IMPROVING PATIENT OUTCOMES IN NURSE-PLACED VASCULAR ACCESS DEVICES

by

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Abstract

A lack of standardized practice in IV placement and inconsistent availability of advanced-skilled vascular access nurses was identified at an approximately 275-bed hospital. To address the gap in practice, a performance improvement project was piloted on four medical/surgical units using the standard plan-do-check-act method of quality improvement and Donabedian’s theory of quality assurance in healthcare. The aim of the project was to determine if, in an adult population with difficult venous access (DVA), would the use of an evidence-based vascular access protocol and development of a specialized nurse team affect first-time success rates, cost, catheter dwell times, and complications of peripheral vascular access placement. Several of the Infusion Nurses Society 2016 Infusion Therapy Standards of Practice were incorporated into a nurse-driven protocol and workflow for the identification of DVA patients and combined with an evidence-based practice vascular access device (VAD) selection algorithm to guide nursing actions and improve clinical outcomes. Clinically significant findings included decreased time from the call for assistance to successful placement of difficult IVs, as well as higher first-time attempt success rates and longer catheter dwell times when guide wire assisted peripheral IV catheters were inserted by specialty vascular access nurses. Opportunities for cost savings were identified by decreasing the number of attempts required to place an IV, fewer IV restarts, and prevention of advancement to more invasive lines. The results demonstrate the value of translating evidence in VAD placement into practice and leveraging technology to improve patient care.

Key words: IV access, difficult venous access, standardized/evidence-based practice, vascular access nurse, improved patient outcomes
Improving Patient Outcomes in Nurse-Placed Vascular Access Devices

Hospitalized patients requiring vascular access should expect and receive appropriate, timely care from skilled clinicians using the proper vascular access device (VAD) for all prescribed therapies. While a variety of clinicians across the country are trained to initiate vascular access, nurses are often the primary clinicians that insert, use, and care for VADs. Nurses are trained to evaluate patient intravenous (IV) therapy needs and must be knowledgeable of VADs and insertion-assistive equipment available to facilitate successful placement. Appropriate clinical judgment and assessment skills are especially important to identify patients with difficult venous access (DVA). Nurses must advocate for proper treatment and interventions for this special population in order to expedite peripheral IV (PIV) placement, limit complications, and avoid unnecessary delays in care.

Nurses can be empowered to select and insert the most appropriate VAD to meet individual patient needs through the application of current evidence-based practice (EBP) guidelines for infusion therapy. Implementation of nursing protocols for VAD selection and placement allows nurses to make decisions at the bedside to ensure patients receive optimal IV therapy-related care. Optimal care can only be achieved if nurses responsible for IV placement are proficient at inserting standard and specialty IV catheters and have access to the latest technologies to aid insertion.

The creation of specialized infusion teams or vascular access nurses (VANs) is recommended by the Infusion Nurses Society (INS) as the current best practice for VAD placement, care and monitoring. These teams possess advanced skills and knowledge of VAD placement, vessel health assessment, and maintenance of patient safety. Infusion teams have demonstrated decreased VAD-related complications, improved quality of care, and can limit
unnecessary health care costs associated with infusion therapy (INS, 2016; Meyer & Chopra, 2015; Whalen, Maliszewski, & Baptiste, 2017).

Organizations must commit resources and have systems in place to provide a consistent level of care for VAD placement, with a special focus on patients with DVA. Translating current evidence in VAD selection and placement into practice and the provision of 24-hour availability of appropriately skilled clinicians can limit variations in care and mitigate delays in completion of diagnostic studies, interventions, and delivery of potentially life-saving treatment. Without such provisions, patients are often subjected to multiple failed IV attempts and higher vascular access-related complications from inconsistent practices. Additional ramifications can include increased patient pain, dissatisfaction, and extended hospital length of stay (LOS) (Davis, Owens, & Thompson, 2016; INS, 2016).

Progressive depletion of peripheral veins from repeated IV attempts may also lead to the need to place a peripherally inserted central catheter (PICC) or central venous access device (CVAD). These more invasive lines come with an increased risk to the patient and higher health care costs. These potentially avoidable circumstances, more importantly, can negatively impact patient morbidity and mortality (Helm, Klausner, Klemperer, Flint, & Huang, 2015; Johnson, Snyder, Strader & Zamora, 2017).

Equipped with the right tools and skills, nurses can prevent many poor patient outcomes associated with VAD selection and placement. Consistent system-wide practices and 24-hour availability of advanced skilled infusion nurses or clinicians must be established and adhered to within an organization to provide patients with the right VAD, at the right time, the first time (Davis, Owens & Thompson, 2016; INS, 2016).
Problem Description

A gap in practice for IV placement in patients with difficult to access peripheral veins was identified at an approximately 275-bed hospital located in California. The gap included a lack of set standards to identify patients with poor peripheral vascular access and absence of clear expectations in the hospital policy to guide nurses when to seek the assistance of those with advanced vascular access placement skills. The Peripheral IV Policy indicated that the number of PIV attempts should be limited to two per nurse. However, the total number of nurses that could attempt or cumulative total attempts permitted was not addressed. In addition, the organization did not have established EBP guidelines for standardization in VAD selection based on clinical reasoning, patient condition, or required therapy.

Following an assessment of the current state of the organization, a performance improvement project was designed to address the identified gap in practice and evaluate outcomes resulting from the implementation of a nurse-driven protocol. The protocol included an EBP VAD selection algorithm and several of the 2016 INS Infusion Therapy Standards of Practice related to VAD placement. These were combined into a nursing workflow to identify DVA patients and facilitate successful VAD placement. The selected INS standards were incorporated to guide nursing practice and create a consistent standard of care for all DVA patients requiring IV placement during their hospital stay.

After obtaining buy-in from administration, the nursing protocol was approved for implementation as a performance improvement project to be piloted on four medical/surgical units. The units that participated included a general medical/surgical unit, a renal medical/surgical unit, an ortho/neuro/spine unit, and an oncology unit.
Part of the organizational assessment included an informal survey of the inpatient nurses to determine the existing practice for placing difficult IVs. The reported practice was to call the Diagnostic Imaging (DI) Department and request assistance from one of the nurses trained to use ultrasound guidance for IV and PICC line placement. Alternatively, the inpatient nurses could continue placement attempts which occasionally led to depletion of viable peripheral vein options. On occasion, venous depletion resulted in the need to obtain a PICC insertion order from the physician, which otherwise would not have been medically indicated.

The hospital has a staff of nine DI nurses that are considered the nursing experts in VAD placement. However, they are only available Monday through Friday between 0700 and 1830 and limited daytime hours on the weekend. This creates a significant disparity in care when these skilled clinicians are not available. After-hours, the inpatient nurses have fewer resources to assist with placement of PIVs on DVA patients. The nurses often rely upon the nursing administrative supervisor to find another available nurse to attempt placement. The nurses may also call the Emergency Department (ED) for help. While the ED nurses are highly skilled at placing IVs, this is usually the busiest time in the department and a nurse is not always available. This lack of resources can delay patient care and prolong treatment.

Estimates indicate approximately 70-80% of all patients admitted to the hospital require an IV during their stay. This equates to more than 150 million VADs placed in the United States each year, making VAD placement one of the most common invasive procedures done in the hospital setting (Alexandrou, 2014; Davis et al., 2016; Helm et al., 2015; Idemoto, Rowbottom, Reynolds & Hickman, 2014; Keleekai et al., 2016). Systemwide processes for VAD placement must be established that are efficient, cost-effective, and provide the same level of care to all patients, regardless of the time of day or day of the week the patient presents. Standardized
VAD selection and placement decision-making processes, supported by current EBP, are essential to alleviate the likelihood of a disparity in care, especially in DVA patients. The standard of care must also be clearly defined in hospital policies and clinicians must be provided with adequate support and resources to uphold these standards.

Without established criteria to identify patients with DVA nor guidelines for inpatient nurses in when to seek assistance from advanced-skilled nurses, patients are often subjected to repeated IV attempts. Furthermore, the lack of 24/7 availability of nurses with advanced skills can result in patients being subjected to an increased number of IV attempts which can potentially increase complications related to VAD access. The implementation of this Doctor of Nursing Practice (DNP) project, using Donabedian’s theory of quality assurance in healthcare and standard plan, do, check, act (PDCA) performance improvement strategies, was expected to address the identified practice gap and translate current evidence in infusion therapy into practice.

Available Knowledge

An electronic literature search was conducted using the Capella Library resources to identify appropriate strategies to close the gap in practice. The goal was to synthesize current EBP to answer the PICOT question: In adult patients with difficult venous access (P), how does the use of an evidence-based vascular access protocol and development of a specialized nurse team (I) compared to current practice (C) affect first-time success rates, cost, catheter dwell times, and complications of peripheral vascular access placement (O) within an eight-week period (T)?

ProQuest Central, Ovid, CINAHL and PubMed Central were accessed using standard search methods, MeSH terms, and other keywords including *nurse-driven protocol for vascular*
access device selection, indications for vascular access device selection and placement by nurses, peripheral vascular access quality improvement, and vascular access nurse teams. Additional searches were conducted by accessing the Centers for Disease Control (CDC), Association of Vascular Access (AVA), Emergency Nurses Association (ENA), and the INS websites. Reference lists from selected articles were also manually searched for relevant literature. Articles retained were limited to those written in English, scholarly journals, peer-reviewed, and those in which full-text was available. The timeframe was limited to 2012 – 2017 in most instances.

The search yielded a total of 11,700 articles. A review was performed to determine relevant resources and eliminate any duplicate items. Articles that did not provide additional knowledge for answering the PICOT question or were not specific to nurse-placed vascular access devices were excluded. The in-depth literature synthesis resulted in 36 remaining articles. A total of 29 articles were retained that were directly related to the project and were used to provide guidance for the chosen interventions.

Existing Literature

Existing literature emphasizes the importance of preserving patients’ peripheral veins for access, not just during the current hospital stay, but ongoing for future vascular access needs (Carr et al., 2016; Hallam et al., 2016; Shaw, 2017; Simonov, Pittiruti, Rickard, & Chopra, 2015). With each successive IV placement attempt, the vein availability decreases. With every break in the skin from the IV needle puncture, the chance of infection increases. With every attempt to insert a PIV catheter, micro-tears occur in the vessel intima that can lead to infiltration and extravasation. Furthermore, when a catheter is advanced that is not fully seated within the vein lumen, the chances of infiltration and phlebitis increase (Helm et al., 2015; INS, 2016).
Each of these situations can lead to catheter failure, requiring unplanned removal and the need for replacement and/or treatment of resulting sequelae.

When peripheral veins suitable for cannulation are depleted, patients may require the placement of a more invasive CVAD for treatment. Central venous access devices commonly inserted at the hospital include central lines and PICCs. Both of these catheter types are associated with an increased risk of catheter-related bloodstream infection (CRBSI). These hospital-acquired conditions can result in increased pain and suffering of the patient, prolonged hospital LOS, and increased risk of mortality (CDC, 2011; Meyer & Chopra, 2015; Simonov et al., 2015). Introduction of bacteria into the bloodstream can occur during the line insertion or from repeated access during hospitalization. Risks and benefits of the type of VAD placed, especially when a central line is being considered, must be weighed for each individual patient to limit such infections.

Additional risks of CVAD placement include the possibility of a pneumothorax during insertion of a central line into the neck or chest, guidewire loss, air embolus, accidental cannulation of an artery, and thrombosis formation (Helm et al., 2015; INS, 2016; Moureau & Chopra, 2016; Simonov et al., 2015). Current literature dealing with PICC and CVADs indicate these devices may be over-used from lack of appropriate patient assessment or failure to apply evidence-based decision-making criteria for VAD placement and efforts should be made to limit usage when not medically necessary (Moureau & Chopra, 2016; O’Grady, 2015; Scoppettuolo et al., 2016).

Besides the risk to patients, centrally placed catheters come with additional costs for the invasive line insertion kit and required supplies. There are also costs associated with increased clinician time for insertion and ongoing care requirements (Whalen, Maliszewski & Baptiste,
2017). Best practice is to avoid CVAD placement unless clinically indicated, such as when hemodynamic monitoring is required, or no other options are available (Moureau & Chopra, 2016; O’Grady, 2015). Translating emerging evidence into practice for vascular access-related care ultimately has great potential for revenue savings to an organization as well as reduction in operational loses (Harpel, 2013).

While PIV catheters come with far fewer risks than CVADs, they still have the potential to lead to complications during and after placement. Complications identified in the literature include infiltration (infusion of fluids/medications into the tissue), extravasation (vesicant or irritant leakage into the tissue), occlusion or obstruction, accidental dislodgement, phlebitis (inflammation), and infection ranging from localized to bloodstream infections. The most commonly reported PIV complication is infiltration (Fourie, 2015; Helm et al., 2015; Idemoto et al., 2014; Jackson, Hallam, Corner & Hill, 2013; O’Grady, 2015). Each of these complications can have significant risks and sequelae that may require further treatment, increase health care costs, and can lead to poor patient outcomes (Alexandrou, 2014; Davis et al., 2016; INS, 2016).

Tracking catheter failure is one way to determine complication rates resulting from PIV placement. Failure rates of standard or conventional PIV catheters are reported to be between 22-50% and most catheters fail before completion of therapy (Fourie, 2015; Helm et al., 2015; Idemoto et al., 2014). This highlights the need for better VAD engineering, selection, and improved technology for insertion to prevent failure and extend catheter dwell times.

**Specialty PIV Catheters**

There are now improved products available for peripheral venous access, such as guide wire assisted peripheral IV (GAPIV) catheters, typically inserted with ultrasound. Research studies have demonstrated improved first-time insertion success rates, cost-savings potential, and
improved patient outcomes from the use of these specialty catheters (Chiricolo et al., 2015; Helm et al., 2015; Idemoto et al., 2014; Moureau & Chopra, 2016). These advanced technology devices, because of their unique design and the manner in which they are inserted, also demonstrate fewer complications and longer dwell times. These factors alone can drive down costs associated with supplies, nursing time, and poor patient outcomes by decreasing number of IV restarts required.

An understanding of some of the unique features of a GAPIV catheter can help explain why they have begun to show favor in health care. One such GAPIV catheter is made of polyurethane, which softens after insertion from body heat, and is less likely to kink or occlude. Polyurethane catheters demonstrate superiority when compared to standard IV catheters, which are typically made of polyvinyl chloride or polyethylene (CDC, 2011, Chiricolo et al., 2015; Helm et al., 2015; Idemoto et al., 2014; Scoppettuolo et al., 2016).

A typical GAPIV catheter is inserted with a guide wire that has a coiled tip which enters the vein prior to catheter advancement. The wire smoothly glides within the vessel and can prevent micro-tears and posterior vessel wall perforation, commonly seen with standard PIV catheters (Idemoto et al., 2014). To improve chances of successful placement, the guide wire will not feed into the vessel unless the needle and catheter tip is inside the vein. In addition, the wire is echogenic and visible with ultrasound, which allows for further confirmation of successful placement. These features can prevent the clinician from attempting to insert a catheter that is not accurately placed within the vein lumen (Chiricolo et al., 2014).

Once placement is confirmed, the IV catheter is fed over the guide wire and the wire is retracted. The unique design of these catheters limits the number of IV attempts required for placement, prevents trauma to the intima of the vein, and results in longer dwell times without
complications (up to 4.4 days compared to 1.5 days for a traditional PIV) (Chiricolo et al., 2015; Idemoto et al., 2014).

A review of the available literature validated the GAPIV catheter demonstrated superior performance over standard PIV catheters (Chiricolo et al., 2014; Helm et al., 2015 Idemoto et al., 2014 & Simonov et al., 2015). A GAPIV specialty catheter is currently used in the hospital. There are 33 nurses trained to insert the catheters using ultrasound guidance. These nurses work a variety of shifts in several different departments within the organization. The majority of the nurses (twenty-one) work in the ED. Three nurses work in the inpatient units (1 in the ICU, 1 in the medical/surgical unit, and 1 in the float pool). In addition, all nine of the DI nurses are trained to insert GAPIVs. The 33 advanced-skilled nurses make up the VAN team referred to in this project.

Specialty Nurse Teams

Current literature recommends the development of specialty nurse teams that possess advanced knowledge of a variety of infusion devices and an understanding of those most appropriate for the patient’s prescribed treatment (Davis et al., 2016; Fourie, 2015; Helm, et al., 2015; Idemoto et al., 2014; INS, 2016). These advanced-skilled nurses are typically trained to use ultrasound or vein visualization equipment and are able to insert uniquely engineered vascular access catheters, such as GAPIV catheters, midlines, and PICCs.

Specialized vascular access teams have demonstrated improved patient outcomes, fewer complications, and reduced costs associated with vascular access (Harpel, 2013; INS, 2016). The prospect of developing a VAN team available 24/7 was evaluated as part of a performance improvement project. The rationale for staffing the hospital all hours with these advanced-
skilled nurses is to maintain a consistent standard of care and better serve patients with difficult to access peripheral veins.

A review of four articles was conducted to validate several of the INS 2016 *Infusion Therapy Standards of Practice* selected for the nurse-driven protocol and interventions to be implemented. Implementation of the INS standards has demonstrated improved outcomes in performance improvement projects and studies evaluating vascular access placement in DVA patients. Positive outcomes include fewer delays in care, decreased length of stay (LOS), and higher first-time success rates in placing vascular access devices. Improved patient satisfaction, decreased physician and nursing staff time, and reduction in supply usage have also emerged in the findings (Chiricolo et al., 2015; Helm et al., 2015; Idemoto et al., 2014; Whalen et al., 2017).

The consensus of the literature lends support to the likelihood that improved clinical outcomes can be demonstrated during the implementation of this project as well (Chiricolo et al., 2015; Fourie, 2015; Helm et al., 2015; Idemoto, et al., 2014). Therefore, the three most relevant INS standards were chosen for implementation due to the specific needs and resources available in the organization. The standards included: (a) Limiting the number of nurses and number of attempts to place a PIV, (b) utilizing specially trained nurses to place difficult IVs with vein-enhancing equipment, and (c) usage of an EBP VAD selection algorithm.

With proper VAD selection and management, vascular access complications are largely preventable. Device selection should always include weighing patient risks versus benefits and use of a multidisciplinary collaborative approach (Alexandrou, 2014; Hallam et al., 2016). A team decision and patient assessment involving the bedside nurses, advanced-practice vascular access nurses or clinicians, and the physicians overseeing patient care is crucial to ensure EBP is appropriately applied (Davis et al., 2016). The decision should include a pre-procedure
assessment of the unique patient needs, treatment prescribed by the physician, and the anticipated length of therapy (CDC, 2011; Helm et al., 2015; Moureau & Chopra, 2016; Shaw, 2017).

Vessel health preservation is described in the existing literature as a priority of care. Thus, appropriate patient therapy decisions must also take into account the need to preserve veins for future use (Carr et al., 2016; Hallam et al., 2016; Shaw, 2017; Simonov et al., 2015). Nurses must advocate for a consistent standard of practice for DVA patients and be empowered to make independent decisions using critical thinking to prevent doing harm to this population. Based on these principles, a standardized nurse-driven protocol was created by the DNP project leader to guide nurses in the placement of difficult IVs. The protocol includes a workflow diagram for identification of patients with DVA and application of the previously identified INS Standards for Infusion Therapy (see Appendix A).

**Rationale**

Donabedian’s theory of quality assurance in healthcare establishes the theoretical framework guiding the performance improvement process for this project. Donabedian’s theoretical framework, introduced by Avedis Donabedian in 1966, remains one of the most influential models to evaluate quality health care today. His model is comprised of three components (structure, process, and outcome). These components are used to assess the quality of care through a repeated cycle of obtaining performance data, analysis, and interpretation. The overall focus of this model is to assess, monitor, and improve patient outcomes through measurable indicators (Donabedian, 1988).

Structure, the first component of the framework, describes the characteristics of the setting in which care is provided. Examples of structure include the administration or leadership
of the organization, qualifications or skills of the care providers, and the overall culture of safety. Each of these influences the levels of high-quality care that can be achieved.

Process describes all aspects of care received by the patient including interactions between the patient and the health care provider, and decisions about which interventions are most appropriate to implement. Process is how care is actually applied or performed within an organization and includes how the intervention or change is implemented or put into place.

The final phase, outcome, describes the effect of a change in the patient’s health status that results from the process or interventions and includes the patient’s level of satisfaction with care (Chin & Muramatsu, 2003; Donabedian, 1988). Outcomes should be measurable to determine if the interventions actually produced a change.

Donabedian’s model is similar to the PDCA process of performance improvement. Both start by identifying a gap in practice or problem needing improvement. A plan is created to implement a process or action to take that will test the chosen interventions. Finally, an evaluation or study is done to determine if the interventions implemented resulted in the desired effect. The iterative cycle continues until the anticipated outcomes are achieved. Donabedian’s model and the PDCA process can effectively be applied to the implementation of health care quality initiatives and used to monitor and evaluate programs to produce measurable outcomes (Ayanian & Markel, 2016; Chin & Muramatsu, 2003; Donabedian, 1988).

An assessment of the current state of the organization was performed using Donabedian’s model (see Appendix B). The performance improvement project was then designed to address the identified gap in vascular access practice. Donabedian’s model informed the decisions in the planning phase and provided the ongoing framework for the pilot project. An assessment of the organizational attributes and resources (structure) and existing policies and standards of practice
(process) was conducted to project if the chosen interventions included in the nursing protocol would be effective. Analysis and interpretation, as guided by the framework, was completed post-project implementation to determine if the anticipated changes (outcomes) were achieved.

The hospital uses the PDCA model for performance improvement. Therefore, the PDCA process was integrated with Donabedian’s model as the framework to implement the project and measure outcomes. The variable being evaluated was whether or not EBP guidelines for selection and placement of VADs was used by the nurses (independent variable) and the effect on the resulting outcomes (dependent variables).

Assumptions were made prior to project implementation and were considered when creating the protocol and interventions. Familiarity with the organization provided the basis for the assumptions and the rationale as to why the project leader believed the protocol would be adhered to and produce the desired outcomes. The project assumptions included: (a) The organization prioritizes patient safety and is outcome driven, (b) hospital nursing administration and leadership are supportive of a nurse-driven vascular access decision-making process and will provide appropriate staffing, equipment, and resources to fully implement the project, (c) nursing staff understand the value of implementing EBP and have a shared nursing philosophy of providing the best patient care possible, and (d) nursing staff will willingly participate in the project and adhere to the recommended protocol and required documentation.

**Specific Aims**

The aim of the project was to determine if the use of an evidence-based vascular access protocol and development of a specialized nurse team would affect first-time success rates, cost, catheter dwell times, and complications of peripheral vascular access placement in the adult patient population during hospitalization. The goal was to standardize clinical practice for
difficult IV placement and prevent escalation to PICC line insertion when not medically warranted. A secondary goal was to demonstrate the need for the same standard of care to be available for all patients at all times.

As identified during the initial assessment using Donabedian’s theory of quality assurance in healthcare framework, the organization has the resources available to meet the needs of the DVA patients. Therefore, the results of this project are hoped to influence hospital administration to take necessary steps to provide 24/7 coverage of advanced-skilled nurses and eliminate the disparity in vascular access care identified in the gap analysis.

Furthermore, quality of care is a significant factor in the rate of reimbursement for services structure and weighs heavily upon the patient perception of care and corresponding satisfaction scores (Chiricolo et al., 2015; Meyer & Chopra, 2015). Though patient satisfaction was not directly measured in the project, patient satisfaction is well-established as a key driver in today’s health care market. Patient satisfaction can potentially be improved by decreasing the number of attempts required to place an IV and limiting delays in care. Therefore, the potential gains to the organization from investing in the implementation of best practices in vascular access, as identified in this project, cannot be discounted.

Methods

Context

This is a hospital with approximately 275 beds located in California. According to the U.S. Census Bureau, more than 75% of the population is Hispanic and a large number of the patients are blue collar, farmers, or field workers.

The hospital is deeply invested in the community to which it serves and provides employment to some 1,700 local residents. The organization’s commitment to the community is
clearly defined in the mission and vision statements and is demonstrated through the thousands
of volunteer hours the employees give back to the community each year.

The organization provides interventional radiology services and has a comprehensive
cancer center, wound center, and sleep center. The hospital is a designated STEMI (ST-elevated
myocardial infarction) and Stroke Receiving Center and has achieved several other notable
designations and awards. There are multiple clinics in the community, affiliated with the
hospital, to serve the local population. According to information from Hospital A, about 10,000
adult patients are admitted each year and more than 55,000 patients are seen in the emergency
department annually.

Improving patient outcomes through the implementation of EBP is a high priority as the
hospital continues to strive for excellence. The organization is currently on the journey to obtain
Magnet status and promotes a culture of transparency and shared decision-making. The
implementation of the nurse-driven protocol piloted in this project demonstrates the concept of
shared governance and empowering nurses to drive the care they provide.

The project was implemented in the medical/surgical units of the hospital as a PDCA
performance improvement project. The pediatric unit, although they admit adult patients, was
excluded. The main medical/surgical unit and the corresponding renal medical/surgical unit
have a combined average monthly census of approximately 150. The other two units are an
ortho/neuro/spine and an oncology unit. These two units have an average monthly census of
approximately 175 and 75, respectively. The renal unit is opened and closed as the census
fluctuates.

The stakeholders most relevant to the project during implementation included the DI
nurses, the director of the medical/surgical units, and the staff nurses, unit clerks, and nursing
assistants on the participating units. The licensed staff on the medical/surgical units are registered nurses that work 12-hour shifts starting at 0700 and 1900. The nurse-to-patient ratio on the unit is one-to-five, in compliance with the staffing ratios of California. The unit clerks and certified nursing assistants provide additional support and patient care on the units. In addition, the DI nurses that assist with DVA are all registered nurses. The administrative nursing supervisors that are called to find an available nurse to assist with difficult IVs after-hours are also key stakeholders.

The target population included only adult patients requiring placement of an IV during their hospital stay. The baseline sample was obtained from a combination of all four medical/surgical units. The patients included in the baseline sample were not differentiated as those with easy venous access versus those with DVA. The project sample was taken from the same four units and only included those patients identified as having DVA.

**Interventions**

The interventions implemented during the project incorporated several of the INS standards and included the following: (a) inpatient nurses limited PIV access attempts to no more than two per nurse and no more than four total prior to seeking advanced-skilled nurses or alternative VAD options, (b) inpatient nurses requested assistance from the team of nurses with advanced vascular access placement skills when indicated as above, or sooner if a patient was initially identified as having DVA, (c) advanced-skilled nurses utilized vein visualization equipment (i.e., transillumination, near-infrared technology, or ultrasound) for PIV placement, and (d) an evidence-based infusion device selection algorithm was used to identify the most appropriate VAD for the prescribed treatment and projected length of therapy.
The CDC Guidelines for the Prevention of Intravascular Catheter-Related Infections (2011) recommend the selection of VADs be based on the intended purpose and the expected duration of use, while considering known complications (infectious and non-infectious), in addition to the skill level of the provider inserting the catheter or device. With this in mind, the VAD decision algorithm by Simonov et al. (2015) (See Appendix C) was selected for this project.

The algorithm incorporates the most current evidence-based guidelines for infusion therapy device selection recommended by the CDC, INS, and AVA (CDC, 2011; Davis, et al., 2016; INS, 2016). The algorithm was also chosen for ease of use, the current level of nursing clinical skills, and vascular access devices and technology available at the hospital.

The VAD selection algorithm guides the clinician to identify the type of vascular access device to insert based on whether a patient has an emergent or non-emergent condition. The algorithm identifies subsequent actions to take depending upon if a PIV site is available, type of infusate to be administered (recommended infusion via peripheral or central vascular access), and length of therapy proposed (less than or greater than one week). If the patient is known to have advanced chronic kidney disease (CKD) stage IIIb or greater, avoidance of a PICC is recommended to prevent usage of an arm that may be viable for future arteriovenous (AV) fistula placement. This VAD selection algorithm is consistent with the nursing protocol and workflow diagram the nurses followed during the project.

**Preparation for Project Go Live**

An initial presentation was done at the hospital Nursing Quality Council to introduce the plan and obtain approval to conduct a performance improvement project. The council included staff nurses from each nursing unit and nursing unit managers. The council agreed to have the
project implemented on the medical/surgical units. Permission was then obtained from the medical/surgical director. The chief nursing officer had already been apprised of the project and fully endorsed implementation.

Since the hospital does not have a formal Institutional Review Board (IRB), the project was submitted to the Clinical Research Manager. As the Chair of the Research Committee, she validated the project was performance improvement and not a research project. Unlike research projects, performance improvement projects do not require additional review by the Committee. The project was filed as such and permission was granted to continue.

The final step was to obtain formal approval to proceed from the Clinical Interdisciplinary Advisory Team. This team consists of physicians, nursing directors, managers, and various departmental leaders throughout the organization. A brief PowerPoint presentation outlining the details of the project was provided and approval was obtained.

Approximately two weeks prior to go-live, the project was introduced to the medical/surgical staff at the monthly staff meeting. A more robust PowerPoint presentation was used to ensure staff were provided a clear timeline for implementation, expectations, and anticipated project outcomes. The nurse-driven protocol and interventions were distributed as a handout titled Identification of Difficult Venous Access Patients (see Appendix A). The protocol, created by the Project Leader specifically for this project, included a detailed workflow of the process to be implemented. The bedside nurses were instructed to use the flow diagram as a guide to identify patients with DVA and actions to take to facilitate successful VAD placement.

For each DVA patient identified, a paper Audit for Difficult Venous Access Patients (ADVAP) was to be completed (see Appendix D). A draft of the ADVAP was presented to the staff with examples of completed forms. Staff input was obtained to ensure the data points listed
on the ADVAP were easy to document and would not significantly disrupt their workflow. Minor changes to the final version were made from staff input.

Project binders were created for each unit. The binders contained blank ADVAPs, examples of completed forms, and a copy of the PowerPoint presentation outlining the project. A colored copy of the nursing protocol for the identification of DVA patients and the VAD selection algorithm were also included. A reference list of the unit champions and the project leader contact information was also provided. Staff was asked to designate a preferred binder location. They unanimously agreed to placement at the charge nurse station of each unit.

Unit champions for each participating unit were identified during the staff meeting in an effort to achieve nursing buy-in and engagement for the project. Participation was voluntary and a total of 11 nurses from both day and night shifts were recruited. A separate meeting was held to educate the champions on their role. The unit champions were to act as a resource on the unit, encourage nurses to follow the nursing protocol for the identification of DVA patients, and ensure an ADVAP was completed for each DVA patient identified. The unit champions were also to answer staff questions and promptly resolve issues as they arose. Issues were promptly communicated to the other champions and project leader. Changes or updates would be made to facilitate the ongoing success of the project and shared by the unit champions at daily staff huddles and by the project leader during rounding. Additional communication was also provided by the project leader through emails to the medical/surgical staff and via postings in the breakrooms.

A presentation was also done at the Diagnostic Imaging (DI) staff meeting to inform them of the upcoming project and educate them on their role during implementation. The DI nurses were taught to use the VAD selection algorithm as a decision-making guide and the
importance of accurately documenting the number of PIV attempts in the EMR. Examples of scripted messages to be used with the inpatient nurses were provided to reinforce compliance with the nursing protocol and workflow for DVA patients. The VAD selection algorithm was provided to each of the nurses and a laminated copy was placed at the DI charge nurse desk for quick reference.

Review of the documentation requirements was also provided for the DI Tracking Log (see Appendix E). The log was an existing paper document used to track calls for help with difficult PIVs. Emphasis was placed on the importance of accurate documentation to obtain reliable information to evaluate the project outcomes. The log included: (a) date and time call received, (b) name and location of the patient, (c) service requested (i.e., difficult IV start or PICC placement), (d) outcome of event (GAPIV, standard PIV, or PICC placed), (e) number of attempts, (f) if ultrasound was used, and (g) if unable to fulfill request, reason why (i.e., not enough staff, call made too late in the day etc.)

Finally, a meeting was held with the nursing administrative supervisors to inform them of the project and alert them of the likelihood of an increased number of requests for assistance in placing difficult IVs during go-live. Contacting the administrative supervisors for assistance is an already established workflow in the hospital so no change in their practice was needed. A complete list of the advanced-skilled nurses trained to place GAPIVs was provided, including the unit and shifts worked. This was done to further ensure all available resources were provided to the inpatient nurses during the project.

Go-Live

Just prior to the project go-live date, storyboards with the project timeline, nursing protocol for identification of DVA patients, and examples of completed ADVAPs were placed in
the medical/surgical breakrooms. The storyboards remained on the units throughout the project. The nursing protocol was posted on the units for quick reference for the staff nurses. Charge nurses and unit champions could easily refer to these for communication during shift huddles and encourage nurse adherence to the protocol.

The following actions were completed by the project leader to facilitate ongoing adherence to the nursing protocol and interventions throughout the project:

1. Conducted daily rounds (Monday through Friday) on the participating medical/surgical units and the DI Department.
2. Collaborated with the VANs, medical/surgical nurses, and unit champions to facilitate: (a) accurate/complete documentation of the number of attempts for PIV placement in the EMR, (b) completion and collection of the ADVAPs, and (c) provision of ongoing education and feedback on the project interventions and expected outcomes.
3. Regularly monitored the DI Tracking Log for completion and encouraged the DI nurses to continue to accurately document all entries.
4. Identified barriers to successful implementation of the project and modified strategies, as necessary, to encourage participation and adherence to the guidelines/interventions.

Mid-point in the project, updates on the progress and initial findings were presented to the medical/surgical staff during their monthly staff meeting. A post-project report was also provided at the following monthly meeting to discuss the preliminary findings and to thank the staff for their participation. All storyboards, postings, binders, and ADVAPs were collected post-project implementation.
Study of the Interventions

The nurse-driven protocol for the identification of DVA patients and corresponding workflow was expected to provide the nurses with a consistent standard of practice for the successful placement of VADs. Difficult venous access patient identifiers came from the literature synthesis performed when preparing for the project. The identifiers included: (a) inability to visualize and/or palpate peripheral veins suitable for IV placement, (b) any patient with a known history of DVA per patient self-report or medical history that included the presence of chronic diseases known to affect peripheral vasculature (e.g., diabetes, hypertension, or sickle cell disease), (c) obesity, (d) multiple or recent hospitalization, (e) social histories such as IV drug abuse (IVDA), or (f) fragility of veins associated with treatments such as chemotherapy administration or dialysis (Carr et al., 2016; INS, 2016; Scoppettuolo et al., 2016; Shaw, 2017).

After initial identification of the DVA patient, the nursing protocol workflow guided the nurse to consider calling for an advanced-skilled nurse to assist with IV placement. Otherwise, if attempts were made to place an IV, the nurse was to limit the number to no more than two per nurse and four attempts total. This was intended to prevent depleting viable peripheral veins and avoid unnecessary escalation to the need for a PICC line. The ongoing nursing actions would be documented on the ADVAP (see Appendix D) by the nurse that identified the DVA patient.

Each ADVAP included the patient name, medical record number, and date of the encounter. In addition, the following information was documented: (a) criteria used to identify the DVA patient, (b) if attempts were made to place an IV, the number of attempts to place and the number of nurses that attempted, (c) if help was needed, date and time of call for assistance of an advanced-skilled vascular access nurse (whether right away or after initially attempting),
(d) time of arrival of assistance (or lack of availability), and (e) final outcomes including type of catheter placed (standard PIV, GAPIV, or PICC) or if care was escalated to request central line placement by a physician (due to the patient requiring invasive monitoring and the VAN was unable to place a PICC or if the patient became unstable and a PIV cannot be established).

A comment section was included at the bottom of the ADVAP for the nurses to further describe events or identify barriers encountered. Upon completion, the ADVAPs were returned to the project binder and double-checked by the unit champions for completeness. Any documentation deficiencies were brought to the attention of the nurse that initiated the ADVAP and completed in real-time to ensure data accuracy.

Without accurate documentation, the significance of the project outcomes from the interventions implemented would be difficult to assess. Additional education was provided to the staff on the importance of accurately documenting the number of attempts to successfully place a PIV in the electronic medical record (EMR). The expectation was reinforced to include the total number of attempts, regardless of the number of nurses that attempted.

Post-project implementation, unique data points were abstracted from the EMR to evaluate whether the observed outcomes were due to the interventions. The data points were selected from the literature synthesis as those most likely to determine if the interventions implemented resulted in improved patient outcomes. The expected outcomes of the interventions included higher first-time attempt success rates in placing PIVs on DVA patients, fewer IV related complications, increased catheter dwell times, and decreased costs associated with PIV starts and restarts. Prevention of escalation to PICC line insertion when not medically indicated was also anticipated.

An in-depth analysis was performed to evaluate the ADVAPs submitted during the
project and the documentation on the DI Tracking Log for the number of calls for assistance with
difficult PIVs and outcomes of the requests. A comparison of these documents was done with
the data abstracted from the EMR for each of the patients included in the baseline and project
samples. A detailed review of existing nursing documentation for each of the patients was done
to cross-reference and validate all data collected.

The nursing protocol was implemented as intended. The nurses adhered to the INS
guidelines and appropriately utilized the VAD selection algorithm, as requested. No PICCs were
placed during the project that were not medically appropriate. This was validated by reviewing
data from the patient medical records to ensure the PICCs were warranted.

**Measures**

A retrospective data analysis of the patient medical records, corresponding ADVAPs, and
DI Tracking Log entries was done to evaluate the outcomes of the interventions. The study
variables chosen for analysis were based on the comprehensive literature synthesis of relevant
research and performance improvement projects. The variables that were measured included:

1. Number of attempts to place the PIV.
2. Day of week and hour of the day the PIV was inserted (to identify if there were more
   PIV attempts after-hours/on weekends when the DI nurses were not available).
3. Whether or not ultrasound was used.
4. Type of VAD placed (standard PIV, GAPIV, or PICC)
5. Name of the nurse who inserted the PIV (to identify inpatient nurses versus the
   DI/advanced-skilled nurses on the VAN team).
6. Dwell times of PIVs (standard PIV catheter versus GAPIV).
7. Complication rates of PIVs (standard PIV catheter versus GAPIV) to include
infiltration/extravasation, phlebitis/tenderness, leaking or oozing, localized versus
bloodstream infection, mechanical failure (occlusion), or dislodgement (accidental or
intentional).

8. Number of PICC lines placed.

9. Determination if the PICCs inserted met the EBP criteria for insertion.

10. Cost of nursing time for PIV insertion and reinsertion, VAD supplies, and PICC lines
placed that did not meet the EBP criteria.

The variables for measurement were provided to a hospital analyst to create an EMR
query report for evaluation of the interventions. The query was pulled by mnemonics or
indicators in the EMR assigned to each entry type or by numerical values. This is a standard
report type used to abstract clinical data from the EMR for a multitude of hospital reports. A
query was run of the four weeks prior to the project go-live to obtain a baseline sample. A
second query was run, at the completion of the project, for the four weeks during which the
project was implemented. These time periods will hereafter be referred to as “baseline” and
“project.” The identified data points were used to establish a correlation between the two
samples to determine if changes occurred as a result of the interventions.

**Baseline and project samples.** The sample size was based on The Joint Commission’s
(TJC’s) sampling guidelines, which recommend a sample size of 50 for a unit that has between
101-500 admissions per month (TJC, 2012). The four medical/surgical units combined had an
average monthly admission rate of 381 in 2016. This was used to determine the ideal sample
size for the project. Thus, the minimum sample of 50 patients was the goal for both the baseline
and project samples.
Only adult patients, 18 years of age or greater, admitted to one of the participating units, and required an IV placement during hospitalization were included in the samples. The first 50 patients in the EMR query that met all criteria during the four weeks prior to go-live were included in the baseline sample. The first 50 patients with completed DVA patient ADVAPs from the four-week intervention time period were to be included in the project sample.

**Validity and reliability.** The initial EMR query pulled for the baseline time period resulted in approximately 1,225 patients. The data were filtered to exclude any patients not admitted to one of the participating medical/surgical units. The list was then filtered to exclude any patient that did not have an IV placed by one of the inpatient medical/surgical nurses or a VAN. The list was further limited to include only patients in which all data points in the EMR query were completed.

The accuracy of data was initially validated by comparing the DI Log with the EMR documentation for each patient that had an IV placed by a DI nurse. The name of nurse that placed the VAD, time of placement, and type of VAD placed were cross-referenced. The number of attempts for successful placement was also verified. Patients with documentation discrepancies, including those with no date and time of IV discontinuation, were eliminated from the sample. This resulted in a final baseline sample of 44 patients (N = 44). The same process was used for the project sample with the addition of comparison of the ADVAP documentation to the patient’s EMR and the DI Tracking Log. The initial project sample was hoped to include 50 patients. However, by the end of the project, only 46 ADVAPs were submitted.

Six of the 46 patients identified from the ADVAPs were excluded from the sample for various reasons. The six patients eliminated included: (a) one was not truly a DVA patient per criteria (he was combative and would not hold still for an IV start), (b) one had multiple IV
attempts in excess of allowable number for the project (a float pool nurse not aware of the project limits made five attempts prior to seeking help), (c) one had an unreliable number of documented attempts (listed as 20 attempts and presumed to be the gauge of the IV needle erroneously documented in the attempts section of the EMR), (d) two had multiple discrepancies in documentation between the ADVAP and the EMR (unable to validate true outcomes/events), and (e) one was missing data on the ADVAP (insertion date and time). This left 40 patients for the project sample ($N = 40$).

Additional data validation was done revealing 16 of the patients did not have the PIV discontinuation date and time documented in the EMR. Since the data could not be validated in comparison to the ADVAP, these 16 patients were excluded. The final step was to determine if there were any documentation discrepancies in the DI Tracking Log for the remaining patients. No significant discrepancies were identified. The final project sample was 24 ($N = 40-16$).

Unfortunately, this small sample size made the statistical significance of the outcomes difficult to establish.

**Analysis**

A retrospective review of the patient medical records, DI Tracking Log, and ADVAPs completed by the nurses was done for each of the patients included in the project sample. A statistical analysis using quantitative methods was performed for all data collected during the baseline and project time periods. The analysis was intended to determine if the pre-intervention patient outcomes were statistically different from the intervention findings with $p$ significant at $p < 0.05$. Summary statistics were computed for the number of attempts to successful IV catheter placement, catheter dwell time, and the number of complications post-insertion for various timespans overall. Several subgroups of interest were also computed including time from the
first attempt to successful placement, time from the call for help to arrival, and time from the call for help until successful IV placement.

Dwell times and number of attempts to successful placement were compared between the two catheter groups (GAPIV and standard PIV) using an exact Wilcoxon test. The association between the number of attempts to successfully place a catheter and dwell time was assessed by computing a Spearman correlation coefficient. Dwell time was defined as the time of insertion to catheter discontinuation and was recorded in hours and then converted to days.

An attempt was counted each time the skin was pierced with an IV catheter. Attempts were documented in the EMR by the nurse inserting the IV catheter and documented on the individual patient ADVAP. The number of attempts for IVs started by the DI nurses was also tracked in the DI Tracking Log. Complications of IV catheters were identified in the EMR query to determine the reason for IV discontinuation. The following were included as complications from the available options in the EMR: leaking or oozing, infiltration, occlusion, tender or reddened. Dwell times were calculated from the time of IV insertion to discontinuation whether due to complications or patient discharge home.

**Ethical Considerations**

Capella University’s IRB declared this project does not meet federal regulations and the requirements for human subject research in October 2017. The IRB milestone was thus completed and the project was taken to the clinical site for approval. As per the hospital policy, the project was cleared by the Research Committee prior to beginning. Though not the same as research, ethical considerations for conducting this performance improvement project were considered. Prior to initiation, an evaluation of risk versus benefits to the patients and organization was conducted. The evaluation reinforced the importance of and requirements to
protect patient information and rights, as well as the hospital’s reputation. Precautions were taken to appropriately secure all documents and anything containing patient information was de-identified to prevent a breach of confidentiality.

With regard to consent, all patients sign a general consent for treatment at the time of admission per hospital protocol. No specific treatment or intervention was provided to or withheld from the patients outside of the normal treatments (placement of an IV) already being prescribed by their physicians. No additional consent is required to place a peripheral IV. When a PICC was warranted, a consent was obtained per hospital policy.

Results

The project was implemented as designed without any delays or significant barriers. The method used to introduce, conduct and monitor the project was effective to produce all intended measurable outcomes. A few unanticipated events and unexpected outcomes did arise. Fortunately, many useful learnings emerged that can guide future PDCA cycles to make additional improvements and sustain the practice should the nursing protocol be continued and expanded organization-wide.

Protocol implementation and communication regarding the expectations did evolve somewhat over time. The initial introduction to the project was done by staff meetings, email notification, project flyers posted in the nursing stations, and storyboards placed in the breakrooms of the participating units. Undoubtedly, with a staff of 125 medical/surgical nurses, it is difficult to reach each individual nurse, even with the best preparation. Therefore, more extensive communication to educate all involved stakeholders to sustain the program is advisable. Increased rounding on the units by the project leader may also prove beneficial to
further increase the nurses’ knowledge of the nursing protocol and expectations for participation in the project.

Approximately one week into the project, a communication issue arose that demonstrated the true value of the unit champions as key stakeholders in the project. A nightshift administrative nursing supervisor misinterpreted the nursing protocol for the identification of DVA patients and initially misguided the nursing staff. The supervisor was called after-hours to locate an advanced-skilled nurse to assist with a difficult IV. The supervisor told the inpatient nurse that the nurses were to complete two IV attempts per nurse and four attempts total prior to calling for a VAN. This is the limitation to the number of attempts but was not intended to indicate that the nurse could not stop sooner if he or she needed the assistance of a VAN. Clarification was done on the spot that evening between the unit champion, nursing supervisor, and inpatient nurse. The unit champion followed up with an email to the other unit champions and the project leader the next morning. The correct workflow was reinforced by the project leader during rounding, via an email to the medical/surgical nurses, and discussed at the next staff meeting. No further misinterpretations of workflow were reported.

Failure to complete all required data points on the ADVAPs was another issue that arose. This possibility was anticipated prior to project go-live and the unit champions were instructed to regularly check the ADVAPs each shift to identify any missing data. Documentation deficiencies were brought to the attention of the staff nurse while still on duty so that the ADVAP was completed appropriately. Despite the diligence of the unit champions, three of the ADVAPs were not corrected in a timely fashion and had to be eliminated from the final sample due to lack of documentation.
Overall the expected project aims were achieved. The nurses followed the INS recommendations to limit the number of PIV attempts per nurse and the total number of nurses that attempted. The only exception to this was a float nurse that made five attempts to place an IV before asking for assistance. The data submitted for this patient was excluded from the sample as the protocol was not appropriately followed.

Several unexpected findings were produced from the project and no statistically significant results were achieved. The small sample size and limited time period in which the project was conducted may explain the findings. Several clinically significant outcomes were produced. These findings can be built upon for future implementation of the project and lend support to the need for further study of the interventions.

**Attempts, Complications and Dwell Times**

During the project time period, the average number of attempts required to place a GAPIV was less than a standard PIV catheter (1.50 versus 1.71). Although the findings were not statistically significant \((p = 0.57)\), the results may demonstrate clinical significance. Insertion of the GAPIV in fewer attempts can be translated into fewer delays in care and reduced resource expenditure including VAD placement supplies and clinician time for insertion.

A comparison of IV complication rates during the project for each of the catheters is shown in Table F1. The type of complications, number, and overall complication rate is identified for each catheter. The standard PIV catheter had fewer complications (14%) compared to GAPIV catheter (38%) during the project time period. Complications identified included oozing or leaking of the IV catheter, occlusion, and infiltration. No other complications were reported during the project. While a statistical significance was not found \((p = 0.37)\), a
statistical difference may exist. However, due to the small sample size \( n = 27 \), this could not be determined.

A comparison of dwell time (in days) was performed for the baseline and project groups combined, separately, during dayshift business hours (Monday through Friday 0700-1830) and night shift/after-hours (Monday through Friday 1830-0700 and weekends). The GAPIV catheter consistently had a longer dwell time on average (0.95 more days) than the standard IV catheter for both sample groups combined \( N = 67 \).

When the catheter dwell times were compared for the individual population samples, the GAPIV catheter had nearly twice the dwell time of the standard IV catheter during the project (3.87 versus 2.01 days). While statistical significance was not found \( p = 0.75 \), these results may be more representative of the true difference in the catheters since the VADs were inserted using the same criteria (the nursing protocol for the identification of DVA patients) during the project.

A catheter dwell time of two more days is clinically significant for numerous reasons. Longer catheter dwell times require fewer PIV restarts which translates to less pain and patient dissatisfaction, reduced cost associated with resource expenditure, and fewer delays in care (receipt of IV medications, fluids or studies requiring IV access or IV contrast). These factors can all positively affect morbidity and mortality (Simonov et al., 2015).

As part of this project, a cost analysis was performed to compare nurse time, VAD product cost, and the number of PIV attempts and restarts required for the average length of stay for this hospital. The analysis is further discussed in the Interpretation section.

The medical/surgical nurses that participated in the project adhered to the criteria to limit the number of attempts to place a PIV to two per nurse and no more than four total 100% of the
time. As the result of adherence to these standards, outcomes of the interventions were expected to be similar to those reported in research studies and demonstrate longer catheter dwell times with fewer number of IV attempts due to decreased trauma to the veins (Chiricolo et al., 2015; Idemoto et al., 2014). The results of the number of attempts for successful IV placement and the associated dwell time length in days included both catheter groups combined, all hours of the day, and days of the week. The results showed dwell times actually increased with the number of attempts, though no statistical significance was identified in baseline \( p = 0.72 \) or project \( p = 0.21 \) (See Table F2). These findings are the opposite of what was expected.

Unfortunately, data were not collected on the location of each IV attempt prior to successful placement (i.e., which arm was used and which veins were punctured) to compare to the final location of the successfully placed IV. Therefore, it is difficult to determine a true correlation between the number of attempts to catheter dwell time. Furthermore, the findings yielded inconsistent results. The trend initially looked promising for the baseline data, as attempts increased from one to three, the dwell time decreased. However, the same patterns were not evidenced in the project data which showed an increase in dwell times between attempts two through four (2.33, 5.04 and 7.78 respectively).

In summary, the results do not provide any reliable outcomes. A more comprehensive PDCA cycle and a repeat of the project is therefore recommended. Data collection on VAD placement should include the location of all unsuccessful attempts to compare to the location of successful IV placement. In addition, a larger sample is needed to reliably evaluate if there is a true correlation between dwell time length and number of attempts.

**Outcomes of Calling for Assistance**
Three different time intervals, related to calling for the assistance of an advanced-skilled nurse, were analyzed during the project time period. Figure G1 represents time in hours from initial IV attempt to successful placement. The data includes all IVs placed during the project, with or without the assistance of a VAN. The comparison differentiates between business hours (Monday-Friday 0700-1830) and after-hours (Monday-Friday 1830-0700 and weekends).

A shorter time from first attempt to successful IV placement was identified in IVs placed after-hours. Both the mean and median were 25 minutes. During business hours, the mean time from the first attempt to successful placement was two hours and 45 minutes. The median was two hours and 21 minutes. As with the other data sets, due to the small sample size (n=3) for both business and after-hours, statistical significance was difficult to establish ($p = 0.10$). However, these results may suggest that the night shift nurses are more skilled at placing IVs since the time from first attempt to successful insertion was shorter after-hours when the DI nurses are not on duty. The difference in skill level could be due to the day shift inpatient nurses’ reliance upon the DI nurses, providing fewer opportunities to maintain their IV placement skills.

The second time interval analyzes time in hours from the call for assistance to the arrival of help and is differentiated between business and after-hours. The time to arrival is 5 minutes longer during business hours than after-hours (1.17 versus 1.09 hours). However, this finding is not statistically ($p = 0.45$) nor clinically significant.

The third time interval shows the mean time in hours from the time of the call for assistance to successful IV placement, comparing business to after-hours. The mean time from call to placement during business hours is 15 minutes less than after-hours (1.41 versus 1.66 hours). This finding is not statistically significant ($p = 0.34$).
A conclusion can be drawn that difficult IVs are successfully placed sooner when more VAN nurses are available (the majority are on duty during business hours) since the time from call for assistance to the successful placement is shorter. However, this needs to be validated by repeating the project for a longer time interval using a larger sample size.

**Outcomes When IVs Placed by Vascular Access Nurses**

The dwell times of the catheters placed during the project were analyzed to determine dwell time based on time of day the catheter was placed and catheter type. When comparing the dwell times of catheters placed during day shift (business hours Monday-Friday 0700-1830) to night shift (after-hours Monday-Friday 1830-0700 and weekends), the results indicate that the IVs placed by the night shift nurses had longer average dwell times than those placed by the day shift. This was true for both catheter types. Dwell times are measured in days.

When an IV was placed by a day shift nurse, the average dwell time for a standard PIV catheter was 1.89 and a GAPIV was 2.32 ($p = 0.37$). When an IV was placed by a night shift nurse, the average dwell time for a standard PIV was 2.10 and the GAPIV was 5.85 ($p = 0.53$). The GAPIV consistently outperformed the standard PIV in dwell time, regardless of shift, as is consistent with the current literature (Chiricolo et al., 2015; Idemoto et al., 2014). Furthermore, the GAPIV catheters placed after-hours have 2.5 times the dwell time of those placed by dayshift (5.58 versus 2.32 days). While the results were not statistically significant, the clinical significance is important to our patients as well as from a financial standpoint from fewer IV restarts and fewer delays in care.

The comments listed on the ADVAPs completed by the medical/surgical nurses were also reviewed as part of the project outcome analysis. Several barriers to receiving timely assistance or lack of assistance from the advanced-skilled vascular access nurses were identified. The most
common barrier noted was the lack of availability of a VAN after-hours. This validates what is already known, there are fewer nursing resources available to assist with difficult IVs on the night shift.

**Requests for DI Nurses to Assist with DVA Patients**

For further insight, the DI Tracking Log was evaluated for the four-week time period the project was implemented. The total number of requests for assistance received by the DI nurses during business hours, Monday through Friday between 0700-1830 were tracked (See Table G1). Of the 148 requests, the DI nurses successfully placed 84 standard PIV catheters and 59 GAPIV catheters. These numbers include all requests hospital-wide, not just from the medical/surgical units. There were two instances where the nurses were unable to successfully place a VAD and the physician was contacted to place a central line. There were two requests unable to be fulfilled by the DI nurses due to inadequate staffing.

A total of four PICCs were placed during the project. All four met the EBP criteria of the VAD selection algorithm used for this project. One PICC was placed based on the DI nurse’s patient assessment. The other three PICCs were placed at the request of the inpatient medical/surgical nurses. When a PICC was warranted per the algorithm, a call was made to the physician for an order and the PICC was inserted by a DI nurse. Of note, PICCs placed by direct physician order (without nurse input) are not included in the numbers above nor does the total include all PICCs that were placed house-wide.

The number of VADs placed by the DI nurses during the four-week project period demonstrates the value added by having nurses on duty with advanced vascular access placement skills. Unfortunately, since the DI nurses have limited availability, the same standard of care is not sustained after-hours and during weekends. Clearly, delays in patient care can occur from
the lack of readily available staff. One additional aspect, not directly measured in this project, is
the nurse reports of patient dissatisfaction with multiple IV attempts. This topic warrants further
attention and if the project were to be continued, measurement of patient satisfaction would be
recommended.

**Discussion**

**Summary**

The results of this performance improvement project suggest that the implementation of
evidence-based VAD selection criteria and application of a standardized approach to placing
PIVs on DVA patients, as represented in the nursing protocol piloted in this project, can
positively affect patient outcomes. Consistent availability of nurses with advanced vascular
access placement skills, able to utilize uniquely-engineered GAPIV catheters and ultrasound
guidance for insertion, can prevent delays in care, and reduce costs associated with product and
supply usage, as well as clinician time for insertion.

The project outcomes demonstrate a possible association between having the VANs
available to assist with difficult IVs and a shorter time from the call for help to successful IV
placement. The project results may lend support to the justification for staffing additional nurses
after-hours and weekends and is hoped to be considered by the organization as a strategy to
explore to provide a consistent standard of VAD-related care.

Cost savings to the organization can be projected by investing in the translation of current
evidence into practice. Resource utilization for VAD supplies and nurse time required to start
and restart IVs can be limited. Patient safety and quality of care can further be improved by
limiting the number of attempts needed for successful IV placement. A relationship between the
presence of a VAN able to insert specialty IV catheters with ultrasound and increased catheter
dwell times also suggest additional cost savings opportunities. Reduction in the placement of PICCs or central lines as rescue vascular access devices from depletion of peripheral veins, can also provide significant savings to the organization.

Anecdotally, patient satisfaction will improve as the result of providing timelier VAD placement, and potentially improve patient morbidity and mortality by expediting completion of diagnostic testing and the provision of necessary treatments. Interestingly, several of the DI nurses, who regularly insert GAPIVs, reported that the DVA patients are actually asking for the nurse to come with the ultrasound and place a GAPIV when they come to the hospital. This is an indicator that even the patients recognize the difference with an advanced-skilled VAN is available and armed with the right equipment.

The implementation of this project has already influenced nursing practice at the hospital. The IV Therapy Policy was updated in December 2017 to reflect current evidence-based practice piloted during the project. The update included the recommendation to use vein visualization equipment when placing PIVs and defined the standard of care for PIV placement by limiting the number of attempts to no more than two per nurse or four attempts total on any one patient per INS Guidelines. Once the limitations are reached, the expectation to request assistance from a nurse with advanced vascular access placement skills is clarified. Further guidance includes contacting the physician for an alternative vascular access route such as a PICC or central line when appropriate. The updates can be considered significant steps toward improving the standard practice within the organization and may begin to close the identified gap in VAD placement.

**Interpretation**
Research studies have demonstrated statistical significance in outcomes when comparing standard versus GAPIV catheters. The study by Idemoto et al. (2014) was a randomized controlled trial conducted over four months in a surgical ICU and surgical telemetry unit. The study had a large sample (standard IV catheter group $n = 125$ and the GAPIV catheter group $n = 123$) and produced statistically significant results. A notable example is the first-time attempt success rate for the GAPIV was 89% compared to the standard PIV of 47% ($p < 0.001$).

Chiricolo et al. (2015) conducted an observational cohort study in an ED alternating the placement of catheter types between the standard PIV and a GAPIV. The sample size included a total of 200 patients with equal distribution (systematically alternated) between placement of the two catheters. The study revealed statistically significant findings ($p = 0.001$) of higher first-time attempt success rates for the GAPIV catheter (85%) over the standard PIV (22%). While statistical significance was not achieved in this DNP project, similarities were seen in higher first-time attempt success rates for the GAPIV versus the standard PIV catheter (1.50 versus 1.71 respectively).

Complications reported by Idemoto et al. (2014) were the same as seen in this project (infiltration, leaking, and occlusion), but also included dislodgement, phlebitis, and patient complaint of pain. The Idemoto study showed a 52% complication rate for the standard PIV catheter and only 8% with the GAPIV catheter ($p < 0.001$). The complications rates for this project were higher at 14% for the standard PIV catheter and 38% for GAPIV catheter, which was not expected. The difference in complication rates in this project may be related to the fact that the GAPIV was not always the first catheter chosen. Several attempts by the inpatient nurse using a standard PIV catheter often occurred prior to the GAPIV being placed. In these
circumstances, the GAPIV was used as a rescue IV, rather than selected as the catheter to be placed initially like the Idemoto study.

As EBP is now the standard for patient care, nurses must have up to date knowledge and the ability to implement best practices in order to increase the likelihood of achieving the desired health outcomes for patients (Farquhar, 2008; Shaw, 2017). Conversely, failure to use EBP guidelines and lack of skilled clinicians comes with many negative consequences. Increased PIV complications and failures, repeated skin punctures, wasted resources, excess use of supplies, and delays in treatments, as well as risks associated with CVADs, are among the most commonly listed in current literature (Carr et al., 2016; Chiricolo et al., 2015; INS, 2016; O’Grady, 2015). Literature also shows that PICCs are overused and inserted when not medically necessary (Chopra, Flanders, & Saint, 2012; Russo et al., 2011). Knowing this, a cost of nursing time for PIV insertion and reinsertion, VAD supplies, and PICC placement was evaluated as part of the project.

In 2016, there were 850 PICCs inserted at the hospital. Projected cost savings can be realized by reducing the number of PICCs placed that are not warranted. One strategy to reduce inappropriate PICC insertion is the application of the VAD selection algorithm used in this project. A viable alternative to PICC line placement is to insert specialty catheters (GAPIVs) under ultrasound guidance to meet the needs of the DVA patients. Further return on investment can thus be realized by continuing to reduce unnecessary PICC insertions and prevention of complications associated with this invasive procedure.

A cost savings to the organization of $9,168 over one year can be projected from decreasing the number of PICC insertions by 6% (from 850 in 2016 to 802 in 2017) (See Table G2). This is the actual number of PICCs inserted at the hospital per the Materials Management
Department and corresponds to the time during which the GAPIV catheters became available for use by the advanced-skilled nursing staff.

A detailed cost analysis reveals opportunities for additional cost savings. The figures used in the analysis were based on the findings of the project and costs obtained from available VAD-related studies. The following elements were used in the calculation:

1. Current hospital product pricing per VAD including all required supplies ($199/ PICC, $32/standard PIV, and $67/GAPIV)
2. Average number of minutes to insert PICCs, standard PIVs, and GAPIVs based on DI nurse report (for PICCs) and current literature for PIVs and GAPIVs (Idemoto et al., 2014)
3. Average hourly wage for a registered nurse at the hospital (approximately $60/hour)
4. Average hospital length of stay of 4.6 days based on the last four quarters (Table G3).
5. Number of attempts to place and catheter dwell time based upon project data for each catheter type (of note, four PICCs were placed during the project, each on the first attempt and all lasted greater than the average hospital LOS. Thus, calculations for PICC placement are based on one attempt).

The final costs for each VAD type included nursing time and demonstrates the increased cost associated with VAD insertion and re-insertion above the price of the catheter and supplies alone (See Table G4). The resulting cost of insertion for a 4.6-day LOS was $251 for a PICC, $175 for a standard PIV, and $130 for a GAPIV. Strategic trade-offs are demonstrated by the decreased use of PICCs and the increased use of the less expensive PIV and GAPIV catheters.

The estimated time for a PICC insertion is between 30-170 minutes, depending upon the patient’s vasculature (Tomaszewski et al., 2017). For this cost analysis, 60 minutes for insertion
was used as this was the average time reported by the DI nurses. Average time to insert a GAPIV (5.6 minutes) versus standard PIV (12.5 minutes) on a DVA patient was calculated using average times from the Idemoto et al. study (2014). This study was conducted in a surgical ICU and medical/surgical telemetry unit and included adults requiring non-emergent IV insertion and thus represents a similar population to that evaluated in this project.

The outcomes of the cost analysis identify potential opportunities for cost-savings by expanding the implementation of the piloted nursing protocol for DVA patients hospital-wide. For every PICC line avoided (non-medically necessary) and replaced by a standard PIV or GAPIV, the cost savings potential is between $76-121 (the difference between the cost of a PICC and standard or GAPIV catheter). This does not account for the potential cost-savings that can come from prevention of central line infections or other complications.

The cost of hiring additional vascular access nurses may be offset by the savings identified herein. This cost analysis provides preliminary support that can be used when considering hiring additional staff to cover VAD placement after-hours. However, a full business case breakdown is needed to justify the additional FTEs (full-time equivalents), including a more in-depth cost analysis, and is beyond the scope of this project.

One final strategic trade-off to consider, well documented in the literature (Chiricolo et al., 2015; Helm, et al., 2015; Idemoto et al., 2014), is the decrease in patient satisfaction from repeated PIV attempts and corresponding delays in care. This is most often related to unskilled vascular access clinicians or lack of availability of appropriate assistive devices that facilitate higher first-time attempt success rates (Jackson et al., 2013; Shaw, 2017). While patient satisfaction was not the main focus of the project, the issue cannot be overlooked in the present era of pay for performance and patient satisfaction-driven reimbursement. The multitude of
variables explored in this project should be considered by the organization when evaluating the existing systems within the hospital and the feasibly of creating a specialty vascular access team (Chiricolo et al., 2015; Helm et al., 2015; INS, 2016).

**Limitations**

The project was limited by the short time period in which it was conducted and the small sample size that resulted. The project was also limited by the fact that it was only conducted at a single site hospital and included only adult patients admitted to medical/surgical units requiring VAD placement during hospitalization. Furthermore, the baseline sample included all patients admitted to a medical/surgical unit while the project data included only DVA patients admitted to these units. Some of the results may therefore not truly be representative as the two groups are not necessarily comparable.

Documentation discrepancies became apparent during the data analysis. Efforts were made to minimize the impact on the results, specifically by eliminating any data in which reliability was questionable. The requirement to document all attempts to place an IV (including those by any nurse that attempted up to and including the successful IV placement) was communicated prior to initiation of the project. However, this was not addressed prior to collection of the baseline sample. As a result, some of the documentation in the baseline sample may not truly reflect the total number of attempts to start an IV. This became evident when comparing the baseline to project data. Very few patients in the baseline data had more than two IV attempts documented. By comparison, multiple patients in the project sample had two or three attempts recorded. Comparison of the number of attempts to successfully place an IV between the baseline and project group were therefore not necessarily reliable, making the
validity of the results questionable. An inference can be drawn that the number of attempts reported in the project data may be more representative of the true state.

Further documentation discrepancies were identified during the review of the baseline and project data pulled from the EMR queries. For example, one patient from the project sample had 20 documented as the number of attempts to place the IV. An assumption was made that the nurse documented the gauge of the needle (20) in the number of attempts field of the EMR. As this was not likely the true number of attempts, the patient was eliminated from the sample. Unfortunately, in the current EMR version, the number of attempts for IV start is a free-text field, thus any number can be entered. A recommendation for future EMR updates would be to replace the free-text section with predetermined options (i.e., 1, 2, 3, 4 or 5 attempts) to reduce such documentation errors.

An additional documentation issue became evident when evaluating catheter dwell times. Nurses occasionally failed to document the date and time of the IV catheter removal. Patients without this documented in the EMR had to be eliminated from the sample. Because of missing documentation, an audit of the EMR on any given day would indicate that many patients go home with their IV still in place. Certainly, this is not truly the case. This issue was brought to the attention of the director of clinical informatics and is reported to be a long-standing challenge to correct.

Due to the project limitations, the work may not be generalizable to other settings. Furthermore, the accuracy of nursing documentation in the EMR and on the DI Tracking Log is dependent upon the individual nurses performing the data entry. While a standard expectation for documentation in the EMR and clear guidance exists for the completion of the DI Tracking
Log, there are inevitably flaws in the documentation. Poor documentation practices may, therefore, further limit the reliability of the project results.

**Conclusions**

Regardless of statistical significance, this project was still worthwhile. An informal survey of several of the nurses on the medical/surgical units that participated in the project reported that several months post-implementation, and without any further effort to hard-wire the practice, they continue to follow the nursing protocol for DVA patients. The nurses also reported that they are continuing to accurately document the actual number of PIV attempts for successful IV placement to include all attempts made, recognizing the importance of painting an accurate picture of patient care.

The next steps for this project would be to perform additional PDCA cycles to further identify if the interventions implemented were sufficiently effective and statistically significant in improving patient outcome. Formal audit and monitoring would be needed to determine if the protocol was being sustained and truly hardwired into nursing practice. Modifications to the process at all stages, as identified throughout this manuscript, could be used to guide the conduction of additional performance improvement efforts.

Finally, by continuing the project, the opportunity to obtain a larger sample size, in both the baseline and project, as well as expanding the use of the nursing protocol to other units, would provide more reliable results. This information could perhaps further justify the investment for more advanced-skilled nurses on all shifts and truly close the gap in care identified by this project.
References


Harpel, J. (2013). Best practices for vascular resource teams. *Journal of Infusion Nursing,


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doi:10.1016/j.java.2016.06.002

doi:10.1513/AnnalsATS.201508-509ED


doi:10.1002/jhm.2335

and resources of peripherally inserted central catheter insertion procedures: a comparison between blind insertion/chest X-ray and a real-time tip navigation and confirmation system. *Clinicoeconomics and Outcomes Research, 2017*(9), 115-125.

APPENDIX A. NURSE-DRIVEN PROTOCOL FOR THE IDENTIFICATION OF DVA PATIENTS (WORKFLOW DIAGRAM)

IDENTIFICATION OF DIFFICULT VENOUS ACCESS PATIENTS

**STEP 1**
Identification of Difficult Venous Access (DVA) Patient

- Peripheral vein neither palpable nor visible - consider calling for advanced skilled vascular access nurse.
- History of difficult venous access, obesity, IV drug abuse (IVDA), dialysis, sickle cell disease, chemotherapy, or other chronic medical conditions.
- No more than 2 peripheral IV (PIV) attempts per nurse or 4 attempts total before advancing to next level (INS, 2016).

**STEP 2**
Call for Assistance from the Specially Trained Vascular Access Nurses

- **DI Nurses:**
  - Trained to insert PIVs on DVA patients with ultrasound and transillumination devices.
  - Skilled at inserting standard PIVs, guidewire assisted catheters (GAPIV), midlines, and PICCs.
- **Speciality Vascular Access Nurses outside of DI:**
  - Trained to insert PIVs using ultrasound guidance (GAPIVs)
  - Currently 33 nurses trained (in ED, Med/Surg, ICU, and Patient Care Resource)
  - Contact Administrative Supervisor after hours (when DI not available).

**STEP 3**
Advance to Central Venous Catheter (CVC) Insertion by MD

- Contact MD if more invasive line (CVC) is needed (e.g., patient requires invasive monitoring and a PICC cannot be placed, or patient is becoming unstable and the vascular access nurse is unable to start a PIV).

Created by Cheryl Campos, MSN, RN-BC, CEN

REFERENCE:
Infusion Nurses Society (INS), 2016. Infusion Therapy Standards of Practice. Journal of Infusion Nursing. 39(1Suppl), Standard 33, S64. [www.journalofinfusionnursing.com](http://www.journalofinfusionnursing.com)
## APPENDIX B. DONABEDIAN'S STRUCTURE, PROCESS, AND OUTCOMES

**Structure**

<table>
<thead>
<tr>
<th>Organizational Attributes (Current State):</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Approximately 275-bed hospital</td>
</tr>
<tr>
<td>• More than 56,000 ED visits annually</td>
</tr>
<tr>
<td>• 10,100 adult admissions annually</td>
</tr>
<tr>
<td>• Designated Stroke and STEMI receiving center</td>
</tr>
<tr>
<td>• Certified Chest Pain Center</td>
</tr>
<tr>
<td>• Unionized</td>
</tr>
<tr>
<td>• Just culture</td>
</tr>
<tr>
<td>• Beginning phases of seeking Magnet recognition status</td>
</tr>
</tbody>
</table>

**Organizational Resources:**

| • Thirty-three advanced-skilled vascular access nurses |
| • Vascular access insertion assistive equipment       |
| • Specialty vascular access devices (PICCs and GAPIV catheters) |

**Process**

<p>| • Intravenous Therapy Policy (indicating the number of allowable IV attempts per nurse) |
| • Identification of DVA patients and guidance of when to seek the assistance of advanced-skilled vascular access nurses |
| • EBP algorithm for VAD selection |</p>
<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Anticipated Results:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a) Improved vascular access device placement decisions</td>
</tr>
<tr>
<td></td>
<td>b) Increased first-time attempt PIV placement success rates</td>
</tr>
<tr>
<td></td>
<td>c) Decreased cost of supplies related to:</td>
</tr>
<tr>
<td></td>
<td>1. Fewer PIV attempts and supplies needed to place VADs</td>
</tr>
<tr>
<td></td>
<td>2. Decreased number of restarts required from less damage to/depletion of peripheral veins</td>
</tr>
<tr>
<td></td>
<td>3. Prevention of escalation to more invasive/costly/risk-associated lines such as PICCs or CVADs when not medically warranted</td>
</tr>
<tr>
<td></td>
<td>4. Decreased use of nursing resources/time due to higher first-time PIV placement success rates and fewer complications requiring restarts</td>
</tr>
<tr>
<td></td>
<td>d) Prevention of potential delays in care and costs associated with increased LOS and poor patient outcomes</td>
</tr>
<tr>
<td></td>
<td>e) Decreased adverse outcomes in vascular access (i.e., fewer incidence of infiltration/extravasation, phlebitis, localized/bloodstream infections, and occlusion)</td>
</tr>
</tbody>
</table>
APPENDIX C. VASCULAR ACCESS DEVICE SELECTION ALGORITHM

Vascular access device selection algorithm. From "Navigating Venous Access: A guide for hospitalists by Simonov et al., 2015, Journal of Hospital Medicine, 10(7), 473. Used with permission V. Chopra MD.
APPENDIX D. AUDIT FOR DIFFICULT VENOUS ACCESS PATIENTS (ADVAP)

MED/SURG PERFORMANCE IMPROVEMENT AUDIT FOR DVA PATIENTS

[Complete Form for Every Identified DVA Patient]

1. Patient identified as having difficult venous access (DVA) - (check all that apply):
   - [ ] Peripheral veins neither palpable nor visible
   - [ ] History of difficult venous access, obesity, IV drug abuse (IVDA), dialysis, chemotherapy, sickle cell disease, diabetes, or other chronic medical conditions.
     Consider calling for assistance from DI nurse/specialty vascular access nurses prior to attempting peripheral IV (PIV).
   - [ ] DVA patient identified – called for assistance prior to attempting PIV (Proceed to # 3).

2. If attempts made to start PIV PRIOR TO calling for assistance, complete the following (If not, proceed to # 3):
   - Date of initial attempt: ________________ Time of initial attempt: ________________
   - # of nurses that attempted prior to calling: ______
   - # of PIV attempts prior to calling for assistance: ______

3. Complete the following for ALL PATIENTS:
   - Date contacted DI nurse/or Administrative Supervisor for specialty vascular access nurse (after hours) for assistance: ______ Time contacted: ______
   - Time DI nurse/specialty vascular access nurse arrived: ______

OUTCOMES (check all that apply):
   - [ ] PIV placed by DI nurse (GAPIV or standard IV catheter)
   - [ ] PIV placed by specialty vascular access nurse (nurse outside of DI) - (GAPIV or standard IV catheter)
   - [ ] PICC placed by DI nurse
   - [ ] Escalated to central line insertion by MD

BARRIERS TO RECEIVING ASSISTANCE WITH PIV START (Complete only if issues identified):
Did not receive assistance due to (mark all that apply):
   - [ ] DI nurse unable to come
   - [ ] Afterhours, no DI nurses on duty and no specialty vascular access nurses available
   - [ ] Other (please list):

4. Additional Comments (continue on back as needed):

Completed by: ________________________________ (Please print)

Please return to DVA Patient Pilot Binder, unit champion, or Cheryl Comas- Project Leader

- [ ] Unit Champion double checked for completeness

PATIENT STICKER
# APPENDIX E. DI TRACKING LOG

<table>
<thead>
<tr>
<th>Date/Time of Request</th>
<th>Room #</th>
<th>Patient Sticker</th>
<th>Service Requested (Difficult IV start, PICC)</th>
<th>Outcome of Event (Peripheral IV placed with ultrasound 1st attempt, GAPIV placed with ultrasound 2nd attempt, PICC placed on 1st attempt etc.)</th>
<th>Name of DI Nurse that inserted line</th>
<th>If unable to fulfill request, document reason (insufficient staff, too many requests at one time, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX F. RESULTS

Table F1. *IV Complications During Project*

<table>
<thead>
<tr>
<th>Complication Type</th>
<th>GAPIV Catheter (n = 16)</th>
<th>PIV Catheter (n = 7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaking/oozing</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Occluded</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Infiltrated</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

Complication Rates

- GAPIV Catheter: 38% (6/16)
- PIV Catheter: 14% (1/7)

Table F2. *Number of Attempts to Place versus Dwell Time*

<table>
<thead>
<tr>
<th>Number of Attempts</th>
<th>Baseline (n = 34/44)</th>
<th>Project (n = 15/23)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Attempt</td>
<td>Mean Dwell Time (in Days)</td>
<td>2.70</td>
</tr>
<tr>
<td>2 Attempts</td>
<td>Mean Dwell Time (in Days)</td>
<td>2.56</td>
</tr>
<tr>
<td>3 Attempts</td>
<td>Mean Dwell Time (in Days)</td>
<td>1.92</td>
</tr>
<tr>
<td>4 Attempts</td>
<td>Mean Dwell Time (in Days)</td>
<td>0.00</td>
</tr>
</tbody>
</table>
APPENDIX G. COST ANALYSIS

Table G1. Total Requests for Assistance

<table>
<thead>
<tr>
<th>Type of Request</th>
<th>Number of Requests</th>
<th># of Standard PIVs Placed</th>
<th># of GAPIVs Placed</th>
<th>DI Nurse Recommended and Placed PICC</th>
<th>Unable to Get</th>
<th>Could Not Assist (too busy etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficult IV Placement</td>
<td>148</td>
<td>84</td>
<td>59</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Table G2. Projected Annualized Savings from Reducing PICC Insertions

<table>
<thead>
<tr>
<th>Number Inserted</th>
<th>Cost per PICC Tray</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total PICCs inserted in 2016 = 850</td>
<td>$191</td>
<td>$162,350</td>
</tr>
<tr>
<td>Total PICCs inserted in 2017 = 802</td>
<td>$191</td>
<td>153,182</td>
</tr>
<tr>
<td>Projected Savings</td>
<td></td>
<td>$9,168</td>
</tr>
</tbody>
</table>

Table G3. Hospital LOS 2016-2017

<table>
<thead>
<tr>
<th>Hospital Average LOS 2016-2017</th>
<th>Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016 Q4</td>
<td>4.4</td>
</tr>
<tr>
<td>2017 Q1</td>
<td>4.6</td>
</tr>
<tr>
<td>2017 Q2</td>
<td>4.5</td>
</tr>
<tr>
<td>2017 Q3</td>
<td>4.8</td>
</tr>
<tr>
<td>Average LOS for last four Quarters</td>
<td>4.6</td>
</tr>
</tbody>
</table>
Table G4. Cost Analysis for VAD Placement

<table>
<thead>
<tr>
<th>Type of VAD Inserted</th>
<th>Product Cost in Dollars per Attempt</th>
<th>Average Nurse Time (in Minutes) per 1 Attempt</th>
<th>Average Hourly Wage of Nurse (Estimated at $1/Minute)</th>
<th>Final Cost for Insertion (Per 1 Attempt)</th>
<th>Average # of Attempts for Successful Insertion (at Project)</th>
<th>Average Dwell Time of VAD (at Project)</th>
<th>Required Restarts During Average LOS (4.6 Days)</th>
<th>Total Cost per Patient per Stay (Cost of Insertion X Attempts X Restarts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PICC</td>
<td>$191</td>
<td>60</td>
<td>$60</td>
<td>$251</td>
<td>1.0</td>
<td>&gt; 4 days</td>
<td>0</td>
<td>$251</td>
</tr>
<tr>
<td>Standard PIV Catheter</td>
<td>$32</td>
<td>12.5</td>
<td>$12.50</td>
<td>$45</td>
<td>1.7</td>
<td>2.01</td>
<td>2.29</td>
<td>$175</td>
</tr>
<tr>
<td>GAPIV Catheter</td>
<td>$67</td>
<td>5.6</td>
<td>$5.60</td>
<td>$73</td>
<td>1.5</td>
<td>3.87</td>
<td>1.19</td>
<td>$130</td>
</tr>
</tbody>
</table>

Figure G1. First attempt to successful placement