence to infusion therapy standards of practice will guide those fundamental nursing skills to improve the quality of care and prevent patient harm. CCN

Table 7 Infusion therapy competency development: care of the older aldult

Action	Evidence-based recommendations
Initiating PIV access, including PIV catheter insertion in the setting of difficult venous access	"The clinician is responsible and accountable for attaining and maintaining competence with infusion therapy administration and VAD insertion and/or management within her or his scope of practice. . . . Validate initial competency before providing patient care . . . when the scope of practice changes, and with the introduction of new procedures, equipment, or technology."[3(pS18)] "Use evidence and national standards to establish competencies for clinicians providing infusion therapy."[3(pS19)] "Make no more than 2 attempts at short peripheral intravenous access per clinician, and limit total attempts to no more than 4. Multiple unsuccessful attempts cause patient pain, delay treatment, limit future vascular access, increase cost, and increase the risk for complications. Patients with difficult vascular access require a careful assessment of VAD needs and collaboration with the health care team to discuss the appropriate options."[3(pS64)] PIV catheter placement in older adults: Thinning skin decreases resistance when inserting the PIV catheter, so use of reduced pressure is crucial. Because of loss of subcutaneous fat, firm traction with the nondominant thumb is helpful to stabilize the vein to prevent "rolling." Also, a reduced angle of entry (5°-15°) should be used for catheter entry, with further reduced angle once blood return is obtained. Larger veins tend to become more sclerotic with thickening of the tunica intima and media. If rope like, this is poor choice for IV access and will likely fail early. Consider midline or central vascular access early depending on length of therapy in the older adult.[24]
Provision of and proper use of facility PIV access resources	"To ensure patient safety, the clinician providing infusion therapy for special populations [including elderly] is competent in clinical management of such populations, including knowledge of anatomical and physiological differences, safety considerations, implications for . . . VAD planning and management, and infusion administration."[3(pS11)] "Vascular visualization technology is used in patients with difficult venous access and/or failed venipuncture attempts. . . . Consider the use of near-infrared light technology to aid in locating viable superficial peripheral venous sites and decreasing procedure time for short peripheral catheter insertion. . . . Use ultrasonography for short peripheral catheter placement in adults and pediatric patients with difficult venous access."[3(ppS44,S45)]
Replacement of emergently placed IV catheter	"Bacterial phlebitis may be related to emergent [VAD] insertions and poor aseptic technique. Label a catheter inserted during emergent conditions so it can be removed and resited as needed."[3(pS95)]
Use of optimal PIV securement and site protection	"Methods used to stabilize the VAD will not interfere with assessment and monitoring of the access and will not impede vascular circulation or delivery of prescribed therapy. . . . Consider use of an [ESD] to stabilize and secure VADs as inadequate stabilization and securement can cause unintentional dislodgement and complications requiring premature VAD removal."[3(ppS72,S73)] Use of a skin polymer solution should be considered to provide a barrier of protection.[25] "Avoid use of tape or sutures [as securement], as they are not effective alternatives to an ESD."[3(pS73)] "Do not use rolled bandages, with or without elastic properties, to secure any type of VAD because they do not adequately secure the VAD, can obscure signs and symptoms of complications, and can impair circulation of the flow of infusion."[3(pS73)] "Use site protection methods or immobilization devices in a manner that permits visual inspection and assessment of the vascular access site and vascular pathway and does not exert such pressure as to cause circulatory constriction, pressure ulcers, skin impairment, or nerve damage under the device and in accordance with manufacturers' directions for use."[3(ppS75,S76)]

Abbreviations: ESD, engineered securement device; IV, intravenous; PIV, peripheral intravenous; VAD, vascular access device.

Table 8 Key points from case study 3

Topic	Key points
Peripheral intravenous (PIV) insertion	Optimize training and competency development of new nurses, including age-related factors; no more than 2 attempts per caregiver, no more than 4 attempts per site; an algorithm to guide effective use of PIV access resources, including visualization devices, is recommended.
Emergently started PIV sites	Should be labeled as emergently started, and should be resited when indicated.
PIV securement	Cannot interfere with assessment or monitoring of the site or impair vascular circulation; an engineered securement device is recommended; do not use tape or sutures as securement; do not use rolled bandages (with or without elastic) for securement.

Acknowledgments
The author thanks Lisa Gorski, MS, RN, HHCNS-BC, CRNI, FAAN, chair of Infusion Nurses Society Standards of Practice Committee, for her substantive review of this manuscript.

Financial Disclosures
None reported.

eLetters

Now that you've read the article, create or contribute to an online discussion about this topic using eLetters. Just visit www.ccnonline.org and select the article you want to comment on. In the full-text or PDF view of the article, click "Responses" in the middle column and then "Submit a response."

See also

To learn more about infusion therapy, read "Safety of Continuous Peripheral Infusion of 3% Sodium Chloride Solution in Neurocritical Care Patients" by Jones et al in the *American Journal of Critical Care,* January 2017;26:37-42. Available at **www.ajcconline.org.**

References

1. The National Academies of Sciences, Engineering, and Medicine. Crossing the quality chasm: the IOM Health Care Quality Initiative. 2013. http://www.nationalacademies.org/hmd/Global/News%20Announcements/Crossing-the-Quality-Chasm-The-IOM-Health-Care-Quality-Initiative.aspx. Accessed August 25, 2018.
2. Helm RE, Klausner JD, Klemperer JD, Flint LM, Huang E. Accepted but unacceptable: peripheral IV catheter failure. *J Infus Nurs.* 2015;38(3):189-203.
3. Gorski LA, Hadaway L, Hagle M, et al. Infusion therapy standards of practice. *J Infus Nurs.* 2016;39(1 suppl):S1-S159.
4. Dickerson B. Centers for Medicare and Medicaid Services. SEP-1 Early Management Bundle: Severe Sepsis/Septic Shock. Part 1: Severe Sepsis. Webinar presented August 24, 2015. https://www.qualityreportingcenter.com/wp-content/uploads/2016/03/IQR_Webinar-August_SEP-1-Part-I-20150824-vFINAL-508cr.pdf/. Accessed November 25, 2017.
5. Peterson MH, Barnason S, Donelly B, et al. Choosing the best evidence to guide clinical practice: application of AACN levels of evidence. *Crit Care Nurse.* 2014;34(2):58-68.
6. Stevens K. The impact of evidence-based practice in nursing and the next big ideas. *Online J Issues Nurs.* 2013;18(2):4.
7. Czaplewski L. Clinician and patient education. In: Infusion Nurses Society; Alexander M, Corrigan A, Gorski L, et al. *Infusion Nursing. An Evidence-Based Approach.* 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:71-94.
8. Austin ED, Sullivan SB, Whittier S, Lowy FD, Uhlemann AC. Peripheral intravenous catheter placement is an underrecognized source of Staphylococcus aureus bloodstream infection. *Open Forum Infect Dis.* 2016;3(2):ofw072.
9. Stuart RL, Cameron DR, Scott C, et al. Peripheral intravenous catheter-associated Staphylococcus aureus bacteremia: more than 5 years of prospective data for two tertiary health services. *Med J Aust.* 2013;198(10):551-553.
10. Ishikane M, Hayakawa K, Kutsuna S, Takeshita N, Ohmagari N. Epidemiology of blood stream infection due to candida species in a tertiary care hospital in Japan over 12 years: importance of peripheral line-associated candidemia. *PLoS One*. 2016;11(10):e0165346.
11. Trihn TT, Chan PA, Edwards O, et al. Peripheral venous catheter-related staphylococcus aureus bacteremia. *Infect Control Hosp Epidemiol.* 2011;32(6):579-583.
12. Wallis MC, McGrail M, Webster J, et al. Risk factors for peripheral intravenous catheter failure: A multivariate analysis of data from a randomized control trial. *Infect Control Hosp Epidemiol.* 2013;35(1):63-68.
13. Bhosale GP, Shah VR, Extravasation injury due to dopamine leading to dermal necrosis and gangrene. *J Anaesthesiol Clin Pharmacol.* 2012;29(4):534-535.
14. Infusion Nurses Society. Noncytotoxic vesicant medications and solutions. https://www.learningcenter.ins1.org/products/noncytotoxic-vesicant-medications-and-solutions. 16. Accessed August 25, 2018.
15. Gorski L, Hallock D, Kuehn S, Morris P, Russell JM, Skala LC. Recommendations for frequency of assessment of the short peripheral catheter site. *J Infus Nurs.* 2012;35(5):290-292.
16. Perruca R. Peripheral venous access devices. In: Alexander M, Corrigan A, Gorski L, et al. *Infusion Nursing. An Evidence-Based Approach.* 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:456-479.
17. Young Bradford J, Reeve NE, Killian, M, et al. *Clinical Practice Guideline: Prevention of Blood Culture Collection.* Des Plains, IL: Emergency Nurses Association; 2016.
18. Infusion Nurses Society. Infusion nursing standards of practice. *J Infus Nurs.* 2006;29(1 suppl):S60.
19. Groll D, Davies B, Mac Donald J, et al. Evaluation of the psychometric properties of the phlebitis and infiltration scales for the assessment of complications of peripheral vascular access devices. *J Infus Nurs.* 2010;33(6):385-390.
20. Hanrahan K. Hyaluronidase for IV extravasation evidence-based guideline. In: McCarthy AM, ed. *Series on Evidence-Based Practice for Children and Families.* Iowa City, IA: The University of Iowa College of Nursing, Office for Nursing Research; 2012.
21. Denton A, Bodenham A, Conquest A, et al. *Standards for Infusion Therapy.* 4th ed. London, England: Royal College of Nursing; 2016.
22. Reynolds PM, MacLaren R, Mueller S, et al. Management of extravasation injuries: a focused evaluation of noncytotoxic medications. *Pharmacotherapy.* 2014;34(6):617-632.
23. Gorski L, Stranz M, Joseph J, et al. Development of an evidence-based list of noncytotoxic vesicant medications and solutions. *J Infus Nurs.* 2017;40(1):26-40.
24. Coulter K. Successful infusion therapy in older adults. *J Infus Nurs.* 2016;39(6):352-358.
25. Fabian B. Infusion therapy in the older adult, In: Infusion Nurses Society; Alexander M, Corrigan A, Gorski L, et al. *Infusion Nursing. An Evidence-Based Approach.* 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:571-582.