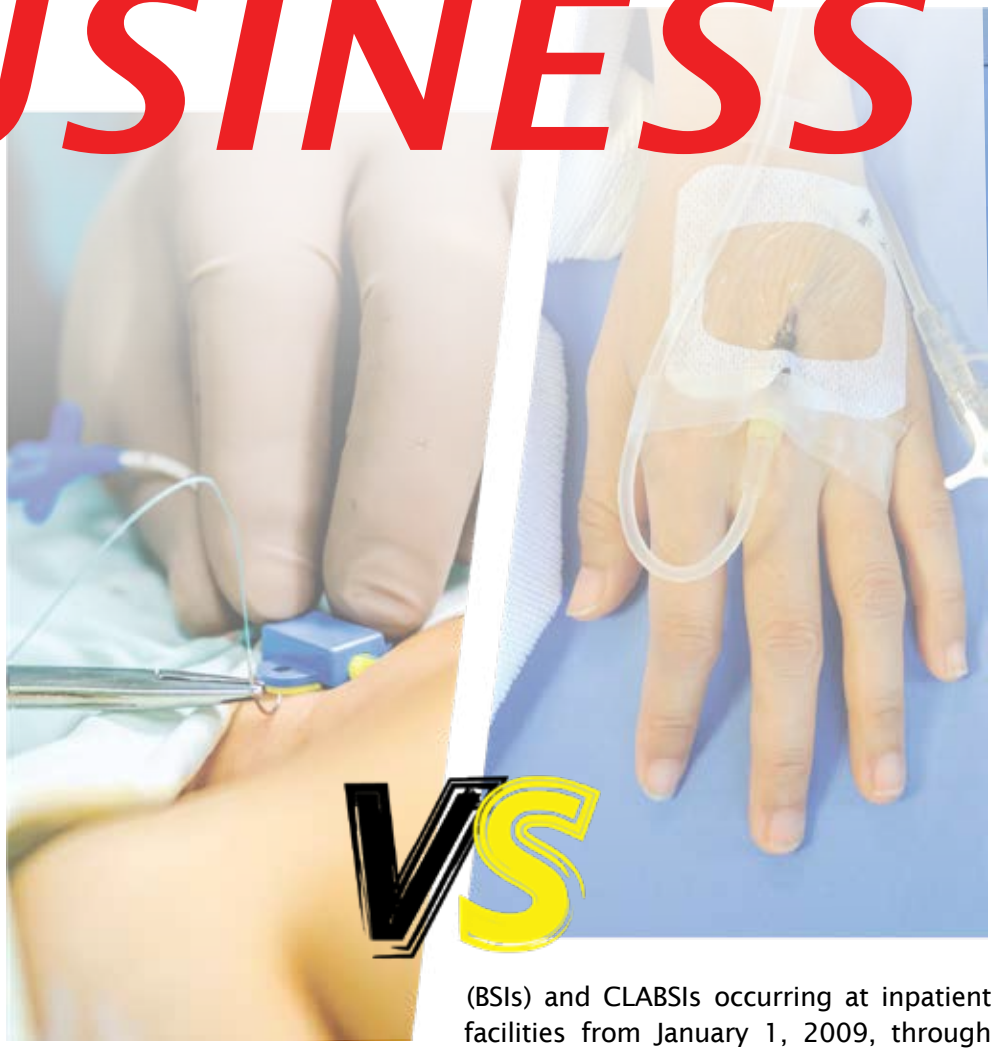
RISKY BUSINESS

Peripheral and Central Venous Catheters Both Pose Risks

Lynette Hathaway[•◇], MSN, RN &
Mary C. Magee[◇], MSN, RN
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Abstract

Venous access is an essential method of providing life-saving therapy. As part of intensive efforts to decrease the incidence of central line–associated bloodstream infections (CLABSIs), healthcare facilities may be increasing the use of short (noncentral) peripheral venous catheters (PVCs). To investigate this, the Patient Safety Authority (PSA) sought to explore the relationship of actual to predicted complications per central venous catheters (CVCs) and PVCs over a nine-year period. In addition, as PVCs are not without risk and CVCs pose risks aside from infection, we sought to identify the type and relationship of PVC to CVC complications and to quantify the timing and types of PVC and CVC complications and their associated risk factors.

A query of the PSA's statewide event reporting database, the Pennsylvania Patient Safety Reporting System (PA-PSRS), for venous catheter complication events and a query of the National Healthcare Safety Network (NHSN) database for both primary bloodstream infections (BSIs) and CLABSIs occurring at inpatient facilities from January 1, 2009, through December 31, 2017, yielded 115,937 events. A methodical sampling of PA-PSRS yielded 2,413 PVC and CVC events. These were analyzed for the timing of complications reported, the type of complication reported, and any identified risk factors.

Overall reports of PVC complications increased, and the correlation between actual and predicted PVC events over the nine years studied is strong and statistically significant. The slight decrease in the number of reported CVC complications was not statistically significant. The authors used regression analysis to determine the best-fitting line through the predicted and actual observed events during the period of observation. These data are not intended to present a predictive model of future events. No correlation was found between the numbers of PVC and CVC complications.

•Corresponding author
◇Patient Safety Authority
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The greatest number of PVC complications, particularly infiltration, occurred during catheter maintenance. Excluding NHSN-reported CLABSIs, the greatest number of CVC complications, particularly pneumothorax, occurred during catheter insertion.

Education and training are key to preventing intravascular device–associated complications. Healthcare facilities are encouraged to evaluate policy, procedures, and actual practices to eliminate complications and improve outcomes. In addition, quality improvement efforts aimed at decreasing CLABSIs should include measuring CVC complications and all PVC complications as a balancing metric.

Keywords: *peripheral venous catheter, central venous catheter, patient safety*

Introduction

The deidentified patient safety event below involving a fatal complication associated with a PVC prompted analysis of data reported through PA-PSRS.

> *Patient with multiple comorbidities was admitted with hematuria. A peripheral intravenous (IV) catheter was placed in patient's arm upon admission. The IV was removed 72 hours later because of pain at the insertion site. An ultrasound of the vein showed thrombosis. Patient was subsequently discharged but returned to the hospital complaining of increased discomfort and swelling and readmitted. Cultures obtained on the new fluid collection at the old IV site were positive. The patient became bacteremic then septic, and expired within 2 weeks of readmission.*

PVCs are the most commonly used medical device during hospitalization, providing fluids and other essential medications to patients.[1] Although many providers assume PVCs are benign, this event narrative illustrates that PVC use has risks.

In the United States, IV therapy—whether delivered centrally or peripherally—is the most common therapy provided to hospitalized patients. An estimated 85% of hospitalized patients receive IV therapy.[2,3] It is used to deliver medical treatment and as a component of life-saving therapy. Annually, about 330 million PVCs are used[4,5] and more than five million central venous catheters (CVCs) are inserted.[6] The selection of a PVC versus a CVC is determined by the types of infusions necessary, the anticipated duration of therapies, and the patient's overall medical condition.[7]

Failure to remove an infected catheter places the patient at risk of developing septic thrombophlebitis with PVCs and septic thrombosis of a great vein with CVCs.[8] Patients' pain and fears related to PVC replacements and failed attempts cost healthcare facilities in both money and patient satisfaction.[4,9]

Complications of CVC use, especially infection, are well documented,[8,10] while the incidences of infection and other complications related to PVCs are not well defined.[2] Reducing the number of CVC insertions is one strategy to reduce the number of CLABSIs and, as a byproduct, the incidence of other central line complications. Healthcare facilities may attempt to decrease the use of CVCs, if appropriate (or as medically necessary), by increasing PVC insertions. Analysts investigated whether decreases in the number of CVCs and CLABSIs are associated with an increase in the number of PVC complications as reported in PA-PSRS.

Methods

Level I Methods—NHSN and PA-PSRS

Data Queries

To compare numbers of PVC and CVC complications over time, analysts queried PA-PSRS for PVC and CVC complications *and* queried the NHSN for CLABSIs and primary BSIs occurring from January 1, 2009 (the first full year of NHSN reporting), through December 31, 2017. Infections, which are the majority of CVC complications, are reported through NHSN while the majority of PVC complications are reported through PA-PSRS. Due to facility reporting practices, an occasional infection may be reported through PA-PSRS. NHSN does not specify reporting the device for primary BSIs unless a CVC is involved.[7] By definition, a primary BSI is not secondary to an infection at another body site.[11] Although some primary BSIs unassociated with a CVC could still be associated with a PVC, in the absence of a better measure, analysts used NHSN primary BSIs in the general query as a surrogate for noncentral line peripheral catheter–associated BSIs.

The PA-PSRS query included the following event subtypes, which are designated pathways for reporting PVC and CVC complications:

- IV site complication
- Extravasation of drug or radiologic contrast
- Intravascular air embolism
- Pneumothorax

Analysts applied a keyword formula to identify and

distinguish peripheral from central catheter events in the PA-PSRS data query.

NHSN data for BSIs and CLABSIs are reported as whole numbers in accordance with established definitions and not open to interpretation. The authors did consider patient days; however, the current best practice for rate-based analysis is to use catheter days, which are only collected and reported for central lines. We could not have obtained catheter days for peripheral lines.

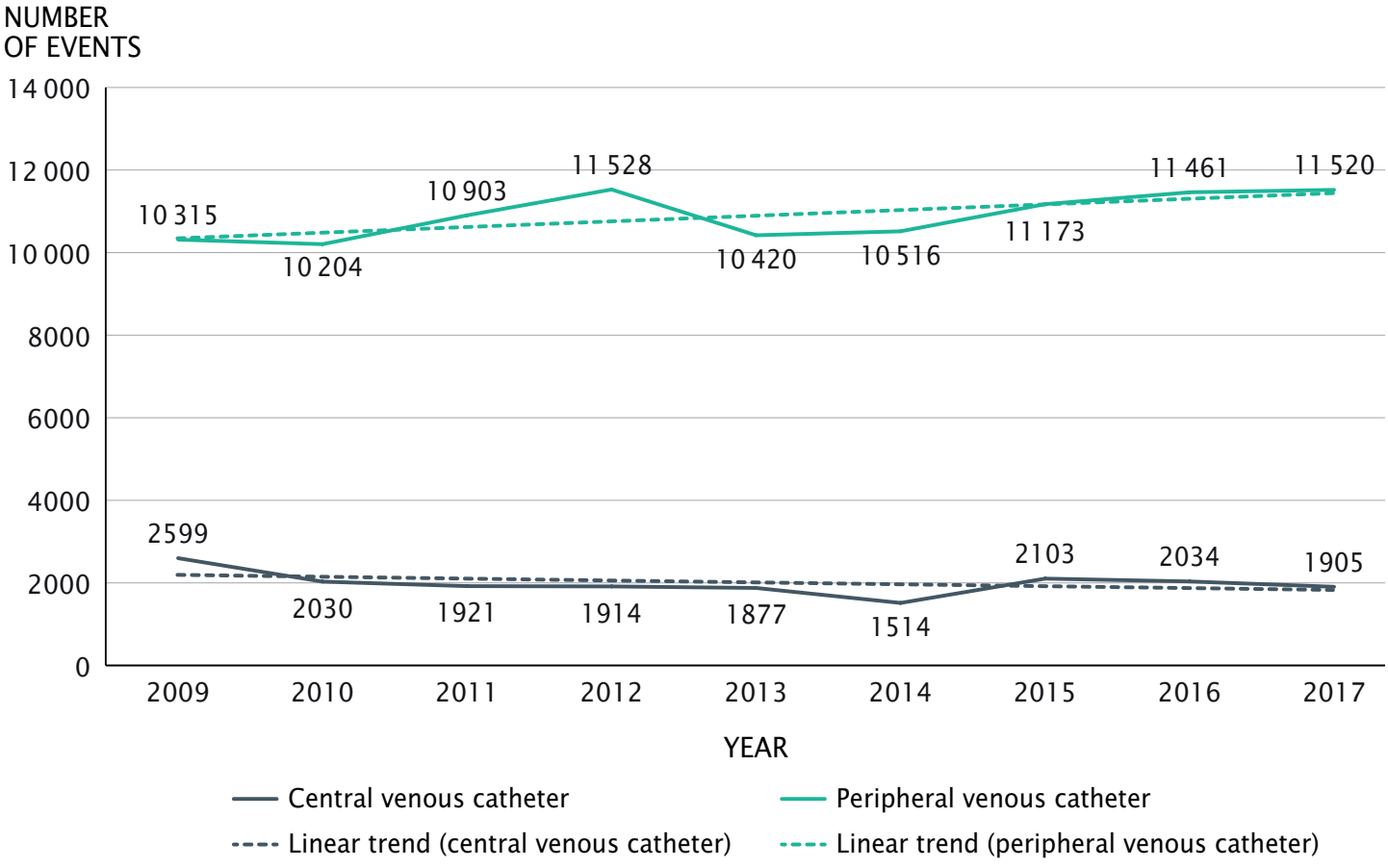
Review and analysis of deidentified reports submitted through PA-PSRS has been exempted from institutional review board review by the Drexel University College of Medicine Office of Regulatory Research Compliance. Any narratives provided in the manuscript have been contextually deidentified.

Definitions

PVCs were defined as midline catheters (the tip of the catheter ends in a peripheral vein) and peripherally inserted short IV catheters with and without fluids infusing.

CVCs were defined as peripherally inserted central catheters; catheters placed centrally in the femoral,

Figure 1. Peripheral and Central Venous Catheter Complications by Year with Linear Trend (N = 115 937)



Data sources: The Pennsylvania Patient Safety Reporting System was queried for venous catheter complication events in the following subtypes: intravenous site complication, extravasation of drug or radiologic contrast, intravascular air embolism, and pneumothorax. The National Healthcare Safety Network (NHSN) was queried for primary bloodstream infections (BSIs) and central line-associated BSIs.

Note: Complications include infection, air embolism, pneumothorax, phlebitis, infiltration including extravasation, leakage/bleeding, occlusion, nerve injury, bruising, and hematoma.

No correlation was found between catheter types in the relationship *between* the actual numbers of peripheral venous catheter (PVC) events and central venous catheter events ($r = 0.15$, $P = .69$).

For reporting purposes, NHSN does not specify reporting a device for primary BSIs; therefore, not all primary BSIs are associated with a PVC.

subclavian, or internal jugular vein; ports; permanent catheters; and umbilical catheters.

Inclusions and Exclusions

Reports in PA-PSRS involving inpatients from acute care, pediatric, and long-term acute care hospital types were included. Reports involving patients designated as outpatients, nonadmitted emergency department patients, and outpatient clinic and ambulatory surgery facility patients were excluded because the majority of patients who have catheters in these settings would be more likely to have a CVC, which may have skewed the results. Reports from rehabilitation and behavioral health hospitals and those units within acute care hospitals were excluded because patients in those settings are unlikely to have a venous catheter. Reports involving nonvenous catheters such as arterial and intrathecal catheters were excluded.

Sampling for Keyword Accuracy

Analysts developed a keyword formula to distinguish PVC from CVC events in data from PA-PSRS. Because the PA-PSRS subtype IV site complication included more than 79,000 events, analysts randomly sampled 10% of that subtype to assess the predictive value of the keyword formula. Peripheral keyword prediction accuracy was 96% and central event keyword prediction accuracy was 95%. The formula also was applied to the extravasation of drug or radiologic contrast subtype.

Fewer intravascular air embolism and pneumothorax event subtype reports were identified in PA-PSRS; each of these events was reviewed manually.

Statistical Analysis

Query results were used to

- Quantify and compare the number of PVC and CVC complications per year
- Determine the linear incidence trend over time
- Calculate percentage change from year one to year nine
- Determine the average annual percent change

The actual performance (i.e., number of events [counts] per year) was plotted. For each measure, a linear regression model was calculated to fit the data using Excel.[12] The starting point of the linear regression (i.e., y-intercept) was used as the baseline value and was used to predict baseline performance. Regression analysis was used to determine the best-fitting line through the predicted and actual observed events during the period of observation. These data are not intended to present a predictive model of future events.

The relationships between actual and predicted number of events per catheter type and between PVC and CVC were analyzed using the regression analysis tool in Excel.[12] The regression function calculates the correlation coefficient (Pearson's r), performs linear regression using the least squares method, and provides a p-value for the association. Alpha was set at 0.05.

Level II Methods—PVC and CVC Complications

Looking only at data from PA-PSRS, analysts used sampling to analyze more than 91,000 PVC and CVC complications.

Data Sampling

To compare complication types across event subtypes and years, IV site complication and extravasation of drug or radiologic contrast subtypes were randomly sampled to yield 2,293 of 91,769 events. The goal of sampling was to achieve a confidence interval of 95% with a 2.5% margin of error.

For each year, the ratio of PVC to CVC events was applied to the number of events sampled per year per catheter type. For sampled CVC events in the IV complications subtype, the resultant annual sample size had few data (i.e., single digits) so analysts sampled 20 events per year to increase result validity. The annual number of CVC extravasation events was also fewer than 20 per year, and analysts reviewed all of these events.

Analysts reviewed all 12 of the intravascular air embolism and all 259 pneumothorax event subtypes. In all, analysts sampled 2,564 events.

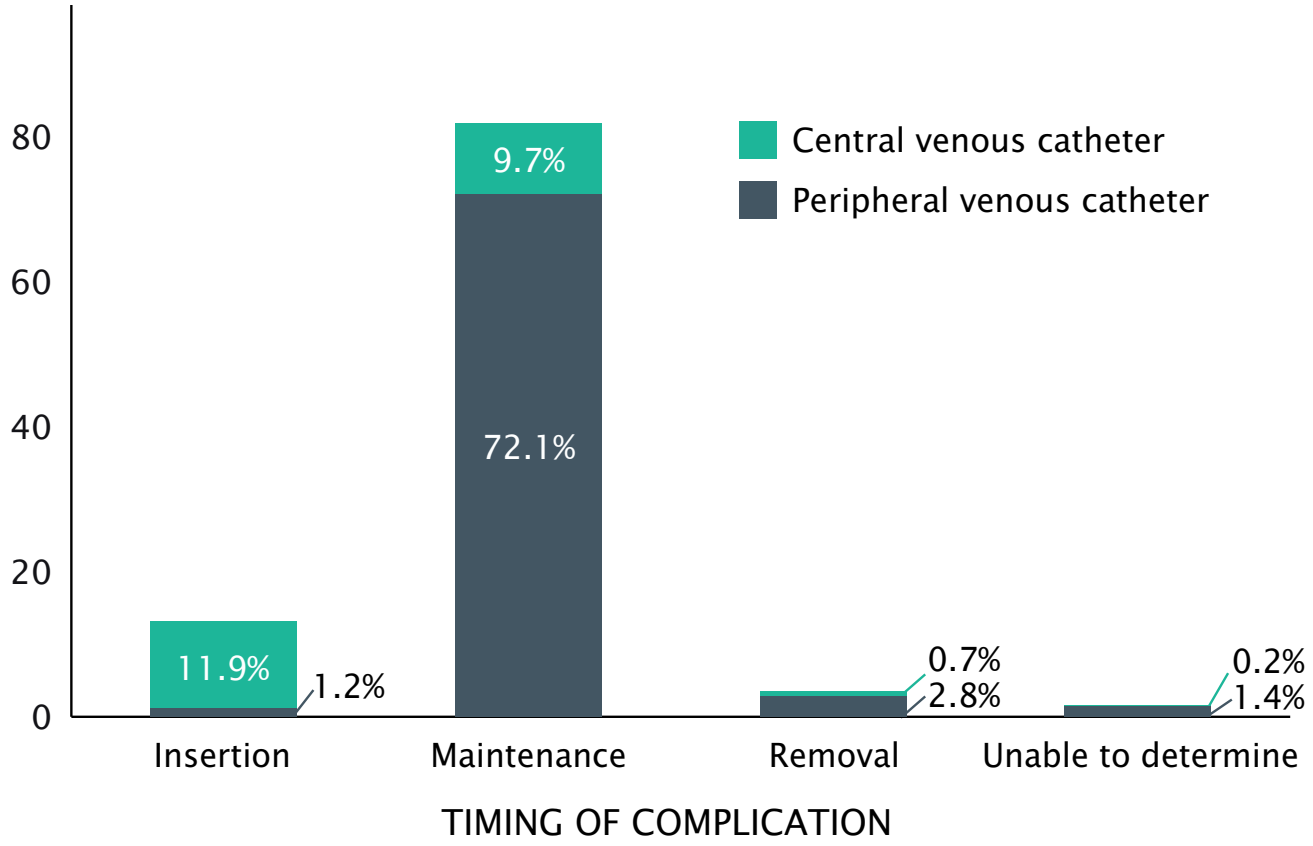
Timing

Analysts reviewed the 2,564 events in the sample and categorized the timing of the complication as occurring either during insertion, maintenance, or removal.

Type of Complications

Analysts sorted events by the following complication types: absence of blood flow or occlusion; ecchymosis, hematoma, or bruising; leakage or bleeding; infiltration (including extravasation); IV pulled, dislodged, or broken; phlebitis; pneumothorax; and other. If an event described multiple complications,

Figure 2. Timing of Complications by Venous Catheter Type (N = 2413)



Note: Sampled data as reported through the Pennsylvania Patient Safety Reporting System, January 1, 2009, through December 31, 2017, in the subtypes IV site complication, extravasation of drug or radiologic contrast, pneumothorax, and intravascular air embolism. Data on the timing of primary blood stream infections and central line-associated blood stream infections from the National Healthcare Safety Network database are excluded.

Abbreviations: CVC, central venous catheter; IV, intravenous; PVC, peripheral venous catheter.

each was categorized separately; the data are not mutually exclusive.

In events involving more than one catheter, each catheter counted as an individual event and complications were attributed to the appropriate catheter. If two catheters were mentioned in the event detail and it was obvious that the event was about only one, analysts attributed complications to the catheter which was the focus of the event.

Risk Factors

Analysts identified conditions described within PA-PSRS event details that could place the patient at risk for developing a complication, such as placing a PVC in a suboptimal location or CVC caps not being cleaned according to policy.

Results

Level I Results—Analysis and Comparison of PVC with CVC

The query from PA-PSRS resulted in 91,769 events: 87,928 PVC and 3,841 CVC events. The NHSN query resulted in 24,168 reports: 10,112 primary BSI (surrogate for PVC-related infections) and 14,056 CLABSI reports. NHSN data were not analyzed but queried only for the number of events reported. This high-level analysis totaled 115,937 events.

The number of PVC complications showed a statistically significant 11.7% increase (r = 0.68, p = .04) and an average annual change of 2.3% (calculated using the number of years for which there are data minus 1). CVC complications showed a 26.7% decrease without statistical significance (r = 0.45, p = .22) and an average annual change of 1.3% from 2009 through 2017 (Figure 1).

Level II Results—PVC and CVC Complications

Of the 2,564 events sampled from PA-PSRS, 151 were deemed nonapplicable for the following reasons: analysts were unable to determine what type of line was being described, a PVC was found in the CVC sample or vice versa, or the care area was determined to be outpatient. The following PVC and CVC complications analysis is based solely on data from PA-PSRS and derived from a final 2,413 sampled events (2.6% of 91,769). It is important to note that Level II analysis excludes CLABSIs.

Timing of the Complication

Analysts identified the complication timing for 2,374 (98.4%) of the PVC and CVC sample events (Figure 2). The remaining 39 events lacked sufficient information for categorization.

Overall, 81.8% of complications for both catheter types (n = 1973 of 2413) occurred during maintenance, primarily driven by the number of PVC events. However, for CVCs alone, the largest percentage of complications occurred during insertion (53.4%, n = 286 of 536).

The trends of complication timing per catheter type were relatively stable year to year.

The following events are examples of timing-related complications.

Insertion

> *Patient admitted with history of respiratory illness. Deterioration of patient's condition despite bilevel positive airway pressure caused the patient to require mechanical ventilation and respiratory status stabilized. Due to poor venous access, CVC was inserted and the patient went into cardiac arrest. An emergent chest tube was placed to relieve possible pneumothorax [author's note: pneumothorax is a possible complication of central line insertion; presumably providers were attempting to alleviate any conditions potentially contributing to the cardiac arrest]. Resuscitation efforts were futile.*

Maintenance

> *Patient had reported painful IV site to nursing staff each time intermittent intravenous medications were administered for 24 hours. When the IV team assessed the site the IV was immediately removed due to phlebitis and signs of infiltration.*

Removal

> *During removal CVC patient was placed in Fowler's [sitting] position. Once the CVC was removed patient developed shortness of breath and cardiac arrest. Patient required intubation and cardio-stimulatory drugs. Subsequent chest x-ray confirmed pneumothorax requiring chest tube insertion. The patient did not recover.*

Type of Complication

Eight complication categories encompassed 2,376 (98.5%) of the 2413 event sample; 2,933 complications were identified (n = 2,304 for PVC and n = 629 for CVC). See Figure 3 for percentages of complication categories. The remaining 37 events lacked sufficient information for categorization.

Infiltrations and extravasations accounted for 60.3% (n = 1,390 of 2,304) of PVC complications, followed by phlebitis, which accounted for 30.1% (n = 693), together comprising more than 90% of PVC complications in the event sample.

Pneumothorax was the most common CVC complication (41.3%, n = 260 of 629) followed by infiltration and extravasation (17.5%, n = 110). Pneumothorax was primarily associated with CVC insertion among the data sample.

Cardiac arrest accounted for 0.3% (n = 11 of 2,933) of the complications reported through the PA-PSRS sample. Most cardiac arrest events (81.8%, n = 9 of 11) occurred during CVC insertion and were attributable to air embolism or pneumothorax. The remaining two cardiac arrest events occurred during CVC removal. There were no cardiac arrest events identified in the PVC event sample.

The following events are examples of catheter complications:

Infiltrations

IV Team was consulted to assess placement of a new IV on a patient with a known infiltration. The primary nurse informed IV team that the patient's IV medication had continued to be infused until the new IV was inserted. Assessment of the patient's IV site shows an area swollen and painful with evidence of acute nerve injury due to IV infiltration.

During assessment of PIV [peripheral IV] site, noted area to be red and inflamed. No medications or infusions had been administered for the past day. Physician notified, PIV discontinued, and culture of PIV site wound collected. Patient required surgical intervention at PIV wound site and a PICC [peripherally inserted central catheter] inserted to deliver long-term antibiotics to promote healing of this PIV wound site.

Phlebitis

Upon assessment, patient found to have palpable venous cord with redness, pain, and warmth. Phlebitis protocol implemented.

Pneumothorax

Physician attempted to place a central line and the patient developed a pneumothorax as evidenced by CXR [chest x-ray image] and symptoms of

Table 1. Risk Factors

TYPE OF RISK FACTOR	CVC	PVC	TOTAL
Policy and procedure not followed (e.g., outdated dressing, outdated femoral catheter lines, nonocclusive dressing/catheter exposed)	13	14	27
Filters/caps/hubs/tubing concern	11	3	14
Substandard site placement	0	10	10
Communication concern	2	3	5
PICC used without confirmation x-ray/no physician order for x-ray	4	0	4
Patient reports pain, but IV site still used	0	3	3
Port not accessed/improperly accessed	2	0	2
Continued IV infusion despite infiltration	0	2	2
Condensate inside cap/tubing	2	0	2
Handcuff/BP cuff/PVC in same arm	0	2	2
IV site without visual assessment/inspection	0	2	2
CVC not sutured	1	0	1
Incompatible IV drugs in close proximity/line not flushed	1	0	1
Tourniquet not removed	0	1	1
Patient refused IV site change	0	1	1
PVC inserted in wrong direction (away from the heart)	0	1	1
Did not know patient had PICC/antibiotic delayed	1	0	1
IV placed in infected hand	0	1	1
No assessment for medical necessity of IV	0	1	1
Total	**37**	**44**	**81**

Note: As reported to the Pennsylvania Patient Safety Reporting System, January 1, 2009, through December 31, 2017, in the event subtypes IV site complication, extravasation of drug or radiologic contrast, intravascular air embolism, and pneumothorax. Because data on primary blood stream infections and central line-associated blood stream infection risk factors are not included in the National Healthcare Safety Network database, those complication types are not reported in the table.

Abbreviations: BP, blood pressure; CVC, central venous catheter; IV, intravenous; PICC, peripherally inserted central catheter; PVC, peripheral venous catheter.

shortness of breath and chest pain. A chest tube was needed.

Risk Factors

In 81 events, a risk factor—such as policy and procedure for CVC site care not being followed—was reported (3.4% of 2413 sampled events). See Table 1. The two main risk factors identified included breaches in policy and procedure (including outdated dressings) and problems related to filters, hubs, and tubing of IV catheters.

Discussion

Level I Discussion—Catheter Analysis and Comparison of PVC and CVC

Relationship of PVC and CVC Complications

With important and long-standing attention focused on CVCs and in particular CLABSI reduction, the scope and impact of PVC complications is often overlooked.[6,8,10] This study identified that serious harm can be related to PVCs, consistent with information in the literature.[2,14-17]

Although this study found no correlation between the increasing number of PVC complication events and the decreasing number of CVC events (based on aggregating the PA-PSRS and NHSN data), it did determine that the increasing number of reported PVC complication events and the correlation between actual and predicted PVC events over the nine years studied is strong and statistically significant.

The authors cannot conclude that a reduction in CVC complications is leading to or causing an increase in PVC complications. However, from a quality-improvement perspective, facilities can consider monitoring and measuring PVC use and complication rates as a balancing measure to those used for CLABSI reduction initiatives.

Level II Discussion—Analysis of PVC and CVC Complications

Timing of the Complication

Almost three-quarters of the PVC sample events occurred during the maintenance phase. Little consensus exists on the timing of IV site rotation. Many PVCs remain idle or continue to be used with symptomatic patients, and they are often inserted in substandard anatomical sites.[3,4,15] The Infusion Nurses Society's standard of practice supports site rotation based on clinical indications rather than a predetermined interval.[3]

The largest number of CVC sample events occurred during insertion. Although previous analysis demonstrated that most CLABSIs occur during maintenance,[18] NHSN data, which include CLABSIs, are excluded from this level II analysis because of differences in structured data fields. The availability of a discrete event report subtype may have facilitated reporting pneumothoraces through PA-PSRS.

Although complications during CVC removal may be rare in the literature as well as in this analysis, outcomes—including cardiac arrest—may be devastating and fatalities have been documented.[19,20]

Much attention is directed toward the practice of CVC insertion; similar attention to the process of CVC removal may also be warrented.[3,19,20]

Type of Complication

Infiltration and phlebitis are the most prevalent complications of PVC use and can result in swelling, pain, and tissue damage.[2,14,21-24] Estimates of PVC infiltrations in the literature range from 11.8% to 48.0%.[14,24] In one extreme case, a rare biceps brachii tear occurred as a result of PVC infiltration.[17]

In contrast to other publications,[21,24,25] this study found more than 60% of PVC complications were related to infiltrations, including extravasations. PA-PSRS has a reporting pathway specifically formatted to capture infiltrations and extravasations, which might facilitate reporting and contribute to the larger percentage.

Our finding that PVC phlebitis was the second-most commonly reported complication is consistent with the literature.[14,16,24,25]

Most CVC noninfection complications are related to mechanical processes, such as puncture and thrombosis formation, which can lead to pneumothorax, vascular damage, and occlusion.[26-28]

The number of non-CLABSI and nonprimary BSI infections reported through PA-PSRS was small. Analysts applaud quality improvement initiatives that have effectively reduced the number and rate of CLABSIs.[29-32] Peripheral BSI reduction has progressed slower than CLABSI reduction; this analysis, as well as other recent research, points to the importance of preventing PVC BSIs.[10,15,33]

When specific quality improvement and patient safety initiatives such as reducing CLABSIs are prioritized, the tendency is to focus attention and resources on that initiative; balancing measures are needed to ensure recognition and management of untoward effects that can result from improvement efforts. As this study suggests, measuring PVC complications may prove beneficial during CLABSI reduction initiatives.

Risk Factors

Risk factors were identified in this analysis. Overall the number of PVC and CVC risk factors were almost equivalent and included breaches in following policy and procedure, similar to what is described in the literature.[1,16]

Risk Reduction Strategies

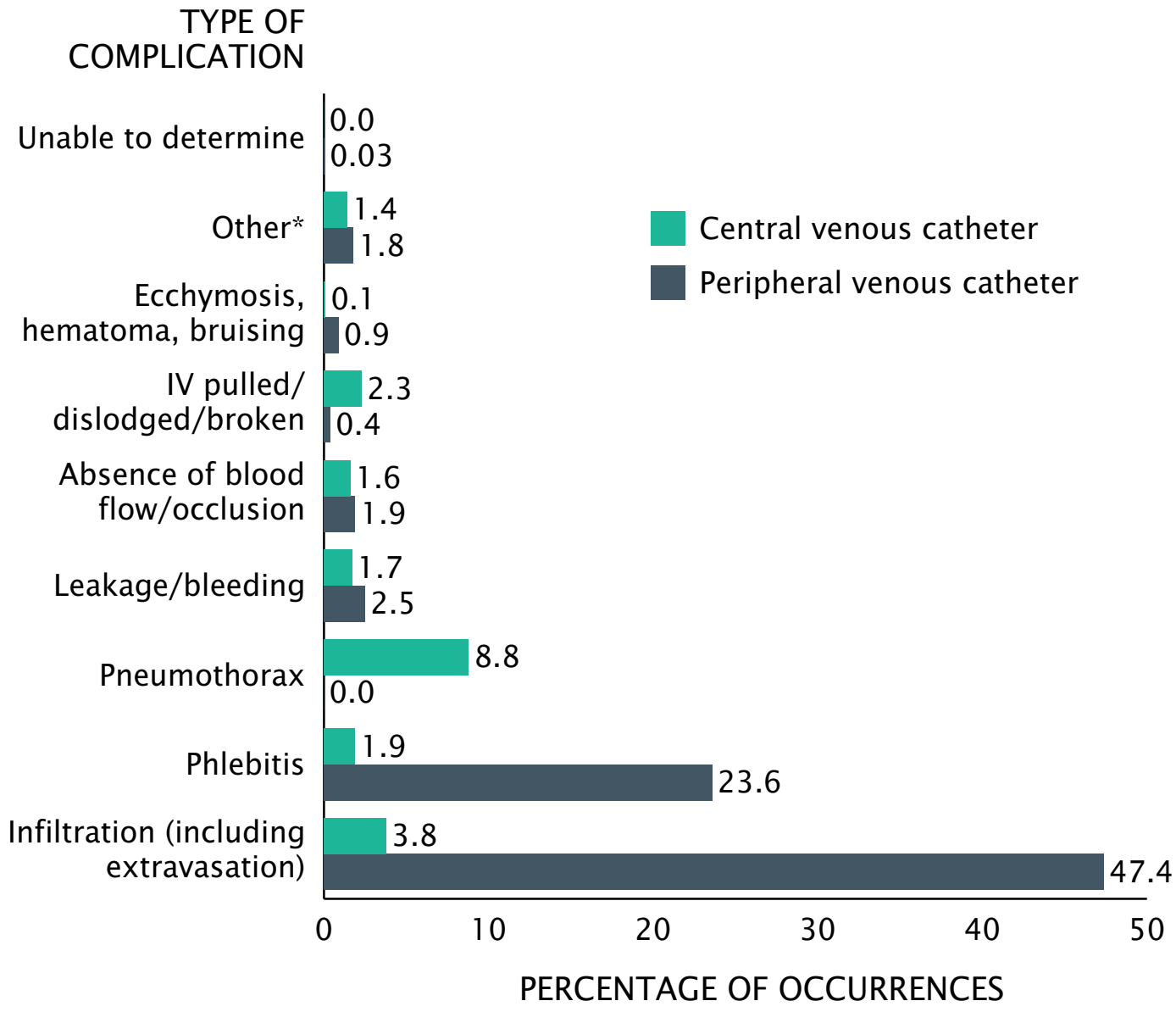
Consider the following strategies that may reduce the incidence of venous catheter–related complications, based on a review of current literature, analysis of events submitted to PA-PSRS, and observations within the practice of nursing:

- Encourage frontline caregivers to identify potential risks before an adverse event occurs[34-36]
- Perform hand hygiene and clean the catheter hub before use[37]
- Visually check catheter sites without active infusions at least every four hours and more frequently if there is an infusion[3]
- Monitor infusions and palpate the site if patient reports pain, pins and needles, numbness, burning, stinging, and/or tightness at or around insertion site, catheter tip, or entire venous pathway; stop the infusion and remove the catheter[3]
- Use a transparent, semipermeable dressing to provide visualization and potentially reduce bacterial contamination at the insertion site[1]
- Examine insertion site where the catheter enters the skin for signs of redness, pain, leakage, or swelling; if any of these signs are present, stop the infusion and remove the PVC, unless the PVC will be used to administer antidote directly to tissue according to facility protocol [16]
- Encourage patient engagement during catheter insertion, maintenance, and removal[9]
- Implement nurse-driven protocols, as appropriate, removing catheters that have not been accessed within the preceding 24 hours and may no longer be medically necessary[4]
- Inspect all components of the IV system including end caps, hubs, filters, and tubing compatibility to prevent hazards and identify potential complications such as cracks, disconnections, and condensation[7]
- Review CVC insertion procedures and consider the use of ultrasound during CVC insertion[28]
- Recognize that after two unsuccessful cannulation attempts, the rate of CVC-insertion complications increases, particularly the risk for pneumothorax[28]
- Consider adopting the Infusion Nurses Society's special precautions for preventing air embolism during placement and removal of CVC, including[3]
  - Ensure patient placement in a position (supine or in Trendelenburg) such that the CVC insertion site is at or below the level of the heart
  - Have patient perform the Valsalva maneuver at the appropriate point during catheter withdrawal, unless contraindicated
  - Upon removal of the CVC, apply digital pressure using manual compression with a sterile dry gauze pad until hemostasis is obtained
  - Place a sterile, petroleum-based ointment with the sterile dressing to the access site for at least 24 hours to seal the skin-to-vein tract
  - Encourage the patient to remain in a flat or reclining position, if tolerated, for 30 minutes after CVC removal

Limitations

Despite mandatory reporting laws[38], the number of reports and completeness of report data depends on the reporter as well as on the design and

Figure 3. Type of Complication by Venous Catheter Type (N = 2933)



Note: Sampled data as reported through the Pennsylvania Patient Safety Reporting System, January 1, 2009, through December 31, 2017, in the event subtypes IV site complication, extravasation of drug or radiologic contrast, pneumothorax, and intravascular air embolism. Data on number of primary bloodstream infections and central line-associated bloodstream infections (CLABSIs) from the National Healthcare Safety Network (NHSN) database are excluded. For context, 14,056 CLABSIs were reported through NHSN during this time period.

Total does not equal 100% because of rounding.

Because more than one complication can be reported per event, this resulted in 2933 complications identified (n = 2304 for PVC and n = 629 for CVC).

* Includes air embolism, blister, cardiac arrest, infection, nerve injury, and skin tear.

Abbreviations: CVC, central venous catheter; IV, intravenous; PVC, peripheral venous catheter.

implementation of facility reporting systems.

Reporting patterns may change over time as facilities contend with ever-changing quality and patient safety priorities and values. PA-PSRS and NHSN may contain duplicate reports; differences in structured data fields precluded direct comparisons of some data. In addition, our contention is that the number of PVC and CVC complications is a meaningful representation of the magnitude of the problem and provides complementary information.

The process used to generate the PA-PSRS event sample may have overrepresented uncommon complications.

NHSN does not require that devices associated with primary BSIs are specified; therefore, it is likely that the incidence of PVC-associated BSIs is underrecognized.

Because of taxonomy changes, reports submitted to PA-PSRS before 2012 may have included outpatients.

Database reports often lacked dwell times, which may have impacted interpretation of complication data.

The possible impact of an aging population was not explored, and data to accomplish risk adjustment or assess patient frailty was not available.

Conclusion

Decreases in the number of CVCs and CLABSIs were not found to be associated with an increase in the number of PVC complications as reported in PA-PSRS.

The significant increase in PVC complications reported most commonly occurred during maintenance. Complications of CVC, excluding CLABSIs, most commonly occurred during insertion.

Healthcare providers are advised to examine policy, procedures, and practices to minimize venous catheter complications and improve patient outcomes. In the context of improvement efforts focused on the reduction of CVC complications, healthcare facilities may find benefits in concomitant efforts to measure and reduce PVC complications.

References

1. Miliani K, Taravella R, Thillard D, Chauvin V, Martin E, Edouard S, Astagneau P, CATHEVAL Study Group. Peripheral venous catheter-related adverse events: evaluation from a multicentre epidemiological study in France (the CATHEVAL Project). *PLoS ONE*. 2017;12(1):e0168637. Also available: http://dx.doi.org/10.1371/journal.pone.0168637. PMID: 28045921.

2. Mattox EA. Complications of peripheral venous access devices: prevention, detection, and recovery strategies. *Crit Care Nurse*. 2017 Apr;37(2):e1-e14. Also available: http://dx.doi.org/10.4037/ccn2017657. PMID: 28365664.

3. Infusion therapy standards of practice. *J Infus Nurs*. 2016 Jan-Feb;39(1S):S1-S158.

4. Alexandrou E, Ray-Barruel G, Carr PJ, Frost S, Inwood S, Higgins N, Lin F, Alberto L, Mermel L, Rickard CM. International prevalence of the use of peripheral intravenous catheters. *J Hosp Med*. 2015 Aug;10(8):530-3. Also available: http://dx.doi.org/10.1002/jhm.2389. PMID: 26041384.

5. Zingg W, Pittet D. Peripheral venous catheters: an under-evaluated problem. *Int. J. Antimicrob.* Agents. 2009;34 Suppl 4:S38-S42. Also available: http://dx.doi.org/10.1016/S0924-8579(09)70565-5. PMID: 19931816.

6. Kornbau C, Lee KC, Hughes GD, Firstenberg MS. Central line complications. *Int J Crit Illn Inj* Sci. 2015 Jul-Sep;5(3):170-8. Also available: http://dx.doi.org/10.4103/2229-5151.164940. PMID: 26557487.

7. O'Grady NP, Alexander M, Burns LA, Dellinger EP, Garland J, Heard SO, Lipsett PA, Masur H, Mermel LA, Pearson ML, Raad II, Randolph A, Rupp ME, Saint S, Healthcare Infection Control Practices Advisory Committee (HICPAC). Guidelines for the prevention of intravascular catheter-related infections, 2011. Atlanta (GA): Centers for Disease Control and Prevention (CDC); 2011. 80 p. Also available: http://www.cdc.gov/hicpac/pdf/guidelines/bsi-guidelines-2011.pdf.

8. Intravascular device infection. In: APIC Text Online (ATO). Arlington (VA): Association for Professionals in Infection Control and Epidemiology, Inc. (APIC); 2014 Oct 3. Also available: http://text.apic.org/toc/prevention-measures-for-healthcare-associated-infections/intravascular-device-infection.

9. Cooke M, Ullman AJ, Ray-Barruel G, Wallis M, Corley A, Rickard CM. Not "just" an intravenous line: consumer perspectives on peripheral intravenous cannulation (PIVC). An international cross-sectional survey of 25 countries. *PLoS ONE*. 2018;13(2):e0193436. Also available: http://dx.doi.org/10.1371/journal.pone.0193436. PMID: 29489908.

10. Sato A, Nakamura I, Fujita H, Tsukimori A, Kobayashi T, Fukushima S, Fujii T, Matsumoto T. Peripheral venous catheter-related bloodstream infection is associated with severe complications and potential death: a retrospective observational study. *BMC Infect Dis*. 2017 Jun 17;17(1):434. Also available: http://dx.doi.org/10.1186/s12879-017-2536-0. PMID: 28623882.

11. Centers for Disease Control and Prevention (CDC). Bloodstream infection event (central line-associated bloodstream infection and non-central line-associated bloodstream infection). Atlanta (GA): Centers for Disease Control and Prevention (CDC); 2019 Jan. 45 p. Also available: https://www.cdc.gov/nhsn/pdfs/pscmanual/4psc_clabscurrent.pdf.

12. Microsoft Office Professional Plus 2016. [software]. Microsoft Excel MSO (16.0.4738.1000) 32-bit: Microsoft Corporation; 2016.

13. 2017 Patient Safety Authority Annual Report. Harrisburg (PA): Patient Safety Authority; 73 p. Also available: http://patientsafety.pa.gov/PatientSafetyAuthority/Documents/annual_report_2017.pdf.

14. Danski MT, Johann DA, Vayego SA, Oliveira GL, Lind J. Complications related to the use of peripheral venous catheters: a randomized clinical trial. *Acta Paul Enferm*. 2016;29(1):84-92.

15. Davis J. Peripheral vascular catheter-related infection: dwelling on dwell time. *Pa Patient Saf Advis*. 2014 Mar;11(1):30-5. Also available: http://patientsafety.pa.gov/ADVISORIES/Pages/201403_30.aspx.

16. Alexandrou E, Ray-Barruel G, Carr PJ, Frost SA, Inwood S, Higgins N, Lin F, Alberto L, Mermel L, Rickard CM, OMG Study Group. Use of short peripheral intravenous catheters: characteristics, management, and outcomes worldwide. *J Hosp Med*. 2018 May 30;13(5) Also available: http://dx.doi.org/10.12788/jhm.3039. PMID: 29813140.

17. Nagpal AS, Benfield JA, Dy RT. Longitudinal tear of the biceps brachii from peripheral intravenous catheter infiltration. *Muscles Ligaments Tendons* J. 2015 Apr-Jun;5(2):120-3. PMID: 26261791.

18. Davis J. Central-line-associated bloodstream infection: comprehensive, data-driven prevention. *Pa Patient Saf Advis*. 2011 Sep;8(3):100-5. Also available: http://patientsafety.pa.gov/ADVISORIES/Pages/201109_100.aspx.

19. Marco M, Roman-Pognuz E, Anna B, Alessio S. Air embolism after central venous catheter removal: fibrin sheath as the portal of persistent air entry. *Case Rep Crit Care*. 2013;2013:403243. Also available: http://dx.doi.org/10.1155/2013/403243. PMID: 24829822.

20. Rambhatla T, Miller A, Mina B. Central venous catheter removal: a procedure well performed? *Chest*. 2014 Oct;146(4 Suppl 2):565A. Also available:

https://journal.chestnet.org/article/S0012-3692(16)49823-5/pdf.

21. Al-Benna S, O'Boyle C, Holley J. Extravasation injuries in adults. *ISRN Dermatol*. 2013 May 8;2013:856541. Also available: http://dx.doi.org/10.1155/2013/856541. PMID: 23738141.

22. Doellman D, Hadaway L, Bowe-Geddes LA, Franklin M, LeDonne J, Papke-O'Donnell L, Pettit J, Schulmeister L, Stranz M. Infiltration and extravasation: update on prevention and management. *J Infus Nurs*. 2009 Jul-Aug;32(4):203-11. Also available: http://dx.doi.org/10.1097/NAN.0b013e3181aac042. PMID: 19605999.

23. Intravenous therapy: risk of injury from inflitration. *PSO Navigator*. 2011 Feb;3(1):1-8.

24. Kagel EM, Rayan GM. Intravenous catheter complications in the hand and forearm. *J Trauma*. 2004 Jan;56(1):123-7. PMID: 14749578.

25. Ray-Barruel G, Polit DF, Murfield JE, Rickard CM. Infusion phlebitis assessment measures: a systematic review. *J Eval Clin Pract*. 2014 Apr;20(2):191-202. Also available: http://dx.doi.org/10.1111/jep.12107. PMID: 24401116.

26. Parienti JJ, Mongardon N, Megarbane B, Mira JP, Kalfon P, Gros A, Marque S, Thuong M, Pottier V, Ramakers M, Savary B, Seguin A, Valette X, Terzi N, Sauneuf B, Cattoir V, Mermel LA, du Cheyron D, 3SITES Study Group. Intravascular complications of central venous catheterization by insertion site. *N Engl J Med*. 2015 Sep 24;373(13):1220-9. Also available: http://dx.doi.org/10.1056/NEJMoa1500964. PMID: 26398070.

27. Bowdle A. Vascular complications of central venous catheter placement: evidence-based methods for prevention and treatment. *J Cardiothorac Vasc Anesth*. 2014 Apr;28(2):358-68. Also available: http://dx.doi.org/10.1053/j.jvca.2013.02.027. PMID: 24008166.

28. Tsotsolis N, Tsirgogianni K, Kioumis I, Pitsiou G, Baka S, Papaiwannou A, Karavergou A, Rapti A, Trakada G, Katsikogiannis N, Tsakiridis K, Karapantzos I, Karapantzou C, Barbetakis N, Zissimopoulos A, Kuhajda I, Andjelkovic D, Zarogoulidis K, Zarogoulidis P. Pneumothorax as a complication of central venous catheter insertion. *Ann Transl Med*. 2015 Mar;3(3):40. Also available: http://dx.doi.org/10.3978/j.issn.2305-5839.2015.02.11. PMID: 25815301.

29. Hewlett AL, Rupp ME. New developments in the prevention of intravascular catheter associated infections. *Infect Dis Clin North Am*. 2012 Mar;26(1):1-11. Also available: http://dx.doi.org/10.1016/j.idc.2011.09.002. PMID: 22284372.

30. Chopra V, O'Horo JC, Rogers MA, Maki DG, Safdar N. The risk of bloodstream infection associated with peripherally inserted central catheters compared with central venous catheters in adults: a systematic review and meta-analysis. *Infect Control Hosp Epidemiol*. 2013 Sep;34(9):908-18. Also available: http://dx.doi.org/10.1086/671737. PMID: 23917904.

31. Maki DG, Kluger DM, Crnich CJ. The risk of bloodstream infection in adults with different intravascular devices: a systematic review of 200 published prospective studies. *Mayo Clin Proc*. 2006 Sep;81(9):1159-71. PMID: 16970212.

32. Magill SS, O'Leary E, Janelle SJ, Thompson DL, Dumyati G, Nadle J, Wilson LE, Kainer MA, Lynfield R, Greissman S, Ray SM, Beldavs Z, Gross C, Bamberg W, Sievers M, Concannon C, Buhr N, Warnke L, Maloney M, Ocampo V, Brooks J, Oyewumi T, Sharmin S, Richards K, Rainbow J, Samper M, Hancock EB, Leaptrot D, Scalise E, Badrun F, Phelps R, Edwards JR, Emerging Infections Program Hospital Prevalence Survey Team. Changes in prevalence of health care-associated infections in U.S. hospitals. *N Engl J Med*. 2018 Nov 01;379(18):1732-44. Also available: http://dx.doi.org/10.1056/NEJMoa1801550. PMID: 30380384.

33. 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 Mar;3(2):ofw072. Also available: http://dx.doi.org/10.1093/ofid/ofw072. PMID: 27191005.

34. Deutsch E. Safety stories: it takes a village. *Pa Patient Saf Advis*. 2018 Dec;15(4) Also available: http://patientsafety.pa.gov/ADVISORIES/Pages/201812_SafetyStories_Village.aspx.

35. Wallace SC, Mamrol C, Finley E. Promote a culture of safety with good catch reports. *Pa Patient Saf Advis*. 2017 Sep;14(3) Also available: http://patientsafety.pa.gov/ADVISORIES/Pages/201709_goodcatch.aspx.

36. Marella W. Why worry about near misses? *Patient Saf Qual Healthc*. 2007 Sep-Oct; Also available: https://www.psqh.com/sepoct07/nearmisses.html.

37. Zhang L, Cao S, Marsh N, Ray-Barruel G, Flynn J, Larsen E, Rickard CM. Infection risks associated with peripheral vascular catheters. *J Infect Prev*. 2016 Sep;17(5):207-13. Also available: http://dx.doi.org/10.1177/1757177416655472. PMID: 28989482.

38. Medical Care Availability and Reduction of Error (MCARE) Act of March 20, 2002, P.L. 154, No. 13, Cl. 40. Available: http://www.legis.state.pa.us/cfdocs/legis/li/uconsCheck.cfm?yr=2002&sessInd=0&act=13.

39. Boschi R, Rostagno E. Extravasation of antineoplastic agents: prevention and treatments. *Pediatr Rep*. 2012 Jul;4(3). Also available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4227315/

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