

Implementation of a Phlebitis Prevention Bundle on a Neurotrauma Critical Care Unit

Alexandra W. Del Barco

Under Supervision of

Maranda Jackson-Parkin

Second Reader

Renee Franquiz

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Abstract

Problem: Peripheral intravenous catheter (PIVC) associated phlebitis is a significant cause of morbidity leading to increased healthcare costs, prolonged lengths of stay, additional medical treatments, and increased mortality. Phlebitis, an inflammation of the vein, presents as redness, pain, warmth, streak formation, or a palpable cord. Annually, 80,000 patients with catheter-related blood stream infections are admitted to intensive care units; a large portion of these are attributed to PIVC phlebitis. The Society of Infusion Nurses supports the removal of emergently placed PIVCs and early detection of phlebitis. A neurotrauma critical care (NTCC) unit identified 68 cases of phlebitis over a 17-month period (M=4). PIVCs that are emergently placed or used for vesicant medication infusions are critical risk factors. **Purpose:** The purpose of this quality improvement (QI) project was to implement a Phlebitis Prevention Bundle (PPB) in a 13-bed NTCC unit of a major academic urban trauma center, determine adherence to the practice change, and monitor the incidence of phlebitis following vesicant-prone medications. **Methods:** This project was implemented over 15-weeks following education and training of the project champions and Registered Nurse (RN) staff (N=40). The PPB consisted of two practice changes, specifically the removal of emergently placed PIVCs, within 24 hours of admission to the unit and education pertaining to assessment of phlebitis, knowledge of common vesicants and documentation. Registered nurses completing the PPB training were recognized with a pin and certificate. **Results:** Registered nurses (n=40) completed education and training. Following educational sessions, adherence to the PPB reached 100% by Week 4 and was sustained for the last 9 weeks at 100%. During implementation, 25 (62.5%) PIVC were removed for early phlebitis, despite an increase in the mean incidence (M=13). **Conclusions:** Implementation of the PPB has the potential to increase quality of care for trauma patients and decrease the

incidence of late phlebitis and its associated complications. Nursing assessment of phlebitis and its related complications has improved RN awareness prompting earlier removal of phlebitis PIVCs. Weekly display of PPB data using run charts helped to communicate practice change efforts, improve RN adherence, which in turn promoted acceptance and sustainability of the practice change.

Implementation of a Phlebitis Prevention Bundle in a Critical Care Unit

Peripheral intravenous catheters (PIVC) are common medical devices used in over one billion hospitalized patients worldwide with potential complications such as phlebitis. The literature estimates the incidence of phlebitis between 20 to 80% (Ray-Burrue et al., 2019; Alexandrou et al., 2018; Heng et al., 2020). Phlebitis is an inflammation of the vein that presents as redness, pain, warmth, streak formation, or a palpable cord (Gorski et al., 2016). Many factors increase the risk of developing phlebitis such as type of infusate and emergently placed PIVCs (Heng et al., 2019; Gorski et al., 2016). Phlebitis can develop into thrombophlebitis or deep vein thrombosis (DVT) leading to life-threatening complications such as bacteremia, sepsis, acute endocarditis, and septic pulmonary emboli (Heng et al., 2020). Prospective and randomized trials have reported an occurrence of 80,000 CRBSIs in intensive care units with an estimated total of 250,000 cases of bloodstream infections annually (O'Grady et al., 2011). Current practice does not include removal of these "high-risk" PIVCs (see Figure 3). The trauma patient population is prone to developing phlebitis due to the need for intravenous access during resuscitative or other life-saving events. Secondly, the use of intravenous medications, with vesicant properties may induce phlebitis. While the central venous route may dilute the effects of vesicant medications, PIVCs offer the most expedient route of administration in emergent or life-saving situations. Key stakeholders and leadership within the institution identified the need for an intervention to reduce the incidence of phlebitis after identifying 68 cases of phlebitis over a 17-month period (M=4), 35% of which were placed in the trauma admitting unit, outside hospital (OSH), or by emergency medical services (EMS) and 71% with exposure to the vesicants hypertonic saline (HTS), vancomycin, or potassium chloride.

The purpose of this quality improvement (QI) project was to implement and evaluate the use of an evidence-based phlebitis prevention bundle (PPB) in the trauma population on the NTCC unit (Figure 4). The PPB included a practice change to remove all PIVCs inserted external to the NTCC within 24 hours of admission. Secondly, to educate NTCC staff to recognize, assess, and document phlebitis and risk associated with vesicant prone medications.

Literature Review

A comprehensive literature search was conducted to identify the evidence supporting the use of bundles for the prevention of phlebitis in adults in the acute hospital setting. The literature review identified evidence to support components of the PPB such as education on removing emergently placed lines, assessment of phlebitis, and risk factors of phlebitis such as vesicants. Melnyk and Fineout-Overholt's (2014) rating system was used to determine the level of evidence, while the quality of evidence was established by using Newhouse's (2006) quality of evidence rating system (Table A1 and A2).

The following studies researched the effectiveness of bundles and educational programs on phlebitis rates and associated complications such as bloodstream infections and bacteremia. Studies analyzed for this QI project were conducted in various adult inpatient settings. Ray-Barruel et al. (2019) conducted a systematic review evaluating 13 randomized controlled trials and nonrandomized observational studies and found that 12 of the studies reported reductions in phlebitis and bloodstream infections. The studies varied in bundle components, implementation strategies used, and interventions targeted at PIVC insertion or maintenance. Implementation strategies included in-services, lectures, bedside training, nursing huddles, and leaflets.

Mestre et al. (2013), Chiu et al. (2015), and Saliba et al. (2018) evaluated the effectiveness of different bundles and found bundles reduced the incidence of PIVC phlebitis and

bloodstream infections. Mestre et al. (2013), a quasi-experimental study evaluated a bundle in medical-surgical and intensive care unit settings. Chiu et al. (2015), a retrospective, observational case control study, evaluated a standard operating procedure to prevent phlebitis in a pre-operative setting.

Finally, Saliba et al. (2018), a prospective cohort study, evaluated a PIVC insertion and maintenance bundle to prevent PIVC-related bloodstream infections in wards of a single tertiary university hospital. Rhodes et al. (2016) and Ruegg et al. (2018) found that different prevention programs aimed at PIVC complications were effective at reducing phlebitis and healthcare-associated *Staphylococcus aureus* bacteremia. Both studies implemented QI projects in different settings; Rhodes et al. (2016) in the intensive care unit and Ruegg et al. (2018) in the emergency department. The lack of standardized interventions used in the bundles or prevention programs was a limitation noted across several of the reviewed studies.

Prevention bundles for phlebitis need to target risk factors for developing phlebitis. Heng et al. (2020) conducted a systematic review evaluating 25 studies to identify risk factors for phlebitis such as PIVCs placed in the emergency department and vesicant medications. The studies included in their systematic review included adult patients in varying settings such as medical and surgical wards. These risk factors were supported by additional studies. Furtado et al. (2011) and Stuart et al. (2013), both prospective cohort studies, found emergency department placed PIVCs were risk factors for phlebitis and healthcare-associated staphylococcus aureus bacteremia. Salgueiro-Oliveira et al. (2012), a prospective observational cohort study, found that potassium chloride and antibiotics were risk factors for phlebitis. These studies were used to provide support for the removal of emergently placed PIVCs in the trauma admitting unit, the

field by EMS, or OSH. They also support the need to educate staff on vesicant medications that pose a risk for phlebitis.

The overall quality of the literature was remarkable due to the consistency in results, consideration of prognostic factors and confounding variables, and evidence of author's expertise among majority of the studies. Four of the studies had low quality of evidence due to study design lacking randomization, lacking generalizability, lack of meta-analysis, and small sample size. The systematic review by Heng et al. (2020) had high quality evidence including both randomized controlled trials and nonrandomized controlled trials and included a limited meta-analysis. The sample size was small, but the results were consistent with an extensive literature review and definitive conclusions with expertise. The evidence evaluated clearly supports the use of bundles for the prevention of phlebitis including components that target risk factors such as emergency placed PIVCs and vesicant medications.

Theoretical Framework

Rogers' diffusion of innovation theory (1962) in Figure 1, explains the process of adoption of a new idea, behavior, or product by identifying different types of adopters in a population or social system (Lamorte, 2019). This theory is relevant to this QI project because achieving successful implementation requires 40 registered nurses with varying years of experience to adopt a change of practice over time. Implementation of the phlebitis prevention bundle will depend on innovators and early adopters, such as the project lead, QI champions, senior clinical and charge nurses, to influence late adopters in accepting the practice change and ensuring the staff is adhering to it. Relative advantage, compatibility, complexity, trialability, and observability are major concepts the phlebitis prevention bundle needs to have to influence adoption (Rogers, 1962). The PPB has evidence to support a relative advantage over the current

process. It is compatible with the unit, as leadership and nursing staff have recognized phlebitis to be a significant problem. The PPB was designed to be minimally complex and feasible with extensive literature to support its trialability and observability. The process of adoption can be described as an S-curve as seen in Figure 1.

Helfrich et al. (2007) recognizes organizational involvement and implementation effectiveness as essential aspects for innovation implementation through the Framework of Complex Innovations (Figure 2). Management support from the unit's leadership identified the need for an intervention to address phlebitis. This helped facilitate implementation policies and practices by providing praise for meeting goals such as 100% adherence and created an implementation climate by addressing phlebitis as an organizational priority. With a purpose to improve care for trauma patients by preventing phlebitis, the PPB aligns with the organization's values to provide quality care through a commitment to excellence. Innovation-values fit, and champions help with implementation and promote sustainability of the PPB, positively impacting the implementation climate. This allows for implementation effectiveness by achieving 100% adherence to the PPB.

Methods

This QI project was implemented in the NTCC unit of a level 1 trauma center in a major urban academic medical center. The NTCC is a unique 12-bed intensive care unit serving a specialized trauma population, primarily traumatic brain injury and spinal cord injury patients with injuries varying from falls to gunshot wounds. The intervention was equally distributed among patients admitted to the NTCC from the trauma admitting unit, the operating room, or post-anesthesia care unit. Exclusion criteria included patients admitted from the emergency department, patients upgraded from intermediate care units, patients with ultrasound placed

PIVCs, and patients deemed comfort care within 24 hours of admission. New trauma admissions to NTCC were identified and external lines were removed by nursing staff within 24 hours of admission. Nursing staff were expected to identify, document, and report cases of PIVC-associated phlebitis for all patients during the project period.

The PPB was implemented over several weeks utilizing different educational methods. The QI intervention proposal was initially introduced to RNs by PowerPoint presentation at a staff meeting held virtually using the Zoom platform. Then, upon the project Go-Live, one-on-one hands-on training was conducted with each nurse during his/her shift using the PPB education handout (Figure B1 and B2). Champions were the first to receive training to provide support throughout implementation. Hands-on training allowed for return demonstration of PIVC assessment and documentation. Once training was completed and to demonstrate meaningful recognition, nurses received a “decorative pin” (Figure B3) and a certificate (Figure B4). Various methods were used to measure the structure, process, and outcome measures of the project. The percentage of nursing staff educated was calculated on a weekly basis to determine the structural outcome. Nursing staff were signed off after completing training using a tracking sheet (Table C1). Champions aided in training some of the RNs and received a verbal quiz by the investigator to ensure understanding of the practice change and components of the PPB using the handout (Figure B1 and B2).

The process measures of nursing staff and individual nurse adherence were assessed by weekly chart reviews of the electronic health record (EHR) using adherence tracking tools (Table C2 and C3). To provide interdisciplinary support during day shift, the unit nurse practitioner (NP) and the Infectious Disease service were educated on the PPB to remind nursing staff to remove external lines during rounds. Reminders to report phlebitis were placed on all nursing

station computers (Figure B5). Additionally, a reminder for the NP was created and applied to her computer (Figure B6). The outcome measure of phlebitis cases was reported using a secure messaging system, Tiger Connect allowing the project lead to perform a chart review of the PIVC using a phlebitis tracking tool (Table C4). From these chart reviews, a balancing measure was used to differentiate early grade phlebitis (grade $\leq 2+$) from late grade phlebitis. Many strategies and tactics such as bi-weekly e-mail reminders and a poster run chart (Figure B7) of staff adherence were used to encourage adherence and phlebitis reporting. Adherence was calculated as a percentage and plotted using a run chart to assess for trends and identify if changes were needed. Food incentives were used to celebrate achieving 100% adherence. Tracking both adherence and RN staff education allowed assessment of the rate of adoption. The nurse with the most external PIVCs removed weekly was rewarded with a gift card. Tracking individual RN adherence was extracted from chart reviews as a strategy to support the practice change and phlebitis reporting. Both adherence and individual RN adherence were continually assessed because adoption of the PPB was important to achieving sustainability with the potential to decrease the incidence of phlebitis.

Prior to initiating this QI project, International Review Board approval was obtained to ensure the project was non-human research. Methods to protect human rights were used throughout implementation with the use of de-identified data collection. A staff education tracking sheet was kept in a locked drawer of the clinical site representative's office to protect nursing staff confidentiality. The chart reviews for all data collection were conducted on a password protected computer in the senior clinical nurse office to protect privacy and confidentiality. After completion of the project, the data was destroyed. International Review

Board approval was attained acknowledging this project as non-human subject's research determination.

Results

Outcomes achieved during the implementation of this practice change were facilitated by structural and process changes. Structural changes focused on the education provided to nursing staff with results plotted on a run chart (Figure 5). A total of 40 RNs completed education and training of the PPB. The run chart reflects the progression of RNs educated over a 5-week period increased from 62.5% to 95%. By the seventh week of the project start date, 100% of the RNs completed training.

Process changes included the implementation of the PPB and associated adherence to the practice change of removal of external PIVCs on new patients within 24 hours of admission. A total of 74 eligible patients were admitted during the project time frame. These patients were admitted with a total of 162 PIVCs with 61.1% (n= 99) placed in the trauma admitting unit, 21.6% (n=35) inserted in OSH, and 17.2% (n=28) inserted by EMS. By the end of the project, a total of 147 PIVCs were removed with 58.5% (n=86) from the trauma admitting unit, 22.4% (n=33) from the OSH, and 19% from EMS (n=28). Only 15 PIVCs were missed. The run chart (Figure 6) was very revealing as it showed a small 4-point trend with increasing adherence to 100% within the first 4 weeks of the project start date. There was a small decline in adherence during week 6 associated with short staffing. This was a persistent limitation throughout project implementation. The run chart also reveals adherence of 100% was sustained during the last 9 weeks of the project coinciding with the accomplishment of 100% staff education. As the percentage of RN staff completed training, adherence to the PPB practice change increased.

These results suggest that implementing a PPB with a practice change of removal of PIVCs within 24 hours is feasible and sustainable in a busy intensive care unit.

A total of 40 cases of phlebitis were reported during the project period. Characteristics of phlebitis by grade were calculated as percentages. Results demonstrated: 30% grade 1+ (n=12), 32.5% grade 2+ (n= 13), and 37.5% grade 3+ (15). A mean of 13 cases reported a month demonstrates an increased rate of phlebitis; however, an increased incidence of phlebitis is justified by a balancing measure identifying early phlebitis with a measure of a grade $\leq 2+$. Of the 40 cases, 62.5% (n=25) were classified as early phlebitis cases indicating nursing staff were detecting phlebitis early which is essential for prevention of phlebitis and its associated complications. Additional characteristics of the phlebitis cases collected included vesicant administration: 21.7% (n= 10) received none, 26.1% (n=12) received hypertonic saline, vancomycin, or potassium chloride, and 52.2% (n=24) received unknown IV meds or a different kind of vesicant. A run chart (Figure 7) was used to plot the number weekly cases of phlebitis and a separate run chart plotted number of the early cases of phlebitis (Figure 8). Run chart data depicting incidence of phlebitis identified useful observations but lacked significant trends and shifts. At Week 8, 55.5% (n=10) of the initial 18 cases of phlebitis reported were grade 3+ or late phlebitis. To incentivize staff to report phlebitis at an earlier stage (grade 2+ or 1+), nurses that reported phlebitis and removed PIVCs for concern of phlebitis were included to be eligible for the weekly gift card. The balance run chart (Figure 8) shows no trends or shifts with the expected number of runs, likely due to random variation. There is one astronomical data point in week 2 with 4 reported cases of phlebitis with a grade $\leq 2+$.

Discussion

Despite the anticipated challenges of implementing a quality improvement project during a pandemic, implementation of a PPB proved to be a feasible and sustainable practice change to improve RN awareness and reporting of phlebitis. Adherence to the removal of external PIVCs within 24 hours of admission on new patients was a practical change that RNs integrated into their workflow and sustained in their practice. Additionally, 100% adherence was accomplished prior to 100% of nursing staff completing training indicating the innovators and early adopters had a strong influence on late adopters. A strength of this study was the use of champions, the majority of which worked night shift. Because most patients were admitted on night shift, having a strong group of champions working when admissions were coming in was essential to the project's success and sustainability. Although the monthly average of phlebitis cases increased from 4 pre-implementation to 13 post-implementation, majority of the phlebitis cases reported were identified early indicating that the PPB was effective at improving RN recognition of phlebitis. Early phlebitis identification is essential to preventing phlebitis from leading to life-threatening complications.

There were multiple factors that limited this QI initiative. First, the project took place over a short period of time preventing a larger sample size from being attained. Additionally, during the project period, the NTCC "downsized" a bed becoming a 12 bed ICU. Second, short staffing likely impacted accurate documentation and reporting of phlebitis both of which were extracted using chart reviews from the EHR. This was especially important when reviewing vesicant administration as this was highly dependent on nursing linking the medication administered to the PIVC the medication was administered through. Finally, there was some subjectivity associated with phlebitis grading that could have impacted the accuracy of the data collected. Efforts were made to minimize inaccuracies of phlebitis documentation and

assessment through follow-up with RNs and frequent presence on the unit. Despite these limitations, the project was successful because it demonstrated the PPB was feasible to implement and sustain. This is significant if the inpatient step-down floors implement the PPB to decrease complications from phlebitis.

Conclusion

The implementation of a PPB has yielded numerous quality care outcomes that will benefit persons with requiring emergent care and strengthen nursing practice. This project did not demonstrate the original objective of reducing the incidence of phlebitis. However, it successfully demonstrated that implementing a PPB can decrease the incidence of late phlebitis and increase RN awareness on phlebitis assessment. The project also demonstrated that the PPB is a feasible and sustainable by accomplishing the outcome of 100% adherence for a total of 11 out of the 15-week project. It also increased RN awareness and reporting of phlebitis causing an increased incidence of phlebitis majority of which was classified as early phlebitis. These findings are vital in reducing complications from phlebitis for neurotrauma patients that are twice as likely to develop phlebitis due to risks of emergency placed lines and vesicant administration. This will also allow for an improvement in quality of care in this patient population. The support from key stakeholders, unit leadership, and champions was essential to sustainability and will be needed for potential spread to other units within the hospital.

While this project occurred in a limited timeframe, it will inform future implementations of bundles of potential facilitators and barriers encountered. Suggestions for future implementations include additional structural changes that can be implemented into hospital policy and the EHR using an RN notify order to remove external lines within 24 hours of admission. Additionally, phlebitis auditing should be made as a quality indicator to sustain

importance and reinforcement of the practice change implemented through the PPB. These future implications will ensure sustainability for future projects.

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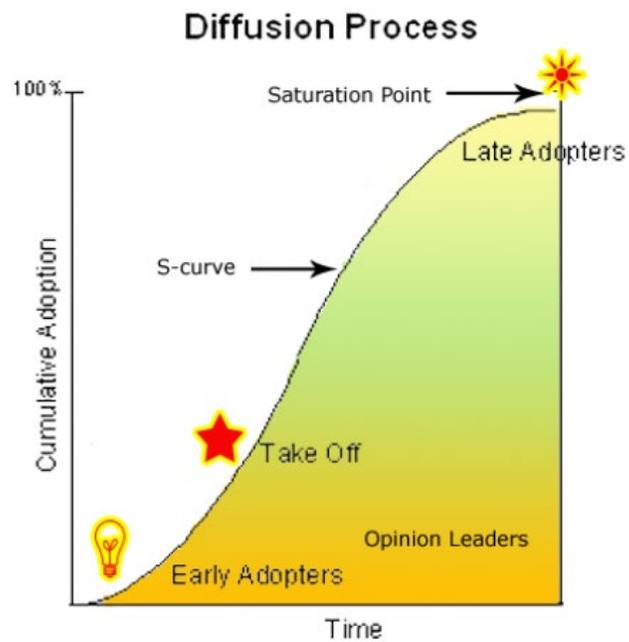
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Figures

Figure 1

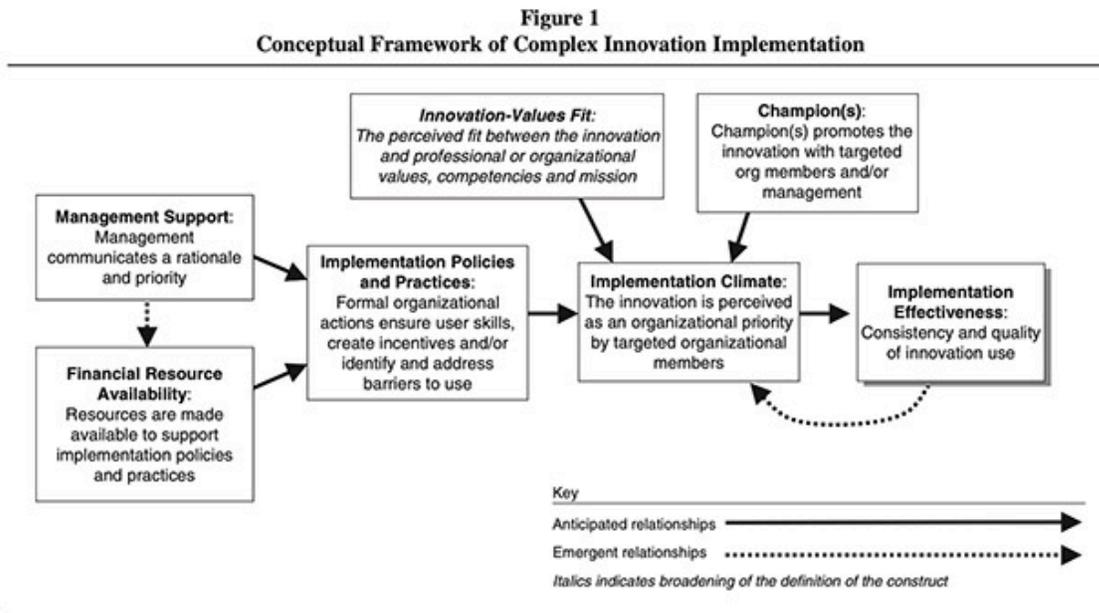
Rogers' Diffusion of Innovation



Note. Obtained from Kaminski, L. (2011)

Figure 2

Framework for Complex Innovations



Source: Adapted from Klein and Sorra (1996, 1056).

Note. Obtained from Helfrich et al. (2007).

Figure 3

Current (pre-implementation) Peripheral Intravenous Catheter Maintenance Process

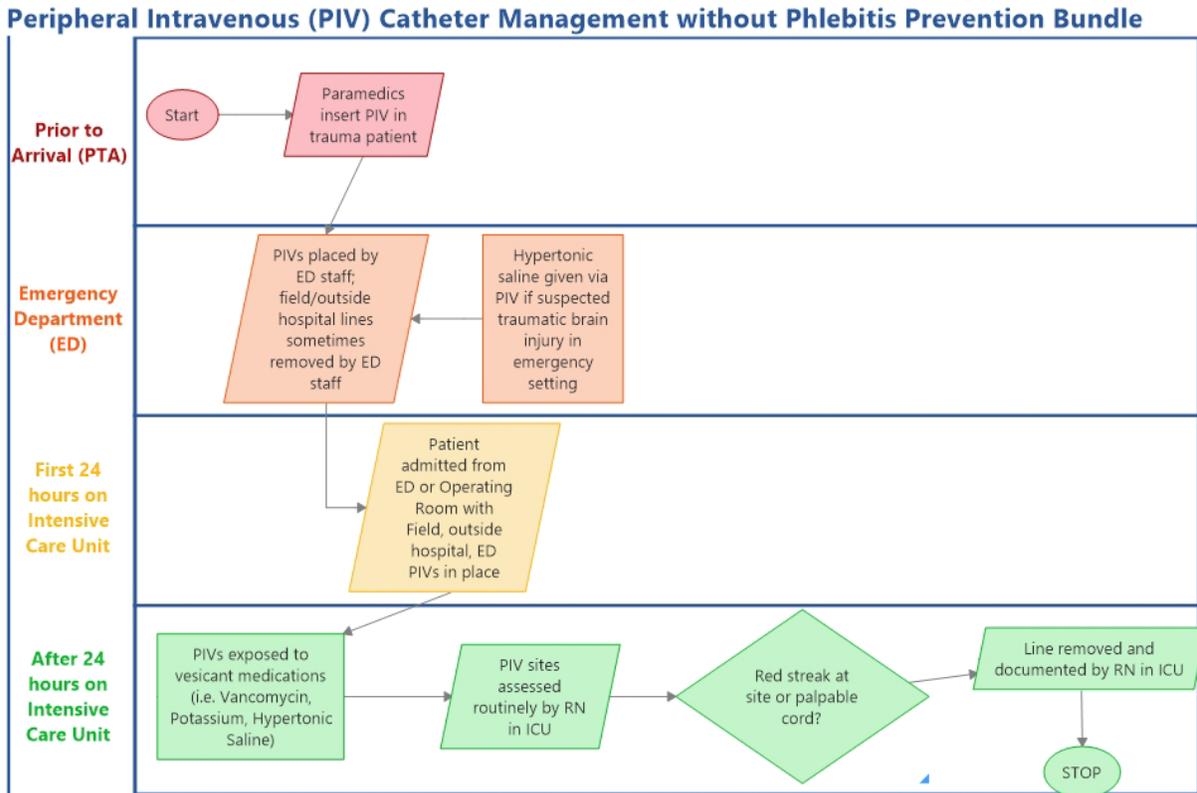


Figure 4

Implemented Peripheral Intravenous Catheter Maintenance Process

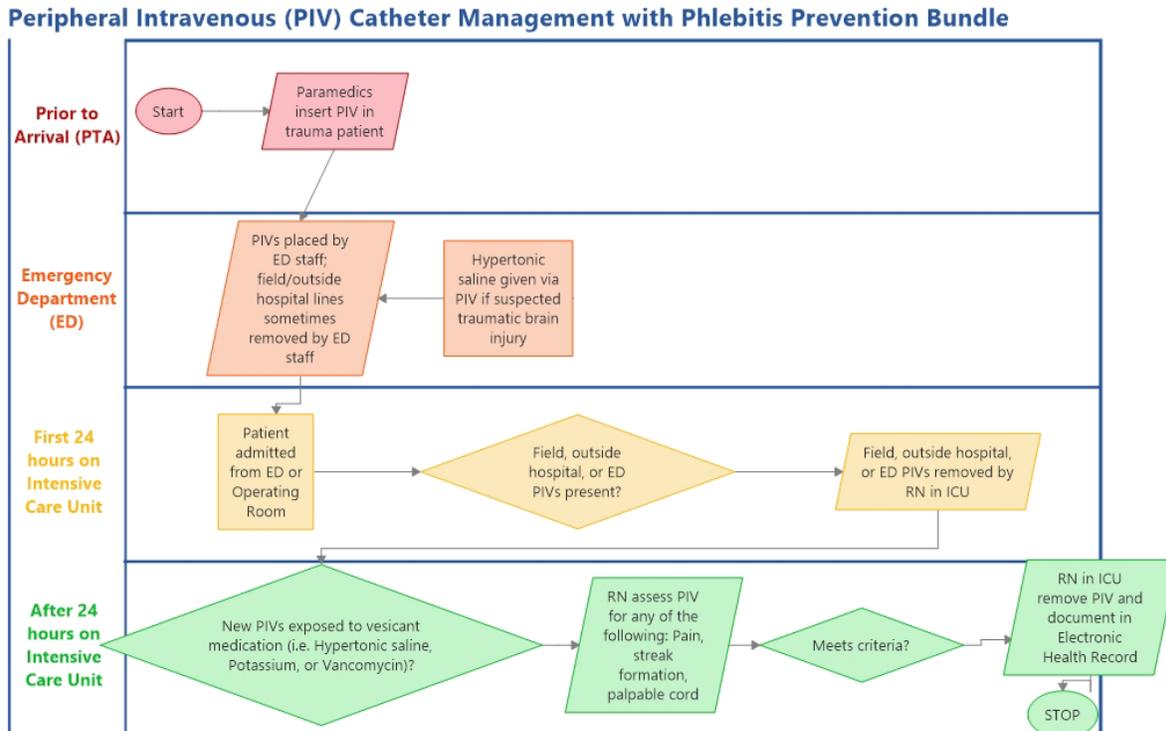


Figure 5

RN Staff Educated on PPB

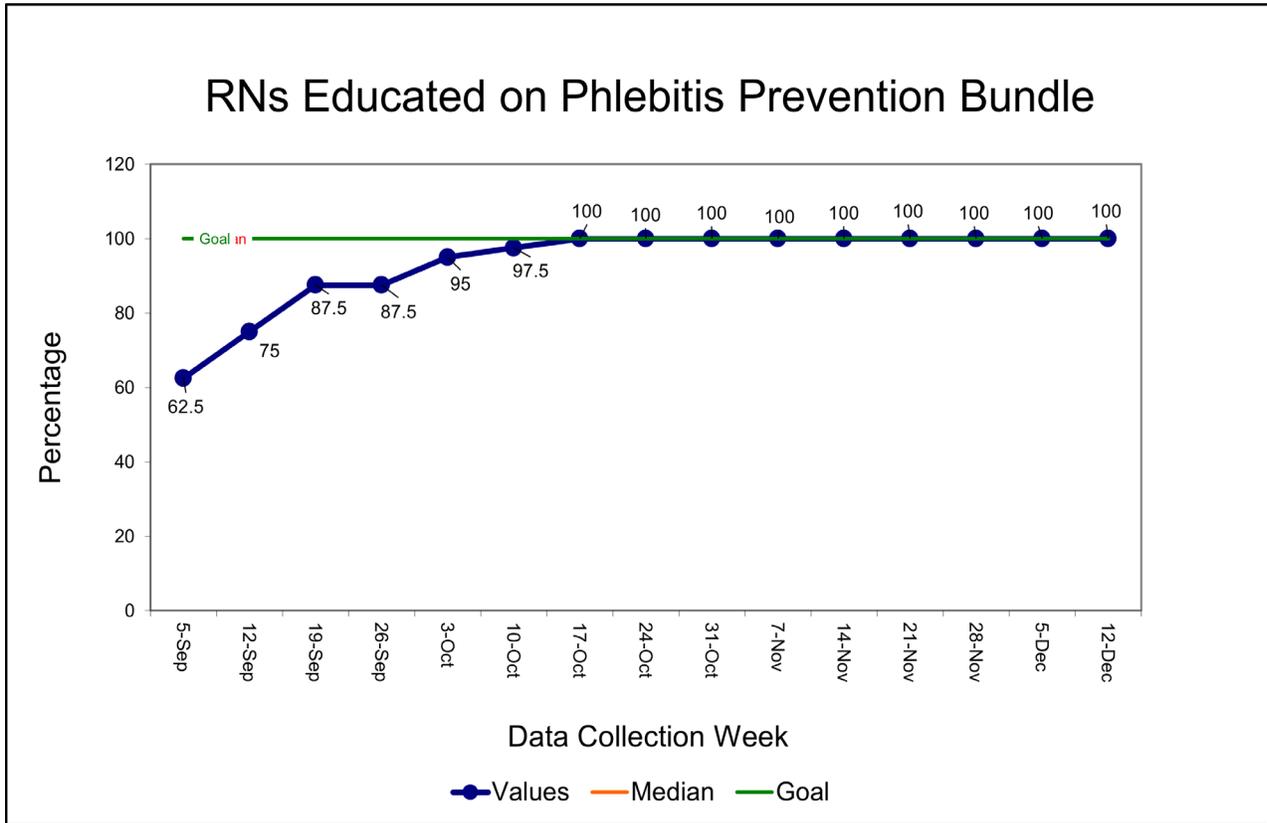


Figure 6

Staff Adherence to the PPB

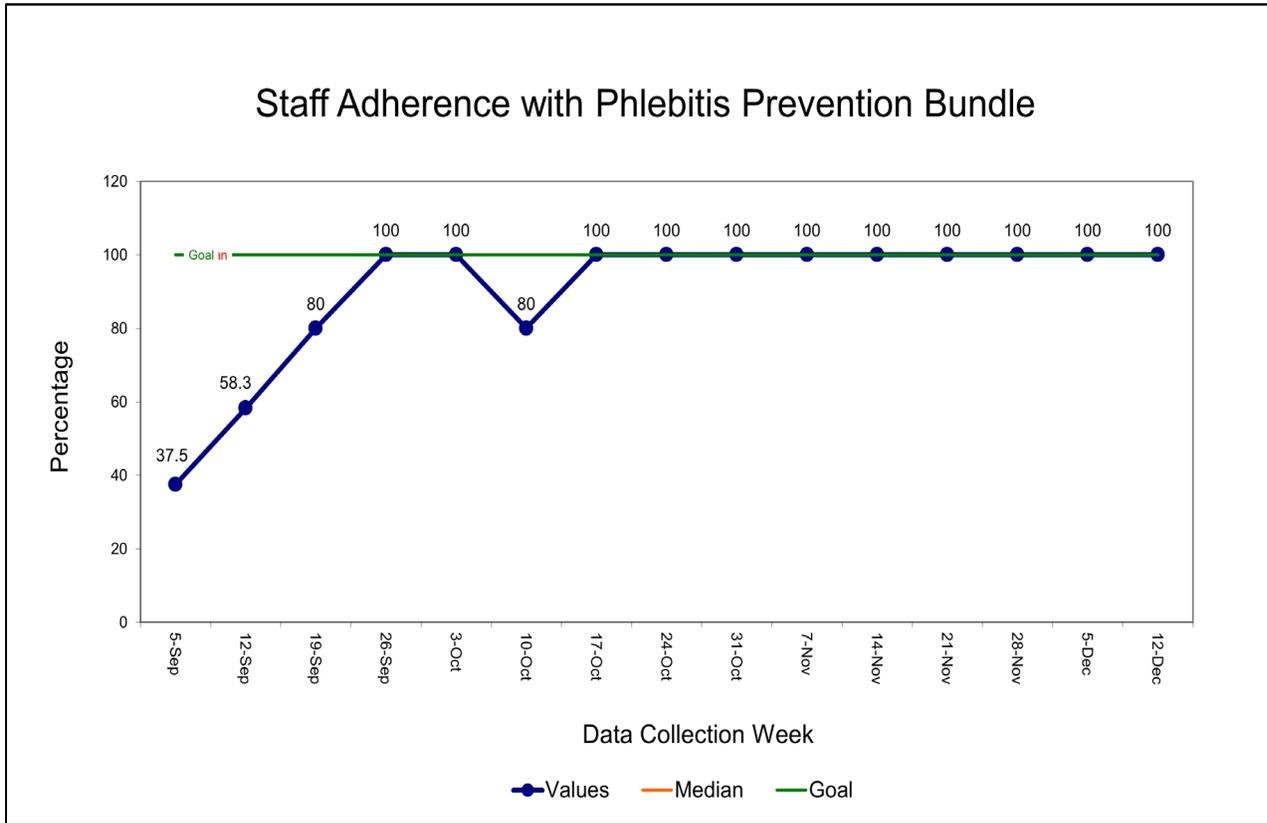


Figure 7

Weekly Cases of Phlebitis

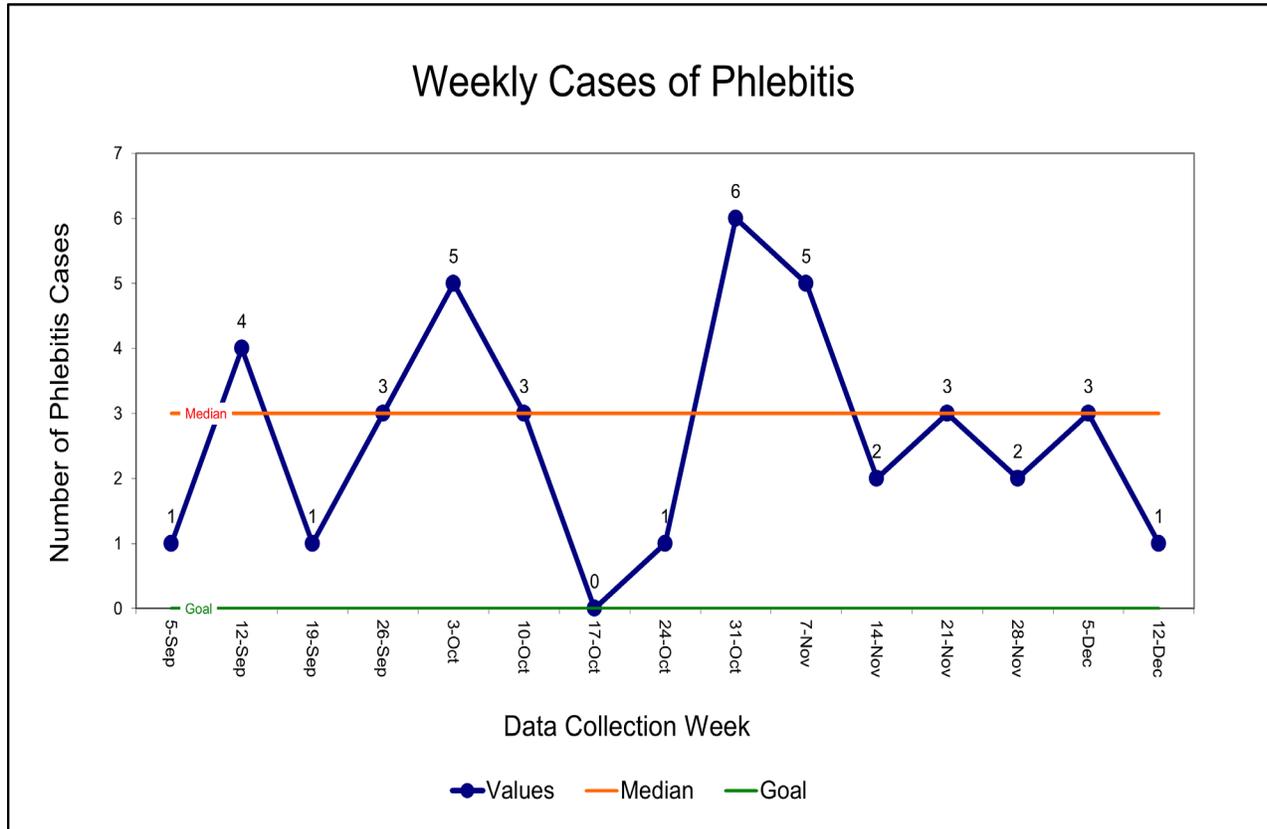
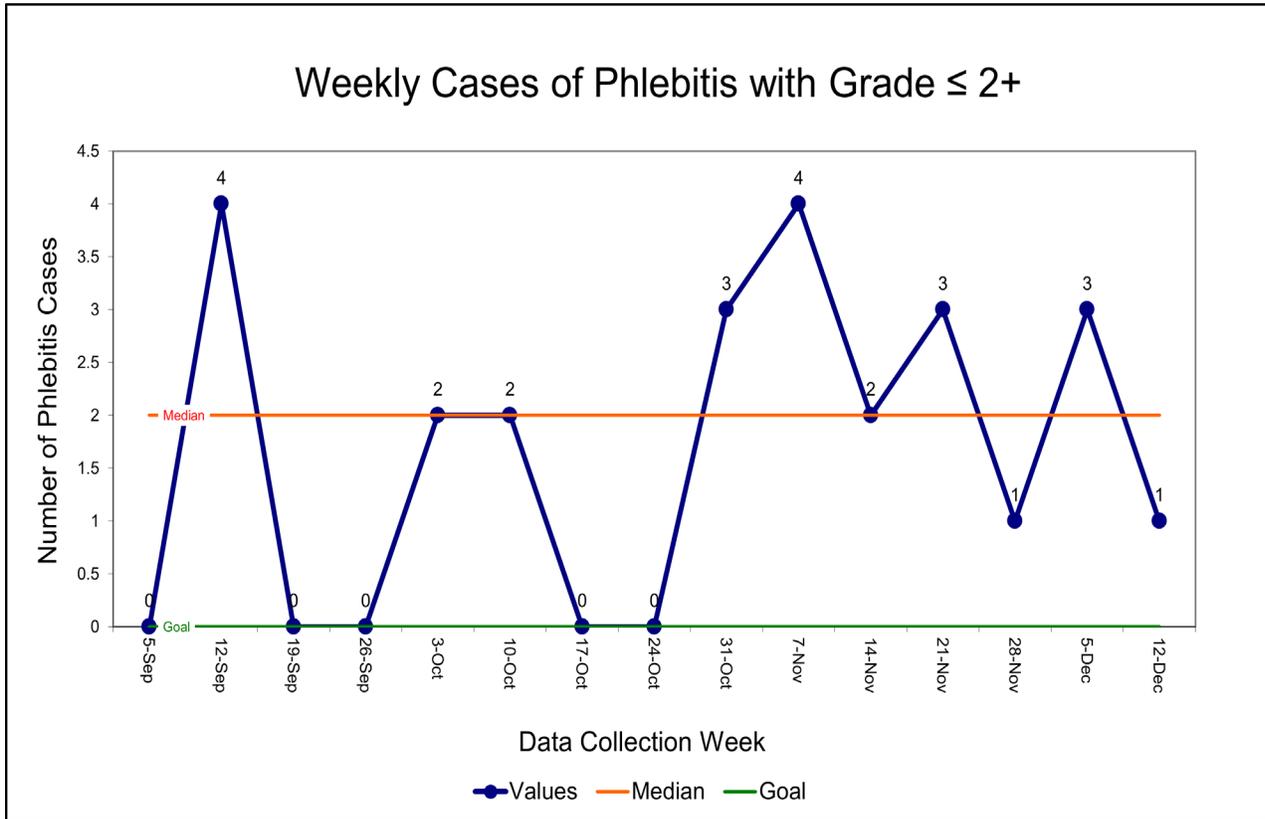


Figure 8

Weekly Cases of Early Phlebitis



Appendix A

Table A1.

Literature Review

Citation: Chiu, P.-C., Lee, Y.-H., Hsu, H.-T., Feng, Y.-T., Lu, I.-C., Chiu, S.-L., & Cheng, K.-I. (2015). Establish a perioperative check forum for peripheral intravenous access to prevent the occurrence of phlebitis. Kaohsiung Journal of Medical Sciences, 31(4), 215–221. https://doi-org.proxy-hs.researchport.umd.edu/10.1016/j.kjms.2015.01.007					Level IV
Purpose/ Hypothesis	Design	Sample	Intervention	Outcomes	Results
“The objective of the study was to investigate the epidemiology of peripheral vein complications and to set up a standard operating procedure (SOP) for the maintenance of peripheral vein catheter patency and the prevention of IV catheter-related complications.”	Retrospective, observational case control study	<p>Sampling Technique: Convenience</p> <p>Eligible Participants: 15,813 patients undergoing anesthesia at the Kaohsiung Medical University Hospital</p> <p>Excluded: 895 outpatient anesthesia patients and 236 patients receiving anesthesia outside of the operation room</p> <p>Accepted: 14,682 patients enrolled with peripheral lines inserted during operation between April 2010 and January 2011</p> <p>Control: 1,340 patients included in the 1-month pretest in April 2010</p>	<p>Control Protocol: Preintervention group did not have peripherals inserted using SOP</p> <p>Intervention Protocol: Intervention group received SOP peripheral placement observed over 9 month period divided into “notification” phase May 2010-July 2010, “observation” phase August 2010 to October 2011, and “end” phase November 2010 to January 2011</p> <p>Treatment fidelity: On admission ward nurses would follow SOP for setting up peripheral IV catheter before surgery. The SOP included:</p>	<p>DV: Phlebitis was graded using the Baxter Scale</p> <p>Measurement tool (reliability) time, procedure: The severity of phlebitis was graded as follows: Grade 0, no pain, no erythema, swelling, induration, or cord; Grade 1, pain at IV site or erythema, no swelling, induration, or cord; Grade 2, pain at IV site with erythema or some swelling, no induration or cord; Grade 3, pain at IV site with erythema, swelling, and induration or a palpable cord of <7.62 cm; Grade 4, pain at IV site with erythema, swelling, induration, and a palpable cord of >7.62 cm; and Grade 5, frank vein thrombosis and all the signs of Grade 4.</p>	<p>Statistical Procedures(s) and Results: SPSS was used to perform statistical analysis.</p> <p>Analyses of categorical variables were performed using Chi-square or Fisher’s exact test- 52% were male and 33.8% were elder (>61 years old)</p> <p>Continuous data analyzed using Student t test-significant difference (p<0.001) of IV therapy related adverse events among phases (0.78% in notification phase, 0.43% in observation phase, and 0.13% in end phase)</p> <p>Association of parameters with phlebitis using logistic regression with statistical significance defined as p < 0.05;</p>

		<p>Intervention: 13,342 patients enrolled in the study group.</p> <p>Power analysis: No power analysis completed.</p> <p>Group Homogeneity: No group homogeneity was completed</p>	<p>washing hands with hand sanitizer first, using aseptic site prep, use of a 22 or 20 gauge IV, use of transparent adhesive film to cover the site. Peripherals were repositioned every 3 days. Every patient would have a PIVC checklist completed (patency, date, site complications, rate, line setup). Before induction of anesthesia, sign-in procedure includes checking for IV patency, drug accuracy, and safety. Day after surgery the IV sites are examined by CRNAs for presence of phlebitis using grading scale</p>	<p>Limitations: Retrospective single academic medical center study with nurse anesthetists and may not be generalizable.</p>	<p>phlebitis was associated with age</p> <p>Overall reduced incidence of IV therapy adverse events including line obstruction, disconnection, line mismanagement, phlebitis from 0.75% before the study to 0.13% after the study</p>
<p>Citation: Furtado, L. C. do R. (2011). Incidence and predisposing factors of phlebitis in a surgery department. <i>British Journal of Nursing</i>, 20(Sup7), S16–S25.</p>					<p>Level IV</p>
Purpose/Hypothesis	Design	Sample	Intervention	Outcomes	Results
<p>“The aim of this study was to determine the incidence of phlebitis associated with peripheral cannulae in a general surgery department, as well as the factors which are potentially associated with its development.”</p>	<p>Prospective cohort study</p>	<p>Sampling Technique: Convenience</p> <p>Eligible Participants: 357 patients of the general surgery department at Divino Espirito Santo Hospital</p> <p>Excluded: Patients with a history of intravenous drug abuse, undergoing</p>	<p>Control Protocol: No control group</p> <p>Intervention Protocol: This group was assessed for incidence of phlebitis</p> <p>Treatment fidelity: All nurses on the general surgery unit were trained for 6</p>	<p>DV: Phlebitis incidence</p> <p>Measurement tool (reliability), time, procedure: All patients were assessed using the Phlebitis Monitoring Scale developed by Jackson in 1998. The IV sites were routinely monitored at least three times a shift and</p>	<p>Statistical Procedures(s) and Results:</p> <p>SPSS v17.0 for Windows was used for data analysis</p> <p>Pearson’s Chi-squared and binary logistic regression tests analyzed potential predisposing factors of phlebitis such as dwell time, gauge size,</p>

		<p>chemotherapy or immunosuppressives drugs, history of previous venous thromboembolism, those whose medication or intravenous infusions were administered by infusion pump</p> <p>Accepted: 171 patients ≥18 years old, that had a peripheral cannula receiving infusions or intravenous drugs for at least 24 hours Control: No control group</p> <p>Intervention: 171 patients and 286 monitoring peripheral cannulae</p> <p>Power analysis: None</p> <p>Group Homogeneity: No control/intervention group comparison</p>	<p>hours on the use of the phlebitis assessment scale and data collection tool. They were involved in data collection and monitoring of the cannula site. The data collection included patient’s characterization, characters of the peripheral cannula, use of the cannula, and removal of the cannula.</p>	<p>before and after any IV drug was administered.</p> <p>Limitations: Elements of the cannulation procedure were not recorded; data was collected by all nursing staff despite receiving same training had potential to cause variations in the interpretation of phlebitis scale</p>	<p>emergency department placed, and anatomic location have a dependent association with incidence of phlebitis (p<0.05); Factors related to how the cannula was used such as for continuous infusion or administration of IV potassium and the type of medication revealed dependent relationship with phlebitis (p<0.05)</p> <p>Binary logistic regression used to determine which variables had a greater probability to result in the development of phlebitis-pre-existing diabetes (P=0.011), duration of cannula (P=0.000), and department where the catheter was inserted (P=0.038); catheters placed in a department other than general surgery had a higher risk of developing phlebitis with odds ratio of 1.879</p>
<p>Citation: Heng, S. Y., Yap, R. T.-J., Tie, J., & McGrouther, D. A. (2020). Peripheral Vein Thrombophlebitis in the Upper Extremity: A Systematic Review of a Frequent and Important Problem. <i>The American Journal of Medicine</i>, 133(4), 473–484. https://doi-org.proxy-hs.researchport.umd.edu/10.1016/j.amjmed.2019.08.054</p>					<p>Level V</p>
<p>Purpose/ Hypothesis</p>	<p>Design</p>	<p>Sample</p>	<p>Intervention</p>	<p>Outcomes</p>	<p>Results</p>
<p>“We performed a systematic review to determine the risk factors for peripheral vein thrombophlebitis in adult inpatients</p>	<p>Systematic review with meta-analysis</p>	<p>Search Strategy: We systematically searched academic databases of PubMed, Medline, and Embase using the terms “risk factors phlebitis,”</p>	<p>Control: Patients who did not develop thrombophlebitis</p> <p>Intervention:</p>	<p>DV: Researchers selected studies that reported risk factors of thrombophlebitis in the upper extremity in adult patients.</p>	<p>Level of Measurement: Meta-analysis is limited because of the range of different outcomes measured across the small number of existing trials.</p>

<p>receiving a peripheral intravenous catheter in the upper extremity.”</p>		<p>“infusion phlebitis risk,” “peripheral intravenous catheter infection risk,” and “septic phlebitis.” 6,910 studies were initially identified and screened for inclusion and exclusion criteria. Two review authors extracted data independently, discrepancies were identified and resolved through discussion with a third author where necessary. The third reviewer will supervise the process of the systematic review. Quality in Prognostic Studies tool was used to assess risk of bias of individual studies.</p> <p>Eligible Studies: Randomized controlled trials, cohort studies, prospective cohort studies, case control studies, cross-sectional studies, review articles, case reports, conference proceedings, and theses published between the inception of each database and May 20, 2019.</p> <p>Excluded: Non-English, not conducted in the adult population, not done on humans, and studies that</p>	<p>-Patient related factors: gender, presence of intercurrent illness, presence of comorbidities, underlying host susceptibility</p> <p>- Catheter related factors: Duration of PIVC, Size, Site, Quality of Insertion site, Location, Infusate</p> <p>-Health Care-Related Factors: Expertise of healthcare personnel, nursing care, and type of hospital</p> <p>Protocol: No applicable to SR technique</p>	<p>Measurement: Diagnostic criteria for peripheral venous catheter phlebitis using 1) Visual Infusion Phlebitis scale (VIP scale) / Jackson scale.</p> <p>Limitations: Possibility that some relevant studies were missed due to differing terminology for care bundles. Search was restricted to English language papers. All studies were quasi-experimental; not RCTs. Lack of reporting context in many of the studies prevents generalization of findings. Lack of meta-analysis due to varying bundle components and implementation strategies. Primary authors were not contacted for more information because variability of bundles and study periods prevented direct comparison of outcomes.</p>	<p>But studies using the same type of intervention and comparator with the same measured outcome, results were pooled using a random effects meta-analysis, with risk ratios/odds ratio/hazard ratios for binary outcomes, and calculate 95% confidence intervals and two-sided P values for each outcome. Odds ratio adjusted logistic regression analysis for meta-analysis on binary variables of thrombophlebitis</p> <p>Outcome Data Retrieval: Researchers pooled data from all included articles</p> <p>Analysis: Researchers pooled similar study results for meta-analysis and used a two-sided P value < 0.5 to consider significance.</p> <p>Conclusions: Female sex, presence of incurrent disease, diabetes, immunocompromised, malignancy, previous thrombophlebitis, burns, high Hgb, underlying host susceptibility were patient related factors found to have a (P<0.5); Catheter related factors: longer duration, larger bore size,</p>
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		<p>did not have a full text, focused on central venous catheter, peripherally inserted central catheters, septic pelvic thrombophlebitis, Lemierre syndrome, and venous thrombosis were excluded.</p> <p>Included: 25 studies that reported on risk factors of peripheral vein thrombophlebitis in the upper extremity in adult patients: 4 randomized controlled trials, 21 prospective observational studies with multivariate analysis. Data that were specific to peripheral vein thrombophlebitis and catheter-related infections were included.</p> <p>PRISMA: Included detailing decision-making criteria for retaining/omitting studies from the SR</p> <p>Power analysis: Not applicable to SR critique</p>			<p>lower extremity, forearm/antecubital location, bruised insertion site, emergency room, great number of catheters inserted, catheter material made of Teflon or FEP-Teflon were all factors with significant risk for phlebitis (P <0.5). Infusate of antibiotics, hypertonic solutions, potassium, and intravenous medications were also significant risk factors (P<0.5). Health care-related factors like house staff, less nursing care, and general hospital were significant risk factors (P <0.5). Recognition of these risk factors will allow for targeted strategies to aid in the prevention of phlebitis inclusive of closer monitoring of patients with these risk factors.</p> <p>SR Bias Risk: The risk of bias across studies is low.</p>
<p>Citation: Mestre, G., Berbel, C., Tortajada, P., Alarcia, M., Coca, R., Fernández, M. M., Gallemi, G., García, I., Aguilar, M. C., Rodríguez-Baño, J., & Martínez, J. A. (2013). Successful multifaceted intervention aimed to reduce short peripheral venous catheter-related adverse events: A quasiexperimental cohort study. <i>AJIC: American Journal of Infection Control</i>, 41(6), 520–526. https://doi-org.proxy-hs.researchport.umd.edu/10.1016/j.ajic.2012.07.014</p>					<p>Level IV</p>
<p>Purpose/ Hypothesis</p>	<p>Design</p>	<p>Sample</p>	<p>Intervention</p>	<p>Outcomes</p>	<p>Results</p>

<p>“To report the development, implementation, and results of a successful hospital- wide multifaceted strategy aimed to reduce adverse events related to PVC, mainly peripheral vein phlebitis (PVP) and PVC-related bloodstream infection (BSI) over a period of 7 years.”</p>	<p>A quasi-experimental cohort study</p>	<p>Sampling Technique: Convenience</p> <p>Eligible Participants: Patients in a 200-bed private hospital with 8 medical-surgical wards and a mixed 11-bed intensive care unit</p> <p>Excluded: None define</p> <p>Accepted: Patients with short (length < 3 inches) PVC inserted during 2004-2011</p> <p>Control: Preintervention period from January 2004 to February 2005; 120 patients and 180 PVC inserted on wards</p> <p>Intervention: Intervention period from March 2005 to December 2011; 1,511 patients with 2,145 PVC inserted on wards; 619 patients from 2005-2007, 892 patients from 2008-2011</p> <p>Power analysis: No power analysis completed.</p> <p>Group Homogeneity: No group homogeneity was completed.</p>	<p>Control Protocol: Preintervention group</p> <p>Intervention Protocol: Intervention group</p> <p>Treatment fidelity: Intervention-education and training from March 2005 to June 2005, bundle for appropriate maintenance of PVC from July 2005 to December 2011 included withdrawal of idle catheters, catheter exchange policy, and daily monitoring of PVP and PVP surveillance. Two different catheter replacement schedules were adopted: re-siting every 96 hours (July 2005-June 2008) and every 120 hours (July 2008-December 2011). Every November from 2005-2011 a period of prevalence surveillance monitoring of all PVCs inserted in wards was performed. Nurses filled out a daily questionnaire including dates of insertion and removal</p>	<p>DV: Quarterly dynamics of suspected PVC-related BSIs and incidence of PVP in preintervention and intervention periods. PVP was defined as any of the following criteria: Persistent pain referred to PVC (duration longer than 2 hours after the end of a given infusion) and/or erythema and/or swelling and/or induration (palpable cord) and/or purulence discharge at PVC insertion site. PVC-related BSIs were defined using modified CDC criteria: Bacteriemia/fungemia with at least 1 positive blood culture obtained from a peripheral vein, clinical manifestations of infection, and no apparent source for BSI except the device with or without positive tip or entry site swab culture. To consider the existence of clinical manifestations of infection, the presence of PVP was mandatory.</p> <p>Measurement tool (reliability), time, procedure: Surveillance of the health care acquired bacteremia audited by the infection control team during the study</p>	<p>Statistical Procedures(s) and Results:</p> <p>Statistical analysis was performed by using Microsoft Windows SPSS</p> <p>Poisson exponentially weighted moving average control chart was used to describe the dynamics of incidence over time of health care-acquired BSI because of S aureus, central venous catheter (CVC)-related BSIs, and PIVC related BSIs.</p> <p>Categorical variables were compared by c2 test or Fisher exact test - 48% relative reduction in phlebitis: pre 23.3%; [95% CI: 16.4-30.1] post 12.1% [95%CI 10.7-13.2]; (p<0.05)</p> <p>-15% of all PVCs were susceptible to routine re-siting procedure (320/2,145)</p> <p>-Adherence to routine re-siting catheter adherence significantly increased when a 120-hour schedule was adopted (from 30.8% [53/172] during 2005-2007 to 68.2% [101/148] during 2008-2011, P < .05).</p>
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			of the catheter, reasons for catheter removal, and severity of phlebitis according to a modified scale derived from the Infusion Nurses Society grading system and Tagar’s scale. Each questionnaire was supervised and validated by a specialist in epidemiology and infectious diseases or by a infection control nurse	Limitations: Single center quasi-experimental study that lacks generalizability and has uncontrolled confounding.PVC-BSIs may have been underestimated because blood and catheter cultures not routinely performed. Successful results could be related to regression to the mean	-81% (48/59) were CVC-related BSIs, and 19% (11/59) were PVC-related BSIs - PVC was the leading known etiology source of BSI (unknown, 37.5%; PVC-related, 28.1%; skin infection, 18.7%; and CVC-related, 15.6%). -PVC-related BSIs were caused by gram positive microorganisms (S aureus [n ¼ 9; 81%], coagulase-negative staphylococci [n ¼ 2; 18%]). -No PVC-related BSI was detected during any active surveillance period
Citation: Ray-Barruel, G., Xu, H., Marsh, N., Cooke, M., & Rickard, C. M. (2019). Effectiveness of insertion and maintenance bundles in preventing peripheral intravenous catheter-related complications and bloodstream infection in hospital patients: A systematic review. <i>Infection, disease & health, 24</i> (3), 152–168. https://doi.org/10.1016/j.idh.2019.03.001					Level V
Purpose/ Hypothesis	Design	Sample	Intervention	Outcomes	Results
“This systematic review aimed to: (i) systematically critique (and meta-analyse, if possible) evidence for the effectiveness of PIVC insertion and maintenance bundles to prevent BSI and catheter-related complications in hospital patients of all ages, and (ii) describe components of bundles,	Systematic review without meta-analysis conducted by two researchers	Search Strategy: Comprehensive searches were undertaken of electronic biomedical databases: MEDLINE, PubMed, CINAHL, EMBASE, Cochrane CENTRAL, and ISI Web of Science. Grey literature was searched via Google Scholar. Clinical trials registries searched. The words used to conduct search were	Control: Most studies had a pre-implementation group that was not exposed to the PIVC intervention Intervention: Interventions in the studies were predominantly bundles with 2-7 items. Most insertion bundles had 2% chlorhexidine	DV: Researchers selected articles with a primary outcome of infection related outcomes such as BSI, PIVC-related SA-BSI, phlebitis. Compliance with the bundle was a secondary outcome. Measure: Infections and PIVC complications were audited in most studies. Audits were used to track	Level of Measurement: Meta-analysis was not feasible due to the expected number and heterogeneity of care bundle components and implementation strategies. Instead the subgroup analyses were planned: (1) Bundle components that increase or reduce the intervention effect; (2) Electronic medical records vs paper-based bundles;

<p>implementation strategies, and reported compliance.”</p>		<p>“peripheral” “vascular” “venous” “intravenous” “intravascular” “catheter” “cannula” “device” “access” “IV” “IVC” “PIV” “PVC” “PVC” “SPC” “bundle” “program” “protocol” “checklist” “framework” “education” “quality” “improv” “prevent” “initiative” “collaborate” “manage” “strategy” “implement” “outcome” “effect” “attempt” “failure” “complication” “phlebitis” “infect” "insert" "maintain" "infiltrate" "extravasation" "thrombosis" "occlusion"</p> <p>This yielded 14,456 studies that had to be screened on inclusion and exclusion criteria. Researchers were not blinded to authors of studies. Two reviewers independently completed the quality assessment of each study and compared results. Discrepancies were resolved with discussion. The Downs and Black checklist was used to assess study methodology risk of bias. All reasons for inclusion and exclusion were documented.</p>	<p>gluconate skin prep, hand hygiene, vessel assessment/site selection, aseptic technique, integrates flossed catheter, and transparent film dressing. Most maintenance bundles included daily review of need for PIVC and poster reminders of the bundle intervention. Implementation strategies included a mix of PIVC site selectin and insertion training, in-service sessions, nursing huddles, bedside training, lectures, online modules, PowerPoint, posters, booklets, leaflets, and case studies</p> <p>Protocol: No applicable to SR technique</p>	<p>compliance with bundle in only 9 studies.</p> <p>Limitations: Includes both randomized controlled trials and nonrandomized observational studies.</p>	<p>and (3) Adult vs paediatric vs neonate bundle components and implementation strategies.</p> <p>Outcome Data Retrieval: Researchers pooled data from all included articles</p> <p>Analysis: Researchers were unable to conduct analysis because of the heterogeneity of the care bundle components and implementation strategies.</p> <p>Conclusions: 12 studies reported reductions in phlebitis and bloodstream infection and one study reported no change in bloodstream infection and an increase in phlebitis</p> <p>SR Bias Risk: Downs and Black quality scores were fair since all studies had methodological limitations and reporting risk of bias was limited across studies. Interrupted time studies and Before-and-After studies have inherent risk of bias that cannot be minimized. No study scores highly on the quality assessment, reporting bias is possible since 12 out of 13 studies reported positive results.</p>
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		<p>Eligible Studies: Randomized controlled trials, interrupted time series, before and after studies and cohort studies reporting multimodal strategies or bundles with two or more components for PIVC insertion or management in hospital patients of all ages to reduce BSI or catheter-related complications published between January 2000-December 2018</p> <p>Excluded: Studies that reported implementing a single intervention, articles that did not define the strategy or bundle components or report outcome measures, conference abstracts, letters, and articles unable to be accessed in full-text.</p> <p>Included: 13 studies- 6 interrupted time-series studies and 7 before-and-after studies. All studies reported implementing a PIVC care bundle for insertion (n=9) or maintenance (n=10) or both (n=8) in an acute hospital setting. Bundles were implemented for adult (n=10), pediatric (n=2), and neonate (n=1)</p>			
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		<p>populations. Sample size ranges from small single center studies with <200 patients to large multicenter studies with over 2 million patient days.</p> <p>PRISMA: Included detailing decision-making criteria for retaining/omitting studies from the SR</p> <p>Power analysis: Not applicable to SR critique</p>			
<p>Citation: Rhodes, D., Cheng, A. C., McLellan, S., Guerra, P., Karanfilovska, D., Aitchison, S., Watson, K., Bass, P., & Worth, L. J. (2016). Reducing Staphylococcus aureus bloodstream infections associated with peripheral intravenous cannulae: successful implementation of a care bundle at a large Australian health service. <i>The Journal of Hospital Infection</i>, 94(1), 86–91. https://doi-org.proxy-hs.researchport.umd.edu/10.1016/j.jhin.2016.05.020</p>					Level VI
Purpose/ Hypothesis	Design	Sample	Intervention	Outcomes	Results
<p>“The objective of this study was to design and implement a prevention programme for improved processes regarding PIVC insertion and maintenance, in order to reduce PIVC-associated healthcare-acquired bloodstream infection (HA-SAB) events at our health service.”</p>	<p>Interrupted time series, quality improvement study</p>	<p>Sampling Technique: Convenience</p> <p>Eligible Participant: Patients admitted to Alfred Health</p> <p>Excluded: No exclusion criteria specified</p> <p>Accepted: 552 patients with peripheral IVs</p> <p>Control: 273 patients with PIVC audited in the preintervention period from January to December 2012</p>	<p>Control Protocol: Baseline Staph aureus bacteremia rates were analyzed in this group for 12 months to enable a targeted intervention to be planned</p> <p>Intervention Protocol: Prevention programme was implemented on this group.</p> <p>Treatment Fidelity: Multi-modal strategy had the following elements:</p>	<p>DV: HA-SAB was defined according to a national standard definition including all SAB events with onset >48 hours after hospital admission; and SAB events identified ≤48 hours after hospital admission if one of the following criteria were met: (i) SAB infection was a complication of the presence of an indwelling medical device; (ii) SAB infection occurred within 30 days of a surgical procedure where the SAB infection was related to the surgical site; (iii) SAB</p>	<p>Statistical Procedures(s) and Results:</p> <p>Stata was used to perform statistical analysis.</p> <p>For process measures, comparisons of proportions using chi-square test-increased frequency of phlebitis scoring was observed post intervention with significantly more PIVC associated with phlebitis score of 0 in the post intervention period (92.1 vs 77.6%; P < 0.05); rate of PIVC-associated SAB in the post</p>

		<p>Intervention: 279 patients with PIVC post intervention period September 2013 to November 2015</p> <p>Power Analysis: None performed</p> <p>Group Homogeneity: None performed</p>	<p>-Heightened awareness of infection risk by use of a poster campaign</p> <p>- Staff education: nursing staff responsible for supervising and assessing staff undergoing PIVC training were educated for uniformity, Junior medical staff was educated on best practice for insertion</p> <p>-Improve documentation: updated PIVC observation chart to streamline assessment and phlebitis scoring</p> <p>-Alerts: alert sticker to prompt 24 hour removal for out of hospital and sub-optimal insertion lines</p> <p>-Standardized equipment: standardized PIVC insertion trolleys</p>	<p>infection was diagnosed within 48 hours of a related invasive instrumentation or incision; or (iv) SAB infection was associated with neutropenia contributed to by cytotoxic therapy. PIVC-associated SAB was a subset of HA-SAB if blood cultures were positive while a PIVC was in situ, or within 48 hours of PIVC removal if no other primary site of S. aureus infection was present.</p> <p>Measurement (reliability) time procedure: A standard audit tool used in the pre-intervention period was used for the post-intervention audits. It collected process measures of all patients with PIVCs and included details of the cannula, dressing and labelling, documentation, and the presence of phlebitis.</p> <p>Limitations: Individual components of the care bundle cannot be evaluated because they were implemented concurrently and sequentially. The null hypothesis of no change in trend or step could not be excluded due to interrupted time-series analysis.</p>	<p>intervention was 64% lower compared to the baseline period [relative rate: 0.36; 95%CI: 0.17, 0.76; P=0.018]</p> <p>Improved documentation regarding PIVC insertion and management was observed with a significantly higher proportion of patients having the date of insertion documented on the PIVC dressing, using a dedicated medical record form during hospitalization and the name of the staff member responsible for PIVC documented in the patient record during post intervention</p> <p>Effect of intervention was assessed using segmented Poisson regression- in the baseline period the monthly rate of PIVC-associated SAB was decreasing (-0.011 per month); no significant change in post-intervention period (-0.008 per month; difference: +0.002; 95% CI: -.0.09, 0.10); no significant reduction in the monthly rate of PIVC-associated SAB at the end of the baseline month (-0.78; 95% CI: -2/1. +0.56)</p>
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				Findings not generalizable to other facilities with lower background rates of infection.	To estimate the probability of distribution of the month in which a change in rate of PIVC-associated SAB occurred using Bayesian analysis-confirmed likely change in underlying rate of PIVC-associated SAB in October 2013
Citation: Ruegg, L., Faucett, M., & Choong, K. (2018). Emergency inserted peripheral intravenous catheters: a quality improvement project. <i>British Journal of Nursing (Mark Allen Publishing)</i> , 27(14), S28–S30. https://doi.org/10.12968/bjon.2018.27.14.S28					Level VI
Purpose/ Hypothesis	Design	Sample	Intervention	Outcomes	Results
“The project sought to reduce the number of ambulance/emergency-inserted PIVCs left in place for longer than 24 hours”	Quality improvement, descriptive study	<p>Sampling Technique: Convenience</p> <p>Eligible Participants: Patients with PIVCs at a regional hospital</p> <p>Excluded: No criteria defined</p> <p>Accepted: 780 PIVCs from September 2015 to September 2017</p> <p>Control: 437 PIVCs audited in Pre-implementation from September 2015 to September 2016, 32/437 were ambulance inserted with 75% dwell time >24 hours</p> <p>Intervention: 343 PIVCs audited in Post-implementation from</p>	<p>Control Protocol: Pre-implementation PIVCs audited</p> <p>Intervention Protocol: Received a PIVC sticker to identify ambulance/emergency inserted PIVCs for early removal</p> <p>Treatment fidelity: The sticker was to be placed in the triage area. Signs were placed in the triage area and screensavers used as reminders. Ambulance staff were educated and communicated with weekly to improve sticker use. Emergency department staff and</p>	<p>DV: Number of ambulance inserted PIVCs</p> <p>Measurement tool (reliability), time, procedure: Audits occurred for 12 months by the Vascular Access Surveillance and Education service. Data collected included which professional inserted PIVC and dwell time. PIVCs had to meet local guidelines including: hand hygiene, aseptic no-touch technique, skin antiseptis, clear documentation of PIVC-insertion and review of device. PIVCs are required to be replaced every 72-96 hours unless unable to gain further access.</p> <p>Limitations: Only number of PIVCs was collected.</p>	<p>Statistical Procedures(s) and Results:</p> <p>No statistical analysis used.</p> <p>-Reduction in ambulance-inserted PIVCs with a dwell time >24hours was significant (p=0.0009)</p> <p>-Relative reduction in healthcare-associated SAB attributed to ambulance inserted PIVCs: Pre-implementation 2; Post-implementation 0 but this was not statistically significant (p=0.1)</p>

		<p>September 2016 to September 2017, 21/343 were ambulance inserted with 29% dwell time >24 hours</p> <p>Power analysis: No power analysis completed</p> <p>Group Homogeneity: No group homogeneity completed</p>	<p>ward staff were educated to be aware of stickers and PIVCs with stickers needed to be removed or replaced within 24 hours of admission. Education included screensavers, fact sheets, and flyers in staff only areas. Education was provided at grand rounds and department managers disseminated information to all staff</p>	<p>Project was not powered to detected statistical significance. Additional educational and quality improvement activities related to PIVC management occurred at the same time as the project and may have contributed to decrease in PIVC dwell time.</p>	
<p>Citation: Salgueiro-Oliveira, A., & Parreira, P. (2012). Incidence of phlebitis in patients with peripheral intravenous catheters: The influence of some risk factors. <i>Australian Journal of Advanced Nursing</i>, 30(2), 32-39.</p>					<p>Level IV</p>
<p>Purpose/ Hypothesis</p>	<p>Design</p>	<p>Sample</p>	<p>Intervention</p>	<p>Outcomes</p>	<p>Results</p>
<p>“This study aimed to identify the incidence of phlebitis and its risk factors in patients with PIVCs”</p>	<p>Prospective observational cohort study</p>	<p>Sampling Technique: Convenience</p> <p>Eligible Participants: Patients with PIVCs hospitalized for 6 weeks with 1,244 catheters observed</p> <p>Excluded: None specified</p> <p>Accepted: 372 catheter placements, 55/372 were rejected due to incomplete documentation or difficulties obtaining consents</p>	<p>Control Protocol: No control group</p> <p>Intervention Protocol: PIVC data was collected in this group over 6 weeks (January 30-March 12 2010)</p> <p>Treatment fidelity: Nurses observed the IV catheterization site daily, tested its functionality and recorded any changes which could influence its removal/ replacement</p>	<p>DV: Phlebitis incidence</p> <p>Measurement tool (reliability), time, procedure: Data collection tool with phlebitis scale that included variables related to: the individual, catheterization, and intravenous drugs</p> <p>Limitations: Different members of the nursing team assessed, and recorded phlebitis may have cause variation in assessment criteria.</p>	<p>Statistical Procedures(s) and Results:</p> <p>SPSS was used to analyze data.</p> <p>Correlation between variables under analysis and phlebitis using t-test and chi-square test with level of significance (p>0.05)- showed statistically significant results in the variables ‘lower limb catheterized’, ‘administration of potassium chloride’ and ‘receiving IV antibiotics’</p>

		<p>Control: No control group</p> <p>Intervention: 317 catheters to observe</p> <p>Power analysis: None</p> <p>Group Homogeneity: None completed</p>			<p>Risk factors assessed using odd ratio- patients with catheterized upper extremities had a less than 72% chance of developing phlebitis than those with lower catheterized limbs (OR: 0.281; CI: 0.97-0.807). The odds increase 1.95 times if potassium chloride is prescribed (OR 1.196; CI: 1.057-3.601) and 1.92 times with IV antibiotics (OR: 1.916; CI: 1.184-3.100)</p> <p>Logistic regression analysis used to identify independent risk factors for phlebitis- the most significant risk factors for phlebitis were patients receiving KCl or antibiotics and patients with an upper catheterized limb</p>
<p>Citation: Saliba, P., Hornero, A., Cuervo, G., Grau, I., Jimenez, E., Berbel, D., Martos, P., Verge, J. M., Tebe, C., Martínez-Sánchez, J. M., Shaw, E., Gavaldà, L., Carratalà, J., & Pujol, M. (2018). Interventions to decrease short-term peripheral venous catheter-related bloodstream infections: impact on incidence and mortality. <i>Journal of Hospital Infection</i>, 100(3), e178–e186. https://doi-org.proxy-hs.researchport.umd.edu/10.1016/j.jhin.2018.06.010</p>					Level IV
Purpose/ Hypothesis	Design	Sample	Intervention	Outcomes	Results
<p>“The aim of this study was to examine the effectiveness of the multi-modal strategy applied at the study centre to prevent PVCr-BSIs over a 14-year period.”</p>	<p>Prospective, longitudinal, cohort study</p>	<p>Sampling Technique: Convenience</p> <p>Eligible Participant: Patients admitted to Bellvitge University Hospital in Barcelona, Spain</p>	<p>Control Protocol: No control in this cohort study</p> <p>Intervention Protocol: PVCr-BCR prevention strategy</p>	<p>DV: Rate of PVCr-BSI, rate of Staphylococcus aureus PVCr-BSI, and rate of mortality within 30 days of onset of PVCr-BSI</p> <p>PVCr-BSI was diagnosed according to a slightly</p>	<p>Statistical Procedures(s) and Results:</p> <p>All analyses were performed using R Version 3.4.1.</p>

		<p>Excluded: No exclusion criteria specified</p> <p>Accepted: 227 hospitalized patients with nosocomial PVCN-BSIs</p> <p>Control: No control</p> <p>Intervention: 227 hospitalized patients with nosocomial PVCN-BSIs from January 2003 to December 2016</p> <p>Power Analysis: None performed</p> <p>Group Homogeneity: None performed</p>	<p>implemented in this group of patients</p> <p>Treatment Fidelity: The prevention strategy included: (a) prospective and continuous PVCN-BSI surveillance (b) implementation of a specific bundle for insertion and maintenance of PVCs according to evidence-based recommendations as well as the hospital's own data (c) educational campaigns targeted at front-line staff, particularly nurse wards (d) same-day notification of the PVCN-BSI case to the nurse ward supervisor via an electronic form (e) assessment of adherence to preventive strategies by periodical ward rounds performed by a trained member of the infection prevention team who inspected all PVCs, focusing particularly on maintenance (insertion site, catheter dressing and connectors), day,</p>	<p>modified Centers for Disease Control and Prevention (CDC) definition, in a suggestive clinical condition, when the growth of concordant bacterial species in a semi-quantitative tip culture and percutaneously drawn blood culture was observed, without another apparent source of bacteraemia. In the absence of a catheter tip culture, the diagnosis of PVCN-BSI required one or more of the following conditions: (a) phlebitis, (b) clear resolution of clinical symptoms after catheter withdrawal, and (c) careful exclusion of an alternative explanation for bacteraemia. For common skin micro-organisms such as coagulase negative staphylococci, at least two consecutive blood cultures were required.</p> <p>Measurement (reliability) time procedure: Surveillance of PVCN-BSIs was standardized throughout the study period and performed in real-time by daily meetings between the infection prevention team, infectious diseases staff and microbiologists following confirmation of a</p>	<p>Incidence rate of PVCN-BSI decreased from 30 episodes in 2003 to 8 episodes in 2016.</p> <p>Poisson regression model was estimated to test the rate trend per year with statistical significance set at 0.05- significant rate reduction of 8% per year [rate ratio of 0.92 per year, 95% CI 0.90-0.96]; significant mortality rate reduction of 18% per year (rate ratio of 0.82 per year, 95% CI 0.74-0.91]</p>
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			and area of catheter placement and replacement according to hospital guidelines.	BSI by members of the microbiology department. All episodes of BSI were reported daily by microbiologists, and patients were visited in the wards to assess the diagnosis of PVC-R-BSI. Episodes were recorded in a specific database, and patients were followed until 30 days after BSI or death. Limitations: Single center study making it non-generalizable to other hospitals. Some of the measures did not align with clinical practice guidelines for PIVC management. Because multiple prevention measures were applied at the same time, difficult to identify which ones are more effective.	
Citation: Stuart, R. L., Cameron, D. R. M., Scott, C., Kotsanas, D., Grayson, M. L., Korman, T. M., Gillespie, E. E., & Johnson, P. D. R. (2013). Peripheral intravenous catheter-associated Staphylococcus aureus bacteraemia: more than 5 years of prospective data from two tertiary health services. <i>The Medical Journal of Australia</i> , 198(10), 551–553. https://doi-org.proxy-hs.researchport.umd.edu/10.5694/mja12.11699					Level IV
Purpose/ Hypothesis	Design	Sample	Intervention	Outcomes	Results
“We sought to review 5 years of PIVC-associated Staphylococcus aureus bacteremia (SAB) in two tertiary referral health services to define the frequency, mortality and associated risk	Prospective observational cohort study	Sampling Technique: Convenience Eligible Participants: Patients > 17 years old with SAB admitted to two tertiary referral health services in Melbourne with	Control Protocol: No control Intervention Protocol: No intervention; data was collected on this group	DV: PIVC-SAB incidence. Defined as a health care-associated SAB in a patient: -with a PIVC in situ or removed within the 7 days before the positive blood culture; and	Statistical Procedures(s) and Results: No statistical analysis completed 23.5% of the 583 health care-associated SAB

<p>factors for this health care-associated complication.”</p>		<p>Excluded: None specified</p> <p>Accepted: 583 health care associated SAB episodes</p> <p>Control: No control</p> <p>Intervention: 583 health care associated SAB episodes</p> <p>Power analysis: No power analysis</p> <p>Group Homogeneity: No intervention/control group comparison</p>	<p>Treatment fidelity: Data collected for each health care-associated SAB episode included patient demographics, place of acquisition, likely source of infection, primary clinical manifestation and outcomes at 7 and 30 days</p>	<p>-with no other source of SAB identified and either a physician or nurse documenting the PIVC as the source of the SAB in the medical record -and/or with physical findings suggesting a PIVC as the source (erythema, induration, phlebitis, tenderness).</p> <p>Measurement tool (reliability), time, procedure: To be device related data collected included details of device type, place of insertion (ambulance, emergency department, ward), and device dwell time. PIVC-associated SAB rate was estimated by using occupied bed days for all overnight stays as the denominator.</p> <p>Limitations: Rate of PIVC-associated SAB definition is too simple. Data on PIVC days was not collected to define longer dwell time as a risk. The results are not generalizable to all health services.</p>	<p>episodes were PIVC related</p> <p>Dwell time could be ascertained in 124 of 137 episodes of PIVC-SAB. Mean dwell time was 3.5 days. 56 PIVC-SAB episodes occurred in PIVCs with dwell times ≥ 4 days</p> <p>44 (39.6%) PIVCs were inserted in the emergency department (ED); of 68 PIVC associated SAB episodes occurring within 3 days of insertion 24 (35.3%) were inserted in the ED or by the ambulance service. This increased to 61% for dwell times of ≤ 4 days</p> <p>PIVC-SAB episodes were associated with a 30-day all-cause mortality rate of 26.5%</p>
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Note. Level of Evidence based upon Melnyk & Fineout-Overholt (2015). PIVC = Peripheral Intravenous Catheter, HA-SAB = Healthcare-Acquired Bloodstream Infection, PVP= Peripheral Vein Phlebitis, PVC = Peripheral Venous Catheter, BSI= Bloodstream Infection, PVCR-BSI = Peripheral Vein Catheter Related- Bloodstream Infection. CI= Confidence Interval, IV = Intravenous, SAB =

Staphylococcus aureus Bacteremia, PIVC-SAB = Peripheral Intravenous Catheter Staphylococcus aureus Bacteremia, SA-BSI = Staphylococcus aureus Bloodstream Infection, VAS = Vascular Access Surveillance, CDC = Centers for Disease Control

Table A2.

Synthesis Table

Evidence Based Practice Question (PICO): On a neurotrauma critical care (NTCC) unit will implementation of a phlebitis prevention bundle reduce the incidence of phlebitis?			
Level of Evidence	# of Studies	Summary of Findings	Overall Quality
IV	6	<p>Furtado et al. (2011) and Stuart et al. (2013), found PIVCs placed in the emergency department to be high risk to develop phlebitis and PIVC associated SAB. Furtado et al. 2011 and Salgueiro-Oliveira et al. (2012) both found IV potassium and antibiotics to be risk factors for phlebitis.</p> <p>The studies by, Mestre et al. (2013), Chiu et al. (2015) and Saliba et al. (2018) used different methods to evaluate the effectiveness of bundles on incidence of complications from PIVCs. All three studies used different strategies decreased phlebitis rates and PIVC-related bloodstream infections.</p>	<p>B, The results were consistent having implications for practice, the use of objective measure were used yet test reliability and validity were not reported. The studies reviewed considered prognostic risk factors and confounding variables. Furtado et al. (2011) and Salgueiro-Oliveira et al. (2012) used odds ratios and confidence intervals to predict risk for phlebitis and sample variability. Stuart et al. (2013) did not evaluate the reliability of the results obtained. All studies render implications for application through the identification of risk factors for development of PIVC complications. These recommendations are based on literature reviews including reference to scientific evidence.</p> <p>B, Saliba et al. (2018) had a prolonged study period, with a high number of cases evaluated, and established patient characteristics strengthening the study’s validity. However, generalizability is limited due to single center study. Reliability of the results is threatened by the multiple prevention strategies implemented.</p> <p>C, Mestre et al., (2013) and Chiu et al. (2015) were single center studies limiting generalizability. However, both included a control group. Mestre et al. had uncontrolled confounding that threatens reliability. Chiu et al. (2015) had a large sample size decreasing risk of random error and increasing power of results. Being retrospective was a limitation of the study. The studies referred to a comprehensive literature review including some reference to scientific evidence and recommended future studies.</p>
V	2	<p>Systematic review by Ray-Baurrel et al. (2019) found 12 of 13 studies using different bundles reduces phlebitis and bloodstream infections in hospital patients of all ages.</p>	<p>C, Insufficient size of 13 studies, none of which were randomized controlled trials. The interventions all varied making it difficult to compare outcomes. Some studies did not report frequency or number of data collection points, some did not report sample size, and all used different scales to assess phlebitis. Meta-analysis was not feasible due to the variability between</p>

		<p>Heng et al. (2020) reviewed 25 studies and found numerous factors that increased the risk of peripheral vein thrombophlebitis including infusate of certain medications such as potassium and hypertonic saline and emergency placed PIVCs. The study concluded targeting strategies to address such risk factors could prevent phlebitis.</p>	<p>bundle components and implementation strategies. Results provide implications for practice, but conclusions cannot be drawn.</p> <p>A, Well-defined, reproducible search strategies were used. Twenty-five studies inclusive of randomized controlled trials and nonrandomized observational studies. Meta-analysis was limited because of the range of different outcomes measured across the small number of existing trials. Results were consistent with similar literature reviews and definitive conclusions.</p>
VI	3	<p>Rhodes et al. (2016), Yagnik et al. (2017), and Ruegg et al. (2018) found different PIVC complication prevention programs, one of which included removal of field placed PIVCs, reduced PIVC-associated SAB and phlebitis. rate that decreased.</p>	<p>B, Rhodes et al. (2016) and Ruegg et al. (2018) are both quality improvement studies lacking randomization and power analysis threatening study validity. Some control was present with a comparison to pre-implementation data in both studies. Rhodes et al. (2016) results were limited by multi-factorial intervention; direct impact of individual components was unable to be evaluated. Ruegg et al (2018) results were confounded due to other quality improvement initiatives related to the management of PIVCs occurring at the same time. Both studies had reasonably consistent recommendations with credible expertise.</p> <p>C, Yagnik et al. (2017) is a small sample sized prospective descriptive study lacking randomization and power analysis inferring threats to validity. There is some control with the use of a pre-intervention group used to collect pre-data on. Fairly definitive conclusions with credible expertise.</p>

Note. Quality of Evidence based upon Newhouse (2006). PIVC = Peripheral Intravenous Catheter, HA-SAB = Healthcare-Acquired Bloodstream Infection, PVP= Peripheral Vein Phlebitis, PVC = Peripheral Venous Catheter, BSI= Bloodstream Infection, PVCR-BSI = Peripheral Vein Catheter Related- Bloodstream Infection. CI= Confidence Interval, IV = Intravenous, SAB = Staphylococcus aureus Bacteremia, PIVC-SAB = Peripheral Intravenous Catheter Staphylococcus aureus Bacteremia, SA-BSI = Staphylococcus aureus Bloodstream Infection

Appendix B

Figure B1

Front Page of PPB Education Handout

Phlebitis Prevention Bundle Education Handout

STEP 1: PRACTICE PREVENTION

Remove any peripheral IV placed in the Trauma Resuscitation Unit/ field/ outside hospital within 24 hours of admission on new patients to Neurotrauma Critical Care

STEP 2: ASSESS

Reminder to assess PIV every 4 hours using the following grading scale:

Phlebitis Grade	Presentation
0	No complications/signs of phlebitis; observe cannula
1+	Early stage of phlebitis: Pain with flushing
2+	Moderate stage of phlebitis: Streak formation-redness above the IV site
3+	Advanced stage of phlebitis: Palpable cord- hard vessel on palpation

Note. Phlebitis Grade Scale provided by EHR in MyPortfolio/EPIC.

STEP 3: DOCUMENT

Upon removal of PIV document correlating assessment:

Post Removal Assessment	<input type="checkbox"/> No Complications <input type="checkbox"/> Bleeding at site <input type="checkbox"/> Bruising at site <input type="checkbox"/> Catheter intact <input type="checkbox"/> Catheter not intact <input type="checkbox"/> Drainage <input type="checkbox"/> Infiltrated 1+=swelling at end of catheter <input type="checkbox"/> Infiltrated 2+-swelling <input type="checkbox"/> Infiltrated 3+- large area of swelling <input type="checkbox"/> Leaking <input type="checkbox"/> Pain <input type="checkbox"/> Phlebitis 1+-Pain <input type="checkbox"/> Phlebitis 2+-Streak formation <input type="checkbox"/> Phlebitis 3+- Palpable cord <input type="checkbox"/> Redness at site <input type="checkbox"/> Swelling <input type="checkbox"/> Warm to touch <input type="checkbox"/> Other (add comment)
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Note. Image from EHR documentation available in MyPortfolio/EPIC.

Figure B2

Back Page of PPB Education Handout

STEP 4: KNOW

NONCYTOTOXIC VESICANT LIST

The first step in reducing the risk of extravasation is to identify and recognize medications and solutions that are associated with tissue damage when the solution escapes from the vascular pathway	
<p>Red List Well-recognized vesicants with multiple citations and reports of tissue damage upon extravasation</p>	<p>Yellow List Vesicants associated with fewer published reports of extravasation; published drug information and infusate characteristics indicate caution and potential for tissue damage</p>
Calcium chloride	Acyclovir
Calcium gluconate	Amiodarone
Contrast media	Amphotericin
Dextrose concentration \geq 12.5%	Arginine
Diazepam	Dantrolene
Digoxin	Dextrose concentration \geq 10-12.5%
Dobutamine	Doxycycline
Dopamine	Esmolol
Epinephrine	Gentamicin
Etomidate	Mannitol \geq 20%
Lorazepam	Metronidazole
Norepinephrine	Nafcillin
Parenteral nutrition solutions	Pentamidine
Phenylephrine	Pentobarbital sodium
Phenytoin	Phenobarbital sodium
Promethazine	Potassium \geq 20 mEq/L
Sodium bicarbonate	Vancomycin hydrochloride
Sodium chloride \geq 3%	Valproate
Vasopressin	

Note. List based on information from the Infusion Nurses Society Vesicant Task Force (2016) and Ong and Van Gerpen (2020).

References

Infusion Nurses Society Vesicant Task Force (2016). *Noncytotoxic vesicant medications and solutions*.

http://www.improvepicc.com/uploads/5/6/5/0/56503399/ins_vesicant_noncyto_list_1.pdf

Ong, J., & Van Gerpen, R. (2020). Recommendations for management of noncytotoxic vesicant extravasations. *Journal of*

Infusion Nursing, 43(6), 319–343. <https://doi.org/10.1097/NAN.0000000000000392>

Figure B3

Pin Nursing Staff Receive Upon Phlebitis Prevention Bundle Training Completion



Figure B4

Certificate Staff Receive Upon Phlebitis Prevention Bundle Training Completion

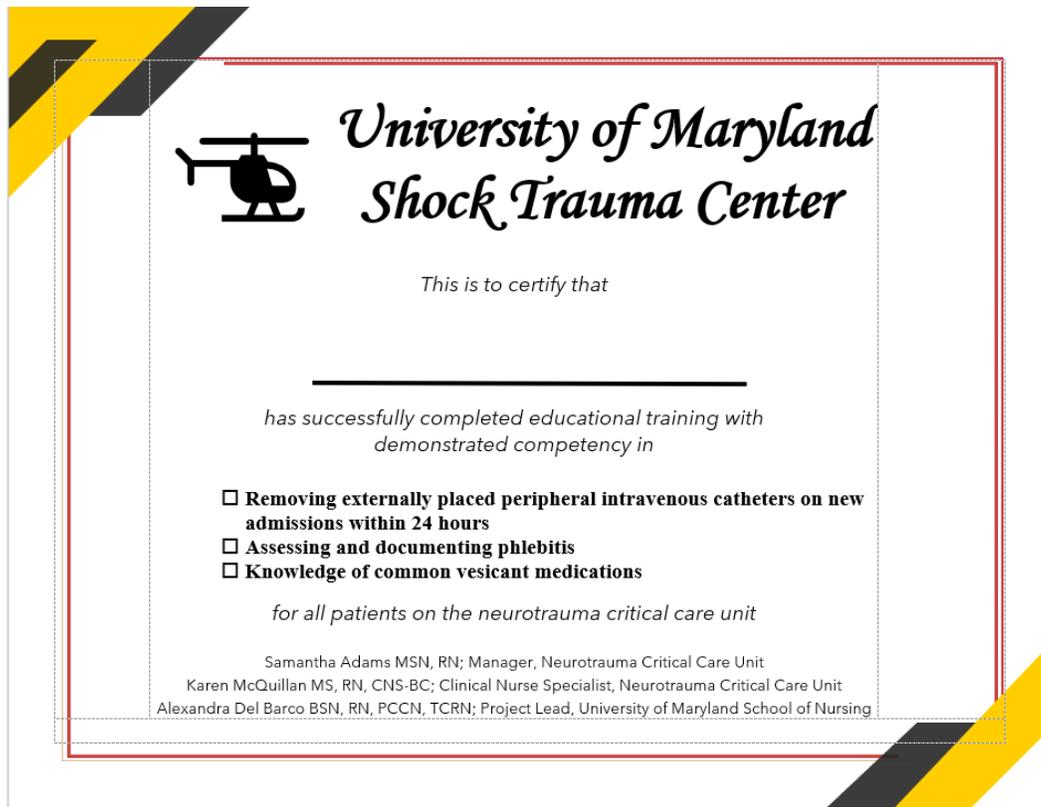


Figure B5

Reminders Placed on Nursing Station Computers

Phlebitis?
Don't forget to send a  text to TC or ADB

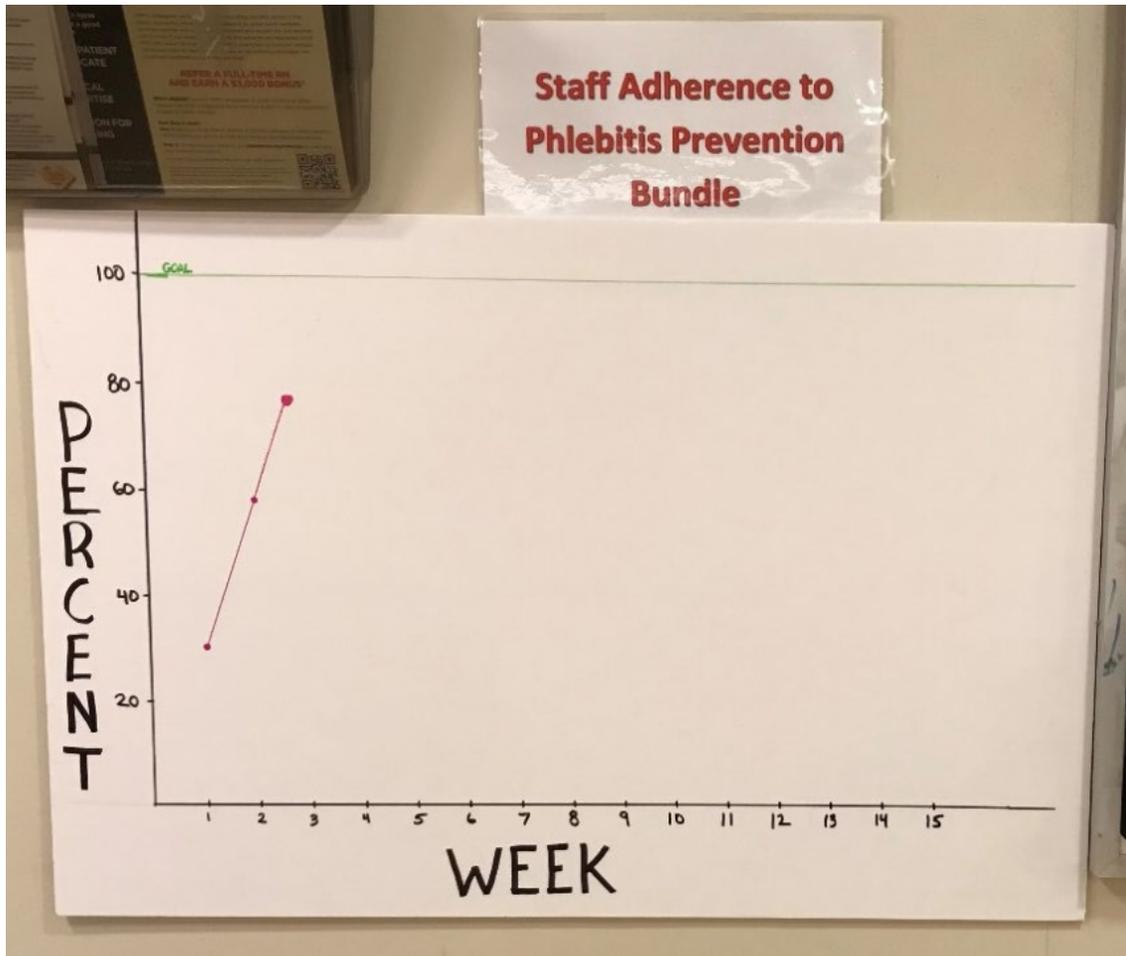
Figure B6

Nurse Practitioner Reminder



Figure B7

Run Chart Poster in Huddle Room



Appendix C

Table C1

Audit Tool for NTCC RN Education Sign-off for In-person Training Collection Tool

Registered Nurse Name (This column to be removed by Nurse Manager prior to data collection by Project Lead)	Staff Signature/ Date (This column to be removed by Nurse Manager prior to data collection by Project Lead)	Nurse Manager Signature Date Cut here→		Code Key Registered Nurse Project-Code	Date Education Completed
				N001	
				N002	
				N003	
				N004	
				N005	
				N006	
				N007	
				N008	
				N009	
				N010	
				N011	
				N012	
				N013	
				N014	
				N015	
				N016	
				N017	
				N018	
				N019	
				N020	
				N021	
				N022	
				N023	
				N024	

				N025	
				N026	
				N027	
				N028	
				N029	
				N030	
				N031	
				N032	
				N033	
				N034	
				N035	
				N036	
				N037	
				N038	
				N039	
				N040	

Table C2

Data Collection/audit form for Assessing Adherence to Phlebitis Prevention Bundle Practice Change

Admit Code	Week #	Date of Audit	Number of PIVCs Admitted With	Number of PIVCs Removed	Was PIVC removed within 24 hours of admission?	If no, why?
ADM001						
ADM002						
ADM003						
ADM004						
ADM005						
ADM006						
ADM007						
ADM008						
ADM009						
ADM010						
ADM011						
ADM012						
ADM013						
ADM014						
ADM015						
ADM016						
ADM017						
ADM018						
ADM019						
ADM020						
ADM021						
ADM022						
ADM023						

Note. ADM# = new admission, PIVC= peripheral intravenous catheter

Table C3

Data Collection/audit form for Individual RN Adherence to Phlebitis Prevention Bundle

Nurse Code	Education Received? Yes/No	IV Removal Wk 1	IV Removal Wk 2	IV Removal Wk 3	IV Removal Wk 4	IV Removal Wk 5	IV Removal Wk 6	IV Removal Wk 7	IV Removal Wk 8	IV Removal Wk 9	IV Removal Wk 10	IV Removal Wk 11	IV Removal Wk 12	IV Removal Wk 13	IV Removal Wk 14	IV Removal Wk 15
N001																
N002																
N003																
N004																
N005																
N006																
N007																
N008																
N009																
N010																
N011																
N012																
N013																
N014																
N015																
N016																
N017																
N018																
N019																
N020																
N021																
N022																
N023																
N024																
N025																

Note. N#= pseudo identifier to be used with Code Key for NTCC RN Education

Table C4

Data Collection/Audit Form for Reported Phlebitis

Date of Chart Audit	Case Code	Phlebitis Grade in EPIC	Was Phlebitis Diagnosed? 0=No 1= Yes	Date of Phlebitis Detection	PIVC Location	PIVC Gauge	Date PIVC Placed	Time PIVC Placed	Date PIVC Removed	Time PIVC Removed	#Days since insertion	Caustic Medications Given?
	P001											
	P002											
	P003											
	P004											
	P005											
	P006											
	P007											
	P008											
	P009											
	P010											
	P011											
	P012											
	P013											
	P014											
	P015											
	P016											
	P017											
	P018											

Note. P#= pseudo-identifier using Code Key for Reported Phlebitis