USE OF ULTRASOUND GUIDANCE DURING CANNULATION OF
ARTERIOVENOUS FISTULAS OR
ARTERIOVENOUS GRAFTS

by

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A scholarly project submitted in partial fulfillment of the requirements for the degree of
Doctor of Nursing Practice in Family & Individual Health

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DEDICATION

There have been many individuals that have supported me throughout the completion of my degree and scholarly project. My family: husband, Gary, daughter, Anne Marie, and son, Brian, have supported me through this adventure with constant love and support. Without them, I may have lost my sanity. My parents, Rocky and Kenni Ann Schauer, instilled in me the thirst for knowledge and raised me with a “can do” attitude. These traits have been invaluable during my life. Without the support of my co-workers at St. Peter’s Hospital’s dialysis department and their willingness to share their expertise and knowledge of ultrasound-guided cannulation, this project would have been difficult to complete and implement. My fellow home-therapy nurse, Lisa Mott RN, whose willingness to “go the extra mile” to assure our patient are successful and thriving on home dialysis therapies, has helped ease my transition. Without her commitment to these patients, I would have struggled “passing the torch.” My director, Nancy Pierce, and Medical Director, Dr. Robert LaClair, have also provided unwavering support. I will forever owe all of these individuals my gratitude.
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ABSTRACT

Individuals who require renal replacement therapy overwhelmingly choose outpatient hemodialysis. In December, 2013, 62.5% of these patients were using an arterial venous fistula (AVF) and 15% were using an arterial venous graft (AVG) for their hemodialysis access (National Institute of Diabetes and Digestive and Kidney Diseases, 2015). Appropriate cannulation techniques are an essential element in access preservation and prevention of access-related complications. Missed cannulations of AVFs result in damage to the fistula (Lee, Barker, & Allon, 2006). Ultrasound-guided cannulation has proven to be an effective technique for the placement of peripheral venous catheters (IVs) and for placement of central venous dialysis catheters (CVCs) (Brannam, Blaivas, Lyon, & Flake, 2004). The purposes of this scholarly project were to determine if ultrasound-guided cannulation of AVFs/AVGs decreased the number of missed cannulations, to determine staff and patient perceptions regarding cannulation, and to implement a quality-improvement project (QIP). The QIP consisted of creating an ultrasound-guided policy and procedure, training program, and competency evaluation at a hospital-based dialysis facility. Analysis of 53 electronic health records (EHRs) determined the number of missed cannulations in relation to the purchase and availability of a bedside ultrasound machine and implementation of the QIP. Likert scale surveys were distributed to staff and patients to determine familiarity with ultrasound-guided cannulation and perceptions concerning access cannulation. Results: Staff surveys demonstrated a need for policy and procedure, training, and competencies for ultrasound-guided cannulation. Patient surveys demonstrated a need for more consistent ultrasound use and showed increased patient satisfaction with cannulation experience when ultrasound guidance was utilized. EHR data revealed a 53% reduction in the number of missed cannulations after the purchase and availability of a bedside ultrasound machine for ultrasound-guided cannulation. Conclusion: Implementation of an ultrasound-guided cannulation policy and procedure, training program, and competency helped guide staff with this cannulation technique. Further research is needed to determine if ultrasound-guided cannulation should be classified as a best practice technique.
The Centers of Medicare and Medicaid Services closely regulate end-stage renal disease (ESRD) and collect data that provide insight into this population. The dialysis facilities are required to maintain patient data on a variety of patient markers thus providing data at the local level. ESRD Networks collect regional data. The ESRD Networks then submit the data to the United States Renal Data System (USRDS) thus providing data on a national level. The National Institute of Diabetes and Digestive and Kidney Diseases has graft survival rates, costs of treatment per patient, arterial venous fistulas (AVF) and arterial venous grafts (AVG) use by gender, and patient demographic data. These data points provide information on chronic kidney disease (CKD) incidence, ESRD incidence, dialysis access prevalence, infection rate, graft survival rates, and associated costs for treatment. All these data points provided background information for this project.

Individuals with chronic kidney disease who require renal replacement therapy overwhelmingly choose outpatient hemodialysis as opposed to home-therapy options (National Institute of Diabetes and Digestive and Kidney Diseases, 2015). In December, 2013, 62.5% of these patients were using an arterial venous fistula (AVF) and 15% were using an arterial venous graft (AVG) for hemodialysis access (National Institute of Diabetes and Digestive and Kidney Diseases, 2015). In 2014, there were 779 dialysis
patients residing in Montana; 82.3% of these patients were receiving in-center hemodialysis (Northwest Renal Network, 2015). St. Peter’s Hospital, a facility in Helena, Montana, provides an average of 554 outpatient hemodialysis treatments per month; 69% of the patients receive treatment through an AVF and 6.9% through an AVG (Pierce, 2016).

AVFs are the optimal vascular access for hemodialysis since they have higher durability, lower infection risk, and lower rate of interventional procedures needed to assure patency (Pisoni, Zepel, Port, & Robinson, 2015). Preservation of an access, preventing access infections, and successful cannulation with minimal attempts are major concerns for nephrology professionals.

The way needles are inserted into an AVF/AVG plays a role in the longevity of the access (Parisotto et al., 2014). The cannulation methods currently used are: (1) rope ladder (Figure 3) and (2) buttonhole or same site (Figure 4). Research comparing these techniques for insertion pain, prevalence of missed cannulation, prevalence of pseudo-aneurism development, and potential for infection is abundant (Parisotto et al., 2014; Santoro et al., 2014; Van Loon, Kessel, Van Der Sande, & Tordoir, 2009b).

Ultrasound-guided cannulation, in order to establish peripheral intravenous (IV) access, has been shown to decrease the number of missed cannulations and time to successful cannulation (Brannam et al., 2004; Brauman, Braude, & Crandall, 2009). Ultrasound use has also been shown to increase user confidence for successful cannulation (Blaivas & Lyon, 2006; Brannam et al., 2004; & Brauman et al., 2009). However, literature regarding the impact of using ultrasound guidance during cannulation
of AVFs and AVGs is scarce. Ultrasound guidance was currently being utilized in the hospital-based dialysis unit that served as the site for the scholarly project; however, there were no policies or procedures in place for standardization of use prior to the implementation of this project.

**Purpose and Objectives**

The purposes of this project were to determine if ultrasound-guided cannulation of AVFs/AVGs decreased the number of missed cannulations, to determine staff and patient perceptions regarding cannulation, and to initiate a QIP to implement an evidence-based ultrasound-guided policy and procedure, training program, and competency evaluation at a hospital-based dialysis facility. This project included an evaluation of patient and staff perceptions regarding ultrasound-guided cannulation and data collection from electronic health records for dialysis patients comparing the number of missed cannulations pre-ultrasound to post-ultrasound availability. The Montana State University statistical department, led by lead statistician Michaela Powell, with oversite by director Lillian Lin, Ph.D., and additional contribution from Kenneth Flagg, M.S. completed data analysis.

**Significance**

**Prevalence of Kidney Disease**

Kidney disease (nephritis, nephrotic syndrome, and nephrosis) is the ninth leading cause of death in the United States (Centers for Disease Control and Prevention, 2014).
One in 10 American adults have some level of chronic kidney disease (CKD) (National Institutes of Health, 2009). Individuals with end-stage renal disease (ESRD) have a glomerular filtration rate of less than 15 mL per minute and require renal replacement therapy (RRT). The incidence of ESRD within the United States has remained relevantly stable since 2013, but the prevalence of patients receiving RRT has increased 3.5% from 2012 to 2015 (National Institute of Diabetes and Digestive and Kidney Diseases, 2015). This increase is attributed to the decline in the mortality rate within this population (National Institute of Diabetes and Digestive and Kidney Diseases, 2015).

The Department of Health and Human Services’ Centers for Medicare and Medicaid Services funds 18 End-Stage Renal Disease Networks. These networks are private, not for profit corporations whose missions are to promote optimal dialysis and transplant care for the CKD patients within their areas. These networks also collect and analyze data collected on patients who are enrolled in the Medicare ESRD program (Northwest Renal Network, 2015). The Northwest Renal Network oversees the dialysis facilities and CKD patients within Montana, Idaho, Washington, Oregon, and Alaska (Northwest Renal Network, 2015). Data collected by the Northwest Renal Network indicated that there were 779 dialysis patients residing in Montana: 82.3% of these patients were receiving in-center hemodialysis (Northwest Renal Network, 2015).

Cost of ESRD

The cost to care for ESRD patients, who comprise 0.07% of the world population, averages 2% of the overall healthcare expenditure for developed countries (Lee et al., 2002). The Social Security Act Amendments of 1972 (Public Law 92-603) extended
Medicare coverage to most ESRD patients residing in the United States (Northwest Renal Network, 2015). Medicare expenditure for patients with kidney failure (ESRD) reached nearly $29 billion in 2012. This accounted for approximately 6% of the total Medicare budget. Medicare expenditure for ESRD patients 65 years or older reached an additional $45 billion in 2012. It cost Medicare more than $20,000 per ESRD patient per year (Centers for Disease Control and Prevention, 2015). Within Montana, 92.6% of the ESRD patients receiving dialysis are enrolled and 1.5% are awaiting approval for Medicare (Northwest Renal Network, 2015).

Cost Associated with Hospitalization

Cardiovascular complications are the most common cause for hospitalization, with infections being the second most prevalent cause (United States Renal Data System, 2012) (Figure 1). The rate of hospitalization related to infections has increased 43% from 1994 to 2012, with the use of dialysis catheters posing the greatest risk for infection (United States Renal Data System, 2012).

Figure 1: Adjusted Hospitalization Rates by Principal Diagnosis and Modality (United States Renal Data System, 2012, p. Chapter 3)
Patients using central venous catheters have a 38% increased risk for major heart problems, a 53% increased risk for mortality, and a twofold increase in the risk for infection compared to those without central venous catheters (Ravani et al., 2013). Compared to AVFs, catheters are more prone to infection, which results in a 25% cost increase or approximately $23,000 to $24,000 per hospitalization (Lok & Mokrzycki, 2011). The cost to treat a catheter-related infection in the outpatient setting or dialysis unit is approximately $7000 to $15,000 per episode (Lok & Mokrzycki, 2011). Lee et al. (2002) found a significant difference in cost associated with access type (Figure 2). Protection of AVFs and AVGs to reduce the need for catheters is paramount to cost containment.

<table>
<thead>
<tr>
<th>Access Type</th>
<th>Mean No./Patient/Yr of access related interventional radiology visits*</th>
<th>Mean Access Related Radiology Cost/Patient/Yr ($)†</th>
<th>Mean No./Patient/Yr of access related Surgical Visits‡</th>
<th>Mean Access Related Surgical Costs/Patient/Yr ($)†</th>
<th>Mean Access Related for Access Related Hospital Admissions ($)$‡</th>
<th>Total Mean Cost/Patient/Yr for Access Related Health Care ($)†</th>
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<tr>
<td>Catheter (n=15)</td>
<td>0.60</td>
<td>1,805 (1,010, 0-1, 768)</td>
<td>0.20</td>
<td>85 (0, 0-0)</td>
<td>301 (0, 0-0)</td>
<td>2,191 (1,479, 0-2, 177)</td>
</tr>
<tr>
<td>AVG (n=36)</td>
<td>0.72</td>
<td>2,017 (1,652, 0-3, 120)</td>
<td>1.08</td>
<td>468 (0, 0-739)</td>
<td>860 (0, 0-0)</td>
<td>3,345 (2,413, 407-4, 638)</td>
</tr>
<tr>
<td>AVF (n=72)</td>
<td>0.32</td>
<td>346 (0, 0-361)</td>
<td>0.10</td>
<td>58 (0, 0-0)</td>
<td>0</td>
<td>388 (0, 0-0)</td>
</tr>
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*Includes vascular catheter placement, fistulograms, and access-related angioplasties.
†Reported as median with 25th to 75th percentile because distribution was not normal.
‡Includes access declotting/revision and creation of new vascular access as a daycare patient.
¶Patients who started the study with a temporary catheter (n = 5) who had active plans to create a permanent vascular access were excluded from this access-related cost analysis.

Figure 2: Annual Dialysis Access-Related Diagnostic Imaging, Surgical, and Inpatient Costs, and Cost of Treating Outpatient Access-Related Bacteremia (Lee et al., 2002)
Types of Dialysis Accesses Requiring Cannulation

AVFs, or fistulas, are the optimal vascular access for hemodialysis since they have higher durability, lower infection risk, and lower rate of interventional procedures needed to assure patency. A surgeon creates an AVF by connecting an artery to a vein in an end-to-side, vein-to-artery anastomosis. This shunts arterial blood flow into the vein causing it to become larger and its walls to become thicker (Oliver, 2015). Unfortunately, AVFs are more difficult to place and have a 35.9% failure rate. AVFs, if functional, require an average of 135 days to mature (National Institute of Diabetes and Digestive and Kidney Diseases, 2015).

AVGs, or grafts, are the second most desirable access type. A surgeon creates an AVG by anastomosing a synthetic conduit between an artery and vein. The most common type of synthetic conduit utilized is an expanded polytetrafluoroethylene (ePTFE) tube (Oliver, 2015). Grafts can be cannulated earlier after creation than fistulas, but are 3.8 times more likely to thrombose and require thrombectomy, and 3.0 times more likely to require access intervention to maintain patency compared to a fistula (Oliver, 2015). They are also more prone to infections than fistulas (10% versus 5% over course of use); graft infections may require removal of the graft whereas fistula infections usually respond well to antibiotics (Oliver, 2015).

Cannulation Techniques

The way needles are inserted into an AVF/AVG plays a role in the longevity of the access (Parisotto et al., 2014). The research team of a retrospective study determined that cannulation techniques influence fistula and graft survival (Parisotto et al., 2014).
The cannulation methods currently used are rope ladder and buttonhole or same site. Research comparing these techniques for insertion pain, prevalence of missed cannulation, prevalence of pseudo-aneurism development, and potential for infection is abundant (Parisotto et al., 2014; Santoro et al., 2014; Van Loon et al., 2009b). Rope ladder technique rotates needle puncture sites up and down the AVF, utilizing the entire length of the AVF (see Figure 3).

Figure 3: Rope Ladder Technique

Buttonhole, or constant site, cannulation was developed by Dr. Twardowski 24 years ago and has recently gained favor with the fistula-first initiative (Ball, n.d.). Establishing the buttonhole site requires cannulating at the same angle and same site by the same cannulator for up to 16 treatments or until a scar tissue “tunnel” is formed (Fistula First, n.d.). After establishing the tunnel, scabs are removed and “dull” needles are inserted into the track, through a flap in the wall of the AVF into the AVF (see Figure 4).
Missed Cannulations

Preservation of an access, preventing access infections, and successful cannulation with minimal attempts are major concerns for nephrology professionals. The research team of a retrospective study determined that cannulation techniques influence fistula and graft survival (Parisotto et al., 2014). Errors in cannulation can result in damage to the AVF or AVG. The most common error in cannulation is infiltration, where the needle enters into the AVF or AVG and then the needle tip exits the AVF or AVG resulting in a hematoma (Kidney Buzz, n.d.). Several researchers found that AVFs are two times more likely to suffer missed cannulations compared to AVGs (Van Loon, Kessel, Van Der Sande, & Tordoir, 2009a; Van Loon et al., 2009b). During a five-year period, Lee et al. (2006) found a 5.2% annual rate of major infiltration during cannulation. A major infiltration is defined as an infiltration that resulted in a large
hematoma that precluded fistula use until resolution of the hematoma (Lee et al., 2006). New AVFs (less than six months in age) had a greater chance of suffering an infiltration than older, more established AVFs. Missed cannulations can lead to hematoma formation and extravasation, which, in turn, make subsequent attempts to cannulate difficult. A patient with a compromised access from hematoma and/or extravasation is at greater risk for shortened or skipped dialysis treatments until the access heals sufficiently to allow cannulation (Lee et al., 2006). These patients are also at greater risk for placement of a central venous catheter as a bridge access until the AVF or AVG heals (Schnoch, Du Toit, Marticorena, & Sinclair, 2015). Catheters, compared to fistulas, have an adjusted relative hazard of death rate of 1.5 (95% CI 1.0-2.2) (Oliver, 2015).

Use of Ultrasound Guidance

Literature regarding the use of ultrasound guidance during cannulation of AVFs and AVGs is scarce. No randomized-control study research could be found on this topic. Ultrasound use during insertion of peripherally inserted central lines and peripheral intravenous access is available. Ultrasound use within emergency departments demonstrated an increase in the percentage of successful peripheral vein cannulations (Blaivas & Lyon, 2006; Brannam et al., 2004; Brauman et al., 2009). Ultrasound use also demonstrated a decrease in the time to successful cannulation and an increase in the first-attempt success rate during placement of central venous catheters (Dolu, Goksu, Sahin, Ozen, & Eken, 2015).
**Definition of Terms**

- **Arterial Venous Fistula (AVF or Fistula) (Figure 5):** A type of vascular access used for hemodialysis therapy. Surgically created by connecting an artery to a vein in an end-to-side, vein-to-artery anastomosis (Figure 7). This shunts arterial blood flow into the vein causing it to become larger and its walls to become thicker thus creating a fistula (Oliver, 2015).

![Figure 5: AV Fistula in Forearm.](image)

- **Arterial Venous Graft (AVG or Graft) (Figure 6):** A type of vascular access used for hemodialysis therapy. Surgically created by anastomosing a synthetic conduit between an artery and vein (Figure 7). The most common type of synthetic conduit utilized is an expanded polytetrafluoroethylene (ePTFE) tube (Oliver, 2015).
Buttonhole or Same-site Cannulation: Cannulation technique that requires cannulating at the same angle and same site by the same cannulator for up to 16 treatments or until a scar tissue “tunnel” is formed (Fistula First, n.d.). After establishing the tunnel, scabs are removed and “dull” needles are inserted into the track, through a flap in the wall of the AVF into the AVF (see Figure 4).

Cannulation (Dialysis): Introduction of a needle into a dialysis access.
• Central Venous Catheter (CVC) for Dialysis: Either a tunneled or non-tunneled double lumen catheter used for hemodialysis (Figure 8).

![Figure 8: Tunneled central venous catheter for dialysis. No copyright (National Institute of Diabetes and Digestive and Kidney Diseases, 2018)](image)

• Chronic Kidney Disease (CKD): Progressive loss of kidney function caused by structural or functional abnormalities of the kidneys for greater than three months with a glomerular filtration rate (GFR) of < 60 mL/min/1.73² (ANNA, 2009).

• End-stage Renal Disease (ESRD): Kidney failure with a GFR < 15 mL/min/1.73². Requires renal replacement therapy (ANNA, 2009).

• Extravasation: The escape of blood from a vessel into the tissue (The Free Dictionary, 2016a).

• Hematoma: A localized collection of clotted extravasated blood in a space or tissue (The Free Dictionary, 2016b) (Figure 9).
Hemodialysis: “A procedure for removing metabolic waste products or toxic substances from the bloodstream by dialysis” (The Free Dictionary, 2016c).

In-Center Hemodialysis: Dialysis treatments provided within a dialysis facility.

Infiltration (Dialysis): Blood that has been discharged into the surrounding tissue when a needle has been dislodged from inside the vein. Can occur during insertion of the needle or during a dialysis treatment. Can be minor (causing localized swelling and bruising that does not impact the use of the dialysis access) or major (sufficient in size to prevent use of the dialysis access for hemodialysis) (Lee et al., 2006).

Missed Cannulation: The needle does not enter the dialysis access correctly or remain in the lumen of the access rendering the needle unusable for a dialysis treatment.
• Renal Replacement Therapy: A term used to encompass life-supporting treatments (renal transplantation, hemodialysis, or peritoneal dialysis) for renal failure (The Free Dictionary, 2016d).

• Rope Ladder Cannulation: A cannulation technique that rotates needle puncture sites up and down the AVF utilizing the entire length of the AVF (see Figure 3).

• Successful Cannulation: Insertion of a needle into the center of the dialysis access lumen that does not cause an infiltration and allows for blood flow into or out of the access in sufficient mL/minute to provide the dialysis treatment.

• Ultrasound Guidance: Use of ultrasound while inserting dialysis needles to locate dialysis access, visualize depth, and determine diameter.
CHAPTER TWO

REVIEWING THE EVIDENCE

Introduction

This section contains information obtained from literary research on cannulation of dialysis accesses; specifically the use of ultrasound guidance. There was very little literature available regarding this cannulation technique.

Review of the Literature

A review of literature was conducted to determine how the use of ultrasound guidance during cannulation compared to clinical judgement (not using ultrasound guidance) impacts the number of missed cannulations in adult hemodialysis patients receiving treatment through an arteriovenous fistula or graft. The methodology of the literature review included many sources: The Centers of Medicare and Medicaid Services (CMS), the ESRD Networks and United States Renal Data System (USRDS), and the National Institute of Diabetes and Digestive and Kidney Diseases. The American Nephrology Nurses’ Association (ANNA) has state fact sheets that discuss prevalence of ESRD at the state levels. The large dialysis organizations (Fresenius and DaVita) also maintain data records accessible via their websites. Locally, the facility in which data were gathered maintains electronic health records on the number of AVFs, AVGs, and catheters utilized by patients and the number of missed cannulations per month.
Research Gate provided the most robust results for grey literature. CINAHL, Medline, PubMed, and Google Scholar provided most of the peer review literature. Personal accounts for cannulation experience utilizing ultrasound guidance from the professional networking site, ANNA Connected, on the ANNA website were also solicited. The articles utilized were limited to no less than 10 years old and written in English. The majority of studies on the use of ultrasound guidance during cannulation were prospective observational in nature. These studies had appropriate-sized sample groups and could be used to support further scrutiny into the use of ultrasound guidance within the adult dialysis population with AVFs or AVGs and its impact on missed cannulation.

**Local Agency Evidence**

St. Peter’s Hospital (SPH) Chronic Outpatient Dialysis unit is a 13-station hospital-based dialysis center. In September, 2014, the concept of using ultrasound guidance to assist with cannulation was informally introduced by a nephrologist to the St. Peter’s Hospital’s dialysis staff. A portable ultrasound machine was intermittently “borrowed” from the hospital’s cardiac lab starting in September, 2014, until April, 2014. During this time, the nephrologist provided informal, individual, hands-on training for the dialysis nursing staff on the use of ultrasound-guided cannulation. There was no formal training or education provided. There had been no policies, procedures, or competency measures established. Staff members who wished to use the ultrasound had trained themselves through repetitive use. Those who did not wish to use the ultrasound had not
engaged in any activities that would further their competency on the use of this
cannulation technique. New staff learned how to use ultrasound guidance from other staff
members, without the guidance of policy or procedures. Learning how to use ultrasound
guidance took place on patients during cannulation of their access sites. There were no
available simulation devices to practice on prior to patient use.

A fishbone analysis was used to evaluate nursing processes associated with AVF
cannulation. The analysis highlighted several factors that could lead to missed
cannulation (see Figure 10). Staff factors leading to missed cannulations included
variations in cannulation skills, personal preference to use ultrasound, the different
cannulation practices, and the lack of formal cannulation training. The process of
initiating dialysis treatments, as well as environmental factors, also could lead to missed
cannulations. Each staff member had three to four patients to initiate, monitor, and
discontinue dialysis treatments on during each patient shift. There were two patient shifts
per day, Monday through Saturday. Any missed cannulation resulted in a delay, either in
the start of the treatment for the patient suffering the missed cannulation, the patient that
followed on the second patient shift, or the patient that was scheduled to have his/her
treatment initiated next during the current patient shift. There were many distractions
during the patient shifts such as machine alarms, patient requests, phone calls, or requests
for assistance by other staff members. These distractions could lead to missed
cannulations. The availability of the ultrasound machine could also contribute to delays,
especially if a staff member waited to cannulate until the ultrasound was available.

Preliminary data suggested that having the ultrasound available for use within the dialysis
facility decreased missed cannulation (see Figure 11), but the use of ultrasound-guided cannulation was inconsistent and unmonitored.

![Fishbone Diagram](image)

Figure 10: Fishbone analysis of factors contributing to missed cannulation at SPH dialysis unit.
Guiding Theoretical Construct

Dorothea Orem’s Self-Care Deficit Theory is a midrange theory and one of the most common theories used in practice settings (Masters, 2015, p. 154). It is comprised of three related theories: self-care, self-care deficit, and nursing systems. Per Orem: “the three-part theory focuses not on individuals, but on persons in relations. Each of the three theories has as its focus a specific dimension of the person: the theory of self-care focuses on self, the I; the theory of self-care deficit focuses on you and me; and the theory of nursing systems focuses on we, persons in community” (Masters, 2015, p. 154).
Orem has three parts to the nursing process: assessment, diagnosis and creation of a plan of care, implementation and evaluation (Petiprin, 2015). The nursing processes coincided with the practice methodologies: diagnostic operations (assessment), prescriptive operations (diagnosis and creation of a plan of care), regulatory operations (implementation), and control operations (evaluation). The prescriptive operations drove the bulk of this project. The top priority of the prescriptive operations is to meet life-essential self-care processes; the second is to prevent personal harm, injury, or health deterioration. The nurse must “…compensate for or overcome known or emerging health-derived or health-associated limitations.” (Masters, 2015, p. 158). Also, within this construct, the “…nurse reviews possible helping methods and identifies the most appropriate methods based on the existing conditioning factors.” (Masters, 2015, p. 161).

Missed cannulations resulted in harm to the patient and could render the access unusable for hemodialysis, which, in turn, could result in health deterioration. The nurse should determine what technique will best prevent missed cannulation, preserve the access, and prevent the use of CVC as a bridge device.

Additional change theories used for this project included Roger’s Innovation Diffusion Theory and Kotter’s 8-Step Change Model. Per Roger’s, the attributes that helped facilitate the adoption of an idea included: Relative advantage of the idea over the status quo in order to achieve the desired outcome; compatibility of the existing values, experience, and needs of the staff; complexity inhibiting the adopter’s ability to understand and use the idea; trial ability allowing the idea to be tried on a small scale and reversed if desired; and observability of the idea in practice (Langley et al., 2009, p. 45).
The successful introduction of ultrasound-guided policy and procedure, training program, and competencies continued to follow the five-step process of innovation diffusion: knowledge, persuasion, decision, implementation, and confirmation (Orr, 2003). Staff had already undertaken some of these steps, but it had been without structure. This project provided the structure.

Kotter’s 8-Step Change Model is organized into three phases. The first phase is to create a climate for change. A sense of urgency for the change helped the staff see why the change needed to occur. The first step was to provide supporting evidence for the use of ultrasound guidance during cannulation to the staff. The next step was to create a guiding coalition by engaging key staff members who had the knowledge, credibility, influence, and skills needed to help implement the use of ultrasound-guided cannulation (Neumeier, 2013). The last step in creating a climate for change was developing a concise, compelling, and articulate statement in the form of a vision statement that outlined why the change needed to occur. This vision was shared with the staff at staff meetings.

The second phase is to engage and enable the organization. The first step in the second phase built upon the steps in phase one by continuing to communicate the vision of the project. Continuous feedback was provided to staff to help embed the vision into everyday practice. Staff members were afforded every opportunity to provide feedback on the change process. Another key step was to remove obstacles. Recognizing and rewarding staff that embraced the change were as important as recognizing those resistant to it. Information was provided and feedback solicited from those who were resistant to
using ultrasound-guided cannulation. The creation of short-term targets helped make the overall process easier to obtain (Mind Tools, n.d.).

The final phase is to implement and sustain the change. Creating a policy and procedure that is usable, obtainable, and sustainable helped assure the success of the project. Creating a workable training program and making sure all staff participated in the program was another key component. Yearly competencies regarding ultrasound-guided cannulation were implemented. In the future, in order to sustain the vision, changes in technology or new research findings need to be shared with the staff, and the policy and procedure, training program, and competency tool need to be updated accordingly (Mind Tools, n.d.).
CHAPTER THREE

METHODS

Introduction

The development of a doctoral scholarly project requires the integration of nursing theory with research. Nursing theory helps guide nursing practice. The intent of this project was to determine the effects of ultrasound guidance on cannulation and to gather staff and patient perceptions about access cannulation. This information was utilized in the development of a policy and procedure (see Appendix I), training program, and competency evaluation tool.

Project Design

Utilizing Roger’s Innovation Diffusion Theory and Kotter’s Change Management Model, this project’s purpose was to develop and implement an evidence-based policy and procedure related to ultrasound-guided cannulation of AVFs/AVGs. Data were collected from 53 dialysis patients’ electronic health records in order to determine the effect of ultrasound guidance on the number of missed cannulations. These data were used to support the project. Patient perceptions regarding ultrasound-guided cannulation were examined. The structure, process, and outcomes as they related to access cannulation were reviewed in order to guide a practice change and policy development in a hospital’s dialysis department. The results of this project may suggest a change in
practice for dialysis access cannulation or, at least, support further research into the use of ultrasound-guided cannulation.

Setting

This project took place in a hospital-based dialysis department in Montana. The department has 13 dialysis stations. Twelve stations are located in a large ward that has half-walls and privacy curtains separating the dialysis stations from each other. A locked, metal box located at the nurses’ station provided a secure location for return of the completed surveys.

Sample/Participants

The 13-station, hospital-based dialysis center provided an average of 554 outpatient hemodialysis treatments per month; 69% of the patients received treatment through an AVF and 6.9% through an AVG during the data collection phases (Pierce, 2016). Inclusion criteria included use of an AVF for dialysis access during the phases of the study period. Additional data gathered included the diabetic status and age of patients, the age of the AVF, and the years of cannulation experience of the staff on the date of the missed cannulation.

Institutional Review Board (IRB)

Scholarly projects typically do not require institutional review board (IRB) review (Moran, Burson, & Conrad, 2014, p. 201), but the results of this project will be published
in a Nephrology-related journal. Per the Montana State University IRB: “The above research…is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101” (see Appendix D). Letters of support were obtained from Robert LaClair, M.D., medical director of the St. Peter’s Hospital’s (SPH) Dialysis department, and Nancy Pierce RN, SPH dialysis department director (see Appendices E and F). Approval was obtained from the SPH Ethics committee that monitors HIPAA compliance (see Appendix C). Patient and staff consent forms were created with guidance from the Montana State University’s Institutional Review Board consent form guidelines (see Appendices G and H). Patient and staff questionnaires were created using the five-point Likert scale. The questions were created to elicit staff and patient perceptions regarding access cannulation (see Appendices I and J).

Procedure

In November, 2016, an evidence-based policy and procedure was created and submitted to the dialysis unit counsel, department manager, and department medical director for input and evaluation. Suggested revisions were integrated into the policy and procedure, and the final product was submitted to the facility’s Policy Committee for approval. The policy and procedure provided the basis for the training program. The training program was created using additional manufacturer’s information on the use of the purchased ultrasound machine (March-June, 2017). A PowerPoint presentation was created and submitted to the dialysis unit counsel and department director for approval.
After approval, the Microsoft PowerPoint presentation was presented at a staff meeting (July, 2017). It was then converted to the facility’s education platform to be integrated into the annual, required educational modules. Completion of the ultrasound-guided cannulation module will meet the annual competency requirement.

Treatment information for each chronic outpatient hemodialysis treatment is electronically entered into a Meditech system. Fields within the assessment screens that provide quantitative data related to this scholarly project included the number of cannulations attempted and the number of missed cannulations for each dialysis treatment. Patients who met the inclusion criteria were assigned a number. The list of patients’ names and associated numbers were kept in a secure electronic document. After consulting the MSU Statistical Consulting Center, the recommended major variables assessed were the date of the missed cannulation, the age of the AVF at the time of missed cannulation, the age of the patient, the patient’s diabetic status, and the number of successful cannulation attempted during each phase.

The data collection occurred during three phases. Phase 1, the six months immediately preceding the purchase of a bedside ultrasound machine for the dialysis department, occurred from October 1, 2013, to March 31, 2014. Due to the extended period between the purchase of the ultrasound machine and the implementation of the scholarly project, phase two was divided into two phases. Phase 2A, the six months immediately post purchase of the bedside ultrasound machine, occurred from April 1, 2014, to September 30, 2014. Phase 2B, the seven months immediately prior to the implementation of the ultrasound-guided cannulation policy and procedure, training
program, and competency evaluation process, occurred from January 1, 2017, to July 31, 2017. Phase 3, the three months post introduction of the ultrasound-guided cannulation policy and procedure, training program, and competency evaluation period, occurred from August 1, 2017, to October 31, 2017.

Developed patient and staff questionnaires with closed-ended questions utilizing a five-point Likert scale provided data about staff and patient perceptions regarding the use of ultrasound-guided cannulation. The staff questionnaire consisted of 17 questions. Ten questions had Likert-type response options that ranged from 5 to 1, with 5 corresponding to strongly agree, 3 corresponding to uncertain, and 1 to strongly disagree. The remaining seven questions solicited quantitative data regarding the number of missed cannulations, use of the ultrasound-guided cannulation technique, and the impact of missed cannulations on patients (delayed treatment, interrupted treatment, or bruised access).

The patient questionnaire consisted of 17 questions. Ten questions had Likert-type response options that ranged from 5 to 1, with 5 corresponding to strongly agree, 3 corresponding to uncertain, and 1 to strongly disagree. Two of the remaining seven questions elicited a yes or no response regarding the use of either lidocaine cream or subdermal lidocaine pre-needle insertion for at-site pain control. The remaining five questions solicited data regarding the number of missed cannulations, use of the ultrasound-guided cannulation technique, and treatment impact caused by missed cannulation (delayed treatment, interrupted treatment, or bruised access). Participation was voluntary. Participants, after explanation of the survey’s purpose, were offered it during their dialysis treatment. Staff members were approached at staff meetings and,
after explanation of the survey’s purpose, they were requested to complete it. The completed surveys were kept in a locked box at the nurses’ station.

**Analysis**

The data from each EHR phase was manually entered into Microsoft Excel. The Montana State University statistical department analyzed the data; the National Institute of General Medical Sciences of the National Institutes of Health provided funding under the Award Number P20GM203474 for this service. The data were used to answer the following questions:

1. Did the presence of the bedside ultrasound machine affect the number of missed cannulations?
2. Did the introduction of the ultrasound-guided cannulation policy and procedure and training program affect the number of missed cannulations?
3. Was the diabetic status of the patient associated with missed cannulation?
4. Was the age of the fistula associated with missed cannulation?
5. Was the age of the patient associated with missed cannulation?
6. Was the experience of the cannulator (nurse) associated with missed cannulation?

The data from the completed patient and staff surveys were manually entered into Microsoft Excel. No implausible entries (missing answers) were discovered among the Likert-type questions though some were noted among the quantitative questions. Descriptive statistics were used to summarize the results of the questions. To address the research question regarding staff and patient perceptions of ultrasound-guided
cannulation, responses were computed using a mean score with standard deviation for each of the ten questions.
CHAPTER FOUR

RESULTS

Findings

During phase one, 34 patients met inclusion criteria. Fifteen were non-diabetic and 19 were diabetic. The patient ages ranged from 30.9 to 84.1 years (m 64.7; SD 11.97). The years of cannulation experience among the cannulators ranged from six months to 25 years (m 9.31; SD 7.94). The age of AVFs ranged from 58 to 2583 days (m 763.08; SD 664.02).

During phase 2A, 38 patients met inclusion criteria. Seventeen were non-diabetics and 21 were diabetic. The patient ages varied from 31 to 84 years (m 65.08; SD 11.42). The years of cannulation experience among the cannulators ranged from nine months to 25 years (m 9.35 SD 7.89). The age of AVFs ranged from 50 to 2897 days (m 96.15; SD 815.85).

During phase 2B, 25 patients met inclusion criteria. Eleven were non-diabetics and 14 were diabetic. The patient ages varied from 34 to 81 years (m 67.55; SD 10.13). The years of cannulation experience among the cannulators ranged from one to 28 years (m 9.22; SD 8.40). The age of AVFs ranged from 40 to 3576 days (m 1181.03; SD 1197.96).

Between phases 2B and 3, a large shift from in-center patients to home-therapy patients occurred. At the conclusion of phase three, 52% of the dialysis patient population were dialyzing at home. Therefore, the number of patients meeting inclusion criteria for
phase 3 declined to 17 patients. Six were non-diabetics and 11 were diabetic. The patient ages varied from 34 to 79 years (m 67.06; SD 2.71). The years of cannulation experience among the cannulators ranged from one to 28 years (m 9.22; SD 8.40). The age of AVFs ranged from 287 to 3778 days (m 1164.56; SD 1221.57).

Per the assisting MSU lead statistician, a sample size of at least 1900 for phase 1 to 2 and 1500 for phase 2 to 3 was needed to detect specific differences related to missed cannulations (Schupbach, 2017).

Fourteen patients met inclusion criteria during the patient survey process. Inclusion criteria included AVF as primary access and cognitive ability sufficient to comprehend the survey questions. Twelve staff members who cannulated accesses were educated about the project during a staff meeting (October, 2016) during which the informed consent was read (see Appendix E), questions were answered, and staff were given the opportunity to complete a Likert-scaled survey (see Appendix H). Nine staff members completed surveys and returned them to a locked box located at the nurses’ station (October, 2016). The 14 patients who met criteria for inclusion were approached individually during their dialysis treatments, and the informed consent (see Appendix F) was read to each individual patient, questions were answered, and each qualifying patient was given the opportunity to complete a Likert-scaled survey (see Appendix G) (October, 2016). Seven patients completed surveys and returned them to a locked box located at the nurses’ station (October, 2016).

For this project, answers to two questions were sought. The first question was whether the ultrasound-guided cannulation of AVFs/AVGs decreased the number of
missed cannulations. The second question asked for staff and patient perceptions regarding cannulation. The results of staff and patient surveys and data analysis of missed cannulations were presented in the following categories:

- Staff perceptions with staff survey responses for quantitative and Likert Scale questions.
- Patient perceptions with patient survey responses for quantitative and Likert Scale.
- EHR data analysis of missed cannulations for each collection phase by diabetic status and total patient population.
- Observational data on the effects of patient and fistula age on missed cannulation.
- Observational data on the effects of cannulator experience on missed cannulation.

**Staff Perception**

Nine out of 12 staff members (75%) completed and returned the staff survey. Data relied on memory recall of the staff members who completed the survey. The Likert scale survey items were analyzed at the interval measurement scale (mean) using a score of 5 (strongly agree) to 1 (strongly disagree). See Tables 1 and 2 for further details of the obtained responses.

**Table 1: Staff Survey Responses (n=9)**

<table>
<thead>
<tr>
<th>Item</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>In the last 7 workdays I have had X missed cannulations in X responses</td>
<td>2/10 (20%)</td>
</tr>
</tbody>
</table>
Table 1: Staff Survey Responses (n=9) Continued

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of times US guidance was used during the missed cannulation attempts</td>
<td>2/2 (100%)</td>
</tr>
<tr>
<td>In the last month number of missed cannulations you have had</td>
<td>4</td>
</tr>
<tr>
<td>Number of times you have bruised an access due to missed cannulations in the last month</td>
<td>2</td>
</tr>
<tr>
<td>Number of times you used US guidance to aid in cannulation of access in the last month</td>
<td>47</td>
</tr>
<tr>
<td>Number of times one of your assigned patient's dialysis treatments was cut short due to needle issues in the last month</td>
<td>1</td>
</tr>
<tr>
<td>Number of times one of your assigned patients had to come in on his/her normal day off to get his/her dialysis treatments due to needle issues in the last month</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2: Mean Scores for Each Item in Staff Survey (n=12)

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cannulation Skills vary among staff</td>
<td>4.11 (0.33)</td>
</tr>
<tr>
<td>I am familiar with the US machine used to assist in cannulation of dialysis access</td>
<td>4.44 (0.53)</td>
</tr>
<tr>
<td>If the ultrasound machine is used during cannulation it makes cannulating less painful</td>
<td>3.44 (0.73)</td>
</tr>
<tr>
<td>If the US machine is used during cannulation there is less missed attempts</td>
<td>4.33 (0.87)</td>
</tr>
<tr>
<td>If the US machine is used during cannulation there is less bruising of accesses</td>
<td>4.00 (1.12)</td>
</tr>
<tr>
<td>The staff is proficient at using the US machine</td>
<td>3.89 (0.78)</td>
</tr>
<tr>
<td>There is adequate training on how to use the ultrasound machine</td>
<td>3.67 (1.12)</td>
</tr>
<tr>
<td>There are policy and procedures in place regarding the use of US guidance for cannulations of AVFs and AVGs</td>
<td>2.78 (1.09)</td>
</tr>
<tr>
<td>I am proficient at using the US machine during cannulation</td>
<td>4.22 (0.67)</td>
</tr>
<tr>
<td>I am proficient at cannulating AVFs and AVGs</td>
<td>4.56 (0.53)</td>
</tr>
</tbody>
</table>
Patient Perceptions

Seven out of 14 eligible patients (50%) completed and returned the patient survey.

Two questions elicited either a yes or no answer. Quantitative data relied on memory recall of the patients who completed the survey. The Likert scale survey items were analyzed at the interval measurement scale (mean) using a score of 5 (strongly agree) to 1 (strongly disagree). See Tables 3 and 4 for further details of the obtained responses.

Table 3: Patient Survey Responses (n=7)

<table>
<thead>
<tr>
<th>Item</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you use EMLA cream on your access (Y/N)</td>
<td>2/5 (40%)</td>
</tr>
<tr>
<td>Does the nurse inject lidocaine prior to putting in your needles</td>
<td>7/7 (100%)</td>
</tr>
<tr>
<td>Number of missed cannulations you have had in the last month</td>
<td>0</td>
</tr>
<tr>
<td>Number of times your access was bruised due to missed cannulations in the last month</td>
<td>10</td>
</tr>
<tr>
<td>Number of times US was used to aid in cannulation of your access in the last month</td>
<td>32</td>
</tr>
<tr>
<td>Number of times your assigned dialysis treatment was cut short due to needle issues in the last month</td>
<td>5</td>
</tr>
<tr>
<td>Number of times you had to come in on your normal day off to get your treatments due to needle issues in the last month</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 4: Mean Scores for Each Item in Patient Survey (n=7)

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>My access is easy to cannulate</td>
<td>3.43 (1.62)</td>
</tr>
<tr>
<td>I become more anxious when thinking about having my access cannulated</td>
<td>2.43 (1.81)</td>
</tr>
<tr>
<td>I have more than one missed cannulation attempts per week</td>
<td>1.57 (0.79)</td>
</tr>
</tbody>
</table>
Table 4: Mean Scores for Each Item in Patient Survey (n=7) Continued

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cannulating my access is painful</td>
<td>2.57 (1.72)</td>
</tr>
<tr>
<td>Cannulation skills vary among staff</td>
<td>3.14 (1.77)</td>
</tr>
<tr>
<td>I am familiar with the ultrasound machine used to assist in cannulation of dialysis access</td>
<td>3.86 (1.46)</td>
</tr>
<tr>
<td>If the ultrasound machine is used during cannulation, it is makes cannulating my access less painful</td>
<td>3.00 (1.0)</td>
</tr>
<tr>
<td>If the ultrasound machine is used during cannulation, there are less missed attempts</td>
<td>3.43 (0.98)</td>
</tr>
<tr>
<td>If the ultrasound machine is used during cannulation, there is less bruising of my access</td>
<td>3.14 (1.35)</td>
</tr>
<tr>
<td>The staff is proficient at using the ultrasound machine</td>
<td>3.57 (0.98)</td>
</tr>
</tbody>
</table>

**EHR Data Analysis of Missed Cannulations**

There were three phases of data collection from the included patients’ electronic medical records. The date, the age of both the fistula and patient, the patient’s diabetic status, and the years of cannulator experience were gathered for each date the patient suffered a missed cannulation. The variables assessed were number of failures and successes and the point estimate of proportion of failure comparing diabetics to non-diabetics (see Table 5). Table 6 summarizes total missed cannulations.

Observation of the data noted a clustering of missed cannulations occurring on the same patients during phases 1 and 2A. Three patients suffered greater than 10 missed cannulations, each, during phase 1, and two patients suffered greater than 10 missed cannulations, each, during phase 2A.
Table 5: Summary of Missed Cannulation per Diabetic Status

<table>
<thead>
<tr>
<th>Phase</th>
<th>Diabetic Status</th>
<th>Number of Failures</th>
<th>Number of Successes</th>
<th>Proportion of Failure per 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Yes</td>
<td>60</td>
<td>2640</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>14</td>
<td>2071</td>
<td>6.7</td>
</tr>
<tr>
<td>2A</td>
<td>Yes</td>
<td>15</td>
<td>2656</td>
<td>5.6</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>29</td>
<td>2010</td>
<td>14.2</td>
</tr>
<tr>
<td>2B</td>
<td>Yes</td>
<td>15</td>
<td>1962</td>
<td>7.6</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>8</td>
<td>1133</td>
<td>7.0</td>
</tr>
<tr>
<td>3</td>
<td>Yes</td>
<td>1</td>
<td>772</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>5</td>
<td>436</td>
<td>11.3</td>
</tr>
</tbody>
</table>

Table 6: Total Number of Missed Cannulations

<table>
<thead>
<tr>
<th>Phase</th>
<th>Number of Failures</th>
<th>Number of Successes</th>
<th>Proportion of Failure per 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>74</td>
<td>4711</td>
<td>16</td>
</tr>
<tr>
<td>2A</td>
<td>44</td>
<td>4666</td>
<td>9.4</td>
</tr>
<tr>
<td>2B</td>
<td>23</td>
<td>3095</td>
<td>7.4</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>1208</td>
<td>5.0</td>
</tr>
</tbody>
</table>

Observational Data on the Effects of Patient and Fistula Age on Missed Cannulation

Data collected appear to support Kamata et al. (2016) findings that new AVFs (less than 6 months in age) had a greater chance of suffering an infiltration than older, more established AVFs. Table 8 demonstrates that patients with zero or one missed cannulation had older AVFs than those who suffered two or more missed cannulations.
Patient age also affects the AVF cannulation success rate (Kamata, Tornita, & Lehara, 2016). Table 7 demonstrates that patients who did not have missed cannulations are typically younger than those who do. During the data collection periods, 18 different cannulators accessed AVFs. Cannulator experience plays a role in cannulation success, although some cannulators can stay in a state of “perpetual novice” (Harwood, Wilson, & Oudshoorn, 2016). Phases 1 and 2A had 13 different cannulators. Phases 2B and 3 had 18 different cannulators. The years of cannulation experience varied from less than one year to 28 years (m 9.22, SD 8.40). Table 9 examines the effects of cannulator experience on missed cannulations. Typically, cannulators with less than five years of experience had the greatest percentage of missed cannulations. Variation occurred during phases 2B and 3 where cannulators with 22+ years of experience had 37.93% of the missed cannulations. A possible explanation for this could be that the most experienced cannulators were the ones cannulating the most difficult accesses.

Table 7: Number of Missed Cannulations with Mean Patient Age

<table>
<thead>
<tr>
<th>Phase</th>
<th>Missed cannulations</th>
<th>0 (%)</th>
<th>1 (%)</th>
<th>2 – 5 (%)</th>
<th>6 – 9 (%)</th>
<th>10 - 14 (%)</th>
<th>15+ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 N=34</td>
<td>Number of Patients</td>
<td>18 (52.94%)</td>
<td>4 (11.76%)</td>
<td>9 (26.47%)</td>
<td>0 (0%)</td>
<td>2 (5.88%)</td>
<td>1 (2.94%)</td>
</tr>
<tr>
<td></td>
<td>Mean Pt Age in years (SD)</td>
<td>61.2 (13.74)</td>
<td>68.9 (5.47)</td>
<td>67.8 (8.56)</td>
<td>N/A</td>
<td>69.4 (17.54)</td>
<td>75.1 (N/A)</td>
</tr>
<tr>
<td>2A N=38</td>
<td>Number of Patients</td>
<td>28 (73.68%)</td>
<td>4 (10.53%)</td>
<td>3 (7.89%)</td>
<td>1 (2.63%)</td>
<td>1 (2.63%)</td>
<td>1 (2.63%)</td>
</tr>
<tr>
<td></td>
<td>Mean Pt Age in years (SD)</td>
<td>63.7 (12.09)</td>
<td>64.7 (7.02)</td>
<td>75.6 (9.69)</td>
<td>58.4 (N/A)</td>
<td>75.6 (N/A)</td>
<td>75.6 (N/A)</td>
</tr>
</tbody>
</table>
### Table 7: Number of Missed Cannulations with Mean Patient Age Continued

<table>
<thead>
<tr>
<th>Phase</th>
<th>Number of Patients</th>
<th>Number of Patients</th>
<th>Mean Pt Age in years (SD)</th>
<th>Mean Pt Age in years (SD)</th>
<th>Mean Pt Age in years (SD)</th>
<th>Mean Pt Age in years (SD)</th>
<th>Mean Pt Age in years (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2B</td>
<td>N= 25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>14 (56.00%)</td>
<td>6 (24.00%)</td>
<td>5 (20.00%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean Pt Age in years (SD)</td>
<td>66.3 (10.89)</td>
<td>70.3 (10.26)</td>
<td>67.7 (9.03)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>3N</td>
<td>N= 17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>13 (76.47%)</td>
<td>3 (17.65%)</td>
<td>1 (5.88%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean Pt Age in years (SD)</td>
<td>68.3 (6.59)</td>
<td>58.2 (20.60)</td>
<td>79.0 (N/A)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Table 8: Number of Missed Cannulations with Mean AVF Age

<table>
<thead>
<tr>
<th>Phase</th>
<th>Missed cannulations</th>
<th>Number of Patients</th>
<th>Number of Patients</th>
<th>Number of Patients</th>
<th>Number of Patients</th>
<th>Number of Patients</th>
<th>Number of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>1N</td>
<td>34</td>
<td>18 (52.94%)</td>
<td>4 (11.76%)</td>
<td>9 (26.47%)</td>
<td>0 (0%)</td>
<td>2 (5.88%)</td>
<td>1 (2.94%)</td>
</tr>
<tr>
<td></td>
<td>Mean Fistula Age in Days (SD)</td>
<td>1389.78 (821.70)</td>
<td>1462.50 (1093.23)</td>
<td>672.92 (474.82)</td>
<td>N/A</td>
<td>166.59 (98.93)</td>
<td>990.71 (38.93)</td>
</tr>
<tr>
<td>2A</td>
<td>N=38</td>
<td>28 (73.68%)</td>
<td>4 (10.53%)</td>
<td>3 (7.89%)</td>
<td>1 (2.63%)</td>
<td>1 (2.63%)</td>
<td>1 (2.63%)</td>
</tr>
<tr>
<td></td>
<td>Mean Fistula Age in Days (SD)</td>
<td>1368.46 (789.97)</td>
<td>1106.50 (1441.46)</td>
<td>1049.33 (13.01)</td>
<td>133.67 (48.77)</td>
<td>308.90 (12.26)</td>
<td>114.82 (44.04)</td>
</tr>
<tr>
<td>2B</td>
<td>N= 25</td>
<td>14 (56.00%)</td>
<td>6 (24.00%)</td>
<td>5 (20.00%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td></td>
<td>Mean Fistula Age in Days (SD)</td>
<td>1674.36 (1351.02)</td>
<td>1338.0 (1361.23)</td>
<td>719.35 (847.49)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>3N</td>
<td>N= 17</td>
<td>13 (76.47%)</td>
<td>3 (17.65%)</td>
<td>1 (5.88%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td></td>
<td>Mean Fistula Age in Days (SD)</td>
<td>1269.77 (1137.54)</td>
<td>1643.67 (1839.09)</td>
<td>293.0 (10.39)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Table 9: Years of Cannulator Experience with Number of Missed Cannulations

<table>
<thead>
<tr>
<th>Phase</th>
<th>Years</th>
<th>1 – 4</th>
<th>5 – 8</th>
<th>9–13</th>
<th>14–17</th>
<th>18–21</th>
<th>22+</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 and 2A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Cannulators (N= 13)</td>
<td>6</td>
<td>(46.15%)</td>
<td>0</td>
<td>4</td>
<td>(30.77%)</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Number of Missed Cannulations (N= 118)</td>
<td>68</td>
<td>(57.63%)</td>
<td>0</td>
<td>22</td>
<td>(18.64%)</td>
<td>0</td>
<td>17</td>
</tr>
<tr>
<td>2B and 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Cannulators (N=18)</td>
<td>7</td>
<td>(38.89%)</td>
<td>4</td>
<td>2</td>
<td>(11.11%)</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Number of Missed Cannulations (N=29)</td>
<td>13</td>
<td>(44.83%)</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>(10.34%)</td>
<td>0</td>
</tr>
</tbody>
</table>
CHAPTER FIVE

DISCUSSION

As the ESRD patient population in the United States ages, it will become important to optimize cannulation practices. Ultrasound-guided cannulation in order to establish peripheral intravenous (IV) access has been shown to decrease the number of missed cannulations and the time to successful cannulation of the patient access (Brannam et al., 2004; & Brauman et al., 2009). Ultrasound use has also been shown to increase user confidence for successful cannulation (Blaivas & Lyon, 2006; Brannam et al., 2004; & Brauman et al., 2009). This cannulation technique is well suited for the dialysis population.

Summary of Results: Patient and Staff Surveys

Data obtained relied on staff and patient recall and may not accurately reflect the true number of missed cannulations, use of ultrasound, access bruising, and treatment interruption. Patients received an average of three treatments per week with two cannulation attempts per treatment (one needle for arterial access and one for venous return), or equivalently 12 treatments with 24 cannulation attempts per month. Seven patients would have had approximately 84 treatments. If ultrasound-guided cannulation was utilized 32 times for the approximately 84 attempts, this would be a patient-reported usage rate for this cannulation technique of 38%. Staff who cannulate reported a 56% usage rate for all patients. Implausible responses were noted within the patient bruising
question since it was reported that there were no missed cannulations during the last month, but there were 10 reported incidences of bruising due to missed cannulation. Staff who cannulate and patient perceptions varied among identical questions. The Likert scale questions, with 5 being strongly agree and 1 being strongly disagree, had values that differed between patients and staff. Staff cannulator responders felt that cannulation skills varied among nurses more than the patient responders did (Staff m 4.11 SD 0.33; patient m 3.14 SD 1.77). Staff cannulator responders were also more familiar with ultrasound availability than were the patients who responded (Staff m 4.44 SD 0.53; patient m 3.86 SD 1.46). Staff cannulator responders also felt that there were fewer missed attempts if ultrasound-guided cannulation was used compared to patient responders (Staff m 4.33 SD 0.87; patient m 3.43 SD 0.98). Self-reported proficiency by staff also varied from patient perception of proficiency (Staff m 4.22 SD 0.53; patient m 3.57 SD 0.98). Staff responses to the questions regarding training and the existence of a policy and procedure demonstrated a need for both elements (staff m 3.67 SD 1.12 and 2.78 SD 1.09 respectively).

**Summary of Results: Missed Cannulations**

Diabetics appeared to have fewer missed cannulations after the introduction and availability of the ultrasound machine, with a decrease in proportion of failure from 22 per 1000 to 1.3 per 1000 from phase 1 to phase 3. There was more variability in missed cannulations among the non-diabetics. During phases 1 and 2B, diabetics had a greater risk for missed cannulations than non-diabetics. From the phase 1 data, we would expect
the diabetic group to have 155 more missed cannulations per 10,000 patients than non-diabetics. From the phase 2B data, this expected number would be six patients. Phases 2A and 3 indicated a lessened chance of diabetics having missed cannulations.

Impact of Patient and Fistula age and Cannulator Experience

During each phase, more patients experienced no missed cannulations than those patients that did experienced missed cannulations (52.94%, 73.68%, 56%, and 76.47%). Within the data collection phases, patients who were younger experienced fewer missed cannulations than older patients did. Fistula age appeared to be related to the number of missed cannulations, with younger fistulas experiencing more missed cannulations than older ones. These findings coincided with Kamata, et al. (2016) research. During phases 1 and 2A, cannulator years of experience appeared to be related to the number of missed cannulations with fewer years equating to more missed cannulations. Phases 2B and 3 data did not support this, with 51.33% of the missed cannulations being cannulators with eight years of experience or less versus 48.27% of the missed cannulations being among cannulators with nine years or more of experience.

Assumptions and Study Limitations

Some assumptions were made regarding the use of ultrasound guidance during cannulation of dialysis accesses. Drawing upon research regarding the use of ultrasound during peripheral intravenous catheter insertions, it was assumed that there was a positive correlation between the use of ultrasound and successful cannulation within the dialysis
population. It was assumed that the dialysis nurse cannulating dialysis accesses had a basic competency level regarding access assessment and use of the bedside ultrasound machine. The age and diabetic status of the patient, the years of experience of the cannulator, and the age of the AVF were noted for each missed cannulation during the three phases of data collection. It was assumed that the access maturity, patient age and diabetic status, and cannulator experience impacted the success rate of cannulation; however, the age/maturity of the access and years of cannulator experience were not gathered for each of the successful cannulations attempts during the three phases of data collection. This presented a limitation to address the questions regarding age of the access and cannulator experience impact on missed cannulation. Only the diabetic impact on missed cannulation could be addressed statistically. However, the question could not be addressed via any inferential methods due to the multiplicity of records for the same patient and nurses; thus the cannulation attempts in the dataset are not independent (Powell, 2017). A second limitation was that data related to the actual use of the ultrasound machine during cannulation could not be captured; only the presence of the machine within the department and staff/patient recall of its use.

Limitations for this project included the lack of literature supporting the use of ultrasound guidance during cannulation as a widespread best practice technique, although Marticorena et al. (2015) stated ultrasound use “has become standard of practice in several hemodialysis units in Canada and worldwide” (Marticorena et al., 2015). Literature review had found mention of ultrasound guidance being introduced in advanced cannulation workshops conducted in Australia and Canada (Marticorena et al.,
2015; Schnoch et al., 2015). A case study by Patel, et al. (2015) suggested that ultrasound guidance “is a potentially cost-effective approach for cannulation of fistulas that are difficult to access” (Patel, Stern, Brown, & Bhatti, 2015). None of these articles had research that unequivically supported the use of routine ultrasound guidance for access cannulation. If statistical review of the data regarding the impact of ultrasound use on the number of missed cannulations from the electronic health records of the targeted dialysis population did show a positive correlation, the sample size was not significant enough to support widespread dissemination of this practice methodology.

Another limitation of the project was that the practice of ultrasound was already in use within the targeted dialysis unit. Staff have been using ultrasound without the benefit of standardized training, guidance from policy and procedures, and assurance of competency in ultrasound-guided cannulation.

Implications for Future Research, Education, and Practice

The goal of this scholarly project was to determine the impact of ultrasound guidance on cannulation and to create policy and procedures, staff competencies, and staff training modules with the information obtained. Very little literature could be found regarding the use of ultrasound-guided cannulation within the ESRD population. Further research with larger patient populations is needed before determining if ultrasound-guided cannulation is best practice.

Information obtained from the EHR review and staff and patient questionnaires was disseminated to the project participants. A poster presentation was presented at the
Western Institute of Nursing (WIN) 2018 Conference. The project will be summarized and formatted per the American Nephrology Nurses Association’s submission guidelines and submitted for publication in the *Nephrology Nursing Journal*.

**Conclusion**

The results of this scholarly project demonstrated a need for an ultrasound-guided cannulation policy and procedures and a standardized training program. It did appear that the availability of a bedside ultrasound machine decreased the number of missed cannulations. Staff comments included, “Most ultrasound guidance with cannulation is used to verify the placement of needles,” and “I have used the ultrasound machine to check needle placement of patients who have moved their arm and potentially dislodged needle.” Using ultrasound to determine where the tip of the needle is in the lumen of the access is also beneficial. A patient commented, “If they [nurses] use the ultrasound before they stick [cannulate]—it makes the stick a lot better. They know where to go.”
REFERENCES CITED


Fistula First. (n.d.). Vascular access planning guide for professionals. In End Stage Renal Disease Network Coordination Center (Ed.).


APPENDICES
APPENDIX A

SPH ETHICS COMMITTEE APPROVAL LETTER
St. Peter's Hospital

St. Peter's Hospital Ethics Committee

Meeting Minutes - January 3, 2017

Committee Members Present: Kim Pepper, BCC, Chair; Michelle Rush, MBA, CPHRM, CHC; Lynne Grant, BSW; Lyndsey Smith, BSW; Cynde Watkins, RN, MSN, FNP-c

Guests: Alice Luehr, RN

It was moved, seconded, and unanimously passed, to approve the minutes of the November 8, 2016 Ethics Committee Meeting.

New Business

Alice Luehr, RN presented her DNP research project, Use of Ultrasound Guidance during Cannulation of Arteriovenous Fistulas or Arteriovenous Grafts. A question and answer period followed. A motion was made, seconded, and unanimously approved, that the Ethics Committee endorse Ms. Luehr's project. The committee also invited Ms. Luehr to present the results of her project to the committee.

Next meeting is February 7, 2017, at 8:00 a.m. in the Sleeping Giant Room.
APPENDIX B

MSU IRB APPROVAL LETTER
INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 00000165

MONTANA STATE UNIVERSITY
900 Technology Blvd. Room 127
c/o Microbiology & Immunology
Montana State University
Bozeman, MT 59718
Telephone: 406-994-6783
FAX: 406-994-4303
Email: cheryl@montana.edu

Chair: Mark Quinn
406-994-4707
markquinn@montana.edu

Administrator: Cheryl Johnson
406-994-4706
cheryl@montana.edu

MEMORANDUM

TO: Alice Luehr and Teresa Seright
FROM: Mark Quinn
DATE: November 7, 2016
SUBJECT: "Use of Ultrasound Guidance during Cannulation of Arteriovenous Fistulas or Arteriovenous Grafts" [AL110916-EX]

The above research, described in your submission of November 8, 2016, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

   (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

   (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

   (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

   (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.

   (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

   (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.
APPENDIX C

ROBERT LACLAIR, M.D., LETTER OF SUPPORT
10/27/2016

Dr. Robert LaClair M.D.
Medical Director St. Peter's Hospital Dialysis Department
2475 E. Broadway

MSU College of Nursing
P.O. Box 173860
Bozeman, MT 59717-3560

To Whom It May Concern:

As the medical director of the St. Peter’s Hospital’s Dialysis Department in Helena, Montana I am aware of Alice Luehr’s proposed scholarly project titled “Use of Ultrasound Guidance during Cannulation of Arteriovenous Fistulas or Arteriovenous Grafts”. I understand that the project involves scrutinizing patient records, tabulation of data, and involvement of patients and staff in questionnaire completion.

This project seeks to expand the knowledge of best practice methodology for cannulation and to create policy and procedures and a staff cannulation training program based on the findings. Alice Luehr, a certified nephrology nurse with 16 years of nephrology experience, is a Doctorate of Nursing Practice/Family Nurse Practitioner student at Montana State University, Bozeman, Montana. Her clinical experience and expertise as a certified nephrology nurse make her an excellent candidate to scrutinize this subject matter.

I fully support Mrs. Luehr’s access to all pertinent medical records (per HIPPA compliance) to gather data needed to support her scholarly project.

Mrs. Luehr’s scholarly project will help improve patient cannulation techniques, improve patient care, and create a standard of practice within St. Peter’s Hospital’s dialysis department. The project will also create policies and procedures and a cannulation training program that are currently lacking.

Sincerely,

[Signature]

Dr. Robert LaClair M.D.
Nephrologist/Medical Director St. Peter's Hospital Dialysis Department
APPENDIX D

NANCY PIERCE LETTER OF SUPPORT
10/27/2016

Nancy Pierce RN, CNN
Director St. Peter’s Hospital Dialysis Department
2475 E. Broadway

MSU College of Nursing
P.O. Box 173560
Bozeman, MT 59717-3560

To Whom It May Concern

As the dialysis department director of the St. Peter’s Hospital’s dialysis department in Helena, Montana I am aware of Alice Luehr’s proposed scholarly project titled “Use of Ultrasound Guidance during Cannulation of Arteriovenous Fistulas or Arteriovenous Grafts”. I understand that the project involves scrutinizing patient records, tabulation of data, and involvement of patients and staff in questionnaire completion.

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Mrs. Luehr’s scholarly project will help improve patient cannulation techniques, improve patient care, and create a standard of practice within St. Peter’s Hospital’s dialysis department. The project will also create policies and procedures and a cannulation training program that are currently lacking.

Sincerely,

[Signature]

Nancy Pierce RN, CNN
Director St. Peter’s Hospital Dialysis Department
APPENDIX E

STAFF INFORMED CONSENT FORM
You are being asked to participate in a research study. This informed consent form is for end stage renal disease patients undergoing hemodialysis via an arteriovenous fistula (AVF) or graft (AVG) and for staff who cannulate AVFs or AVGs at the St. Peter’s Hospital dialysis unit in Helena, Montana. As a person who meets one of these requirements, you are invited to participate in the scholarly project titled: Use of Ultrasound Guidance during Cannulation of Arteriovenous Fistulas or Arteriovenous Grafts.

Introduction:
My name is Alice Luehr, I am currently the home therapy dialysis nurse at St. Peter’s Hospital. I am currently attaining a Doctorate in Nursing Practice degree from Montana State University. My scholarly project is on the use of ultrasound guidance during cannulation of dialysis accesses (arteriovenous fistulas or grafts). The goal of the project is to determine what impact ultrasound guidance has on cannulation, create policies and procedures to help guide staff, and develop a training program and competency checklist for staff using ultrasound guidance. I am going to give you information and invite you to participate in this research by completing a questionnaire about your experiences with cannulation and the use ultrasound guidance. You do not have to decide today whether or not you will participate. Before you decide you can talk with anyone you wish. This consent may contain words you do not understand – please ask me to stop as we go through the information to give you any additional information you need. If you have any questions later you can ask them of me.

Purpose of the research:
All dialysis patients have an access through which they receive their dialysis treatment. The focus of this project is patients with “arms” (arteriovenous fistulas or arteriovenous grafts) that get “stuck” with needles for each dialysis treatment. I want to determine how using the ultrasound machine affects the success rate of good versus bad “sticks” – Did the needle go in the first time? Did in infiltrate (blow)? Was a bad needle able to be repositioned so that it worked? Did the nurse use the ultrasound machine? This information will be used to determine if ultrasound guidance should be included in best practice techniques for access cannulation. It will also help guide the development of policy and procedures and a training program.

Type of research intervention:
This project will involve your participation and completion of a brief survey. To complete the survey should take no more than 15 minutes. There will be no identifying information on the survey.

Participant selection:
All current hemodialysis patients with fistulas and grafts and staff who cannulate these accesses have been asked to
participate. Your experience can help me better understand your perception on the use of ultrasound guidance and personal experiences with cannulation.

**Voluntary participation:**
Your participation in this project is entirely voluntary. It is your choice whether to participate or not. If you choose not to participate all the services at this dialysis unit will continue and nothing will change. Your choice to participate or not will have no impact on the care you receive. You may change your mind at any time and stop participating even if you agreed earlier.

**Procedure:**
I am asking you to complete a brief survey at your convenience and return to the dialysis unit in the locked box marked “Ultrasound Project: Staff” located in the dialysis conference room. The survey will be completely anonymous – no one will know who completed it. If you do not wish to answer any of the questions included on the survey you may skip them and move onto the next one. Only I will have access to your completed surveys. The completed surveys will be kept in a locked cabinet that only I will have access to.

I will distribute the survey to you during a one-month period in 2017. You will have until the last day of the month to complete and return the survey.

**Duration:**
The survey will be distributed during a one-month period in 2017.

**Risks:**
There may be some questions you are uncomfortable answering and a risk you share some personal information by chance. However, I do not wish for this to happen. Again, you do not have to any question you feel uncomfortable answering. The expiration date for using the information from the survey is June 30, 2018.

**Benefits:**
There will no direct benefit to you, but your participation is likely to help us better understand your perspective of cannulation and if ultrasound has any impact on your feelings.

**Confidentiality:**
The surveys I collect will have no identifying information on them. The project includes all the dialysis patients and staff. You may be asked some questions about this project by patients or by dialysis staff. I will not try to figure out who filled the survey. The completed surveys will be kept in a locked cabinet that only I will have access to.

**Sharing the Results:**
The knowledge I obtain from the survey will be shared with dialysis patients and staff prior to being made available to the public. Each participant will receive a summary of the results. The goal of a MSU scholarly project is to be published. I will attempt to have my findings published in a Nephrology related journal. There will be NO information shared or published that will be specifically identified to a specific person.

**Right to Refuse or Withdraw:**
This is a reconfirmation that your participation is voluntary and you have the right to withdraw your participation at any time. Choosing to participate or not will not affect your employment at St. Peter’s Hospital.

**Whom to Contact:**
If you have any questions, you can ask them now or later. If your wish to ask a question later you may contact Alice Luehr at the St. Peter’s Dialysis Unit. 447-6878 or aluehr@stpetes.org.

This approval has been reviewed and approved by the St. Peter’s Hospital’s HIPAA Compliance Committee and the Montana State University IRB committee. These committees’ task is to make sure that this project’s participants are protected from harm. If you wish to find out more about these committees you may contact them at:

- St. Peter’s Hospital HIPAA Compliance/Ethics Committee – St. Peter’s Hospital: Attn: Barb Slunaker 2475 Broadway, Helena, MT 59601 (406) 444-2178

- MSU Institutional Review Board (IRB) - Montana State University P.O. Box 173610, Bozeman, MT 59717-3610 (406) 994-6783
Part II: Certificate of Consent:

I have been asked to participate in Alice Luehr’s DNP scholarly project titled *Use of Ultrasound Guidance during Cannulation of Arteriovenous Fistulas or Arteriovenous Grafts.*

AUTHORIZATION: I have read the above and understand the discomforts, inconvenience and risk of this study. I, _________________________ (name of subject), agree to participate in this research. I understand that I may later refuse to participate and that I may withdraw from the study at any time. I have received a copy of this consent form for my own records.

Signature of Participant __________________________________________
Date ___________________________ (Day/month/year)

Statement by the researcher/person taking consent

I have accurately read out the information sheet to the potential participant, and to the best of my ability made sure that the participant understands that the following will be done:

- Confidentiality of the person completing the survey will be maintained.
- The care the participant receives will not be impacted by his/her participation or withdraw from participation.
- Results of the project will be shared with the participants.

I confirm that the participant was given an opportunity to ask questions about the project, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

**A copy of this ICF has been provided to the participant.**

**Print Name of Researcher/person taking the consent:**

____________________________________________

Signature of Researcher /person taking the consent

___________________________________________

Date ___________________________ (Day/month/year)
APPENDIX F

PATIENT INFORMED CONSENT FORM
You are being asked to participate in a research study. This informed consent form is for end stage renal disease patients undergoing hemodialysis via an arteriovenous fistula (AVF) or graft (AVG) and for staff who cannulate AVFs or AVGs at the St. Peter’s Hospital dialysis unit in Helena, Montana. As a person who meets one of these requirements, you are invited to participate in the scholarly project titled: Use of Ultrasound Guidance during Cannulation of Arteriovenous Fistulas or Arteriovenous Grafts.

Introduction:
My name is Alice Luehr, I am currently the home therapy dialysis nurse at St. Peter’s Hospital. I am currently attaining a Doctorate in Nursing Practice degree from Montana State University. My scholarly project is on the use of ultrasound guidance during cannulation of dialysis accesses (arteriovenous fistulas or grafts). The goal of the project is to determine what impact ultrasound guidance has on cannulation, create policies and procedures to help guide staff, and develop a training program and competency checklist for staff using ultrasound guidance. I am going to give you information and invite you to participate in this research by completing a questionnaire about your experiences with cannulation and the use ultrasound guidance. You do not have to decide today whether or not you will participate. Before you decide you can talk with anyone you wish. This consent may contain words you do not understand – please ask me to stop as we go through the information to give you any additional information you need. If you have any questions later you can ask them of me.

Purpose of the research:
All dialysis patients have an access through which they receive their dialysis treatment. The focus of this research is patients with “arms” (arteriovenous fistulas or arteriovenous grafts) that get “stuck” with needles for each dialysis treatment. I want to determine how using the ultrasound machine affects the success rate of good versus bad “sticks” – Did the needle go in the first time? Did it infiltrate (blow)? Was a bad needle able to be repositioned so that it worked? Did the nurse use the ultrasound machine? This information will be used to determine if ultrasound guidance should be included in best practice techniques for access cannulation. It will also help guide the development of policy and procedures and a training program.

Type of research intervention:
This research will involve your participation and completion of a brief survey. To complete the survey should take no more than 15 minutes. There will be no identifying information on the survey. I will also access your electronic medical record to gather information about the cannulation history of your access (number of attempts, number of missed cannulations, outcomes of missed cannulations, etc). I will only collect data that relates to this research project. A number will be
associated to your medical record number. This number will be used as the identifying code for the data gathered (see confidentiality section). This will allow re-examination of data (if necessary) at a later date. The expiration date for accessing your medical record for this research project is June 30, 2018. After completion of the study this information will be shredded.

**Participant selection:**
All current hemodialysis patients with fistulas and grafts and staff who cannulate these accesses have been asked to participate. Your experience can help me better understand your perception on the use of ultrasound guidance and personal experiences with cannulation.

**Voluntary participation:**
Your participation in this project is entirely voluntary. It is your choice whether to participate or not. If you choose not to participate all the services at this dialysis unit will continue and nothing will change. Your choice to participate or not will have no impact on the care you receive. You may change your mind at any time and stop participating even if you agreed earlier.

**Procedure:**
I am asking you to complete a brief survey at your convenience and return to the dialysis unit in the locked box marked “Ultrasound Project: Patient” located in the post dialysis waiting room. The survey will be completely anonymous – no one will know who completed it. If you do not wish to answer any of the questions included on the survey you may skip them and move on to the next one. Only I will have access to your completed surveys. The completed surveys will be kept in a locked file cabinet that only I will have access to.

I will distribute the survey to you during your dialysis treatment. You will have one week to complete and return the survey.

I will access your medical records as needed until the completion of the project. I will protect your identity by assigning a number to your medical record.

**Duration:**
The survey will be distributed and collected in 2017 over a one-month period. I may collect some information from your medical records even after your direct participation (completing the survey) in the research project ends. The expiration date for accessing your medical record for this research project is June 30, 2018.

**Risks:**
There may be some questions you are uncomfortable answering and a risk you share some personal information by chance. However, I do not wish for this to happen. Again, you do not have to answer any question you feel uncomfortable answering. There is no cost to you to take the survey.

**Benefits:**
There will be no direct benefit to you, but your participation is likely to help us better understand your perspective on being “stuck” (cannulated) and if ultrasound has any impact on your feelings.

**Confidentiality:**
The surveys I collect will have no identifying information on them. The project includes all the dialysis patients and staff. You may be asked some questions about this project by the other patients or by dialysis staff. I will not try to figure out who filled the survey. The completed surveys will be kept in a locked cabinet that only I will have access to. The number assigned to your medical record along with information identifying the medical record as being yours will be kept in a pass word protected computerized document that only I will have access to.

Sharing the Results:
The knowledge I obtain from the survey and medical record review will be shared with dialysis patients and staff prior to being made available to the public. Each participant will receive a summary of the results. The goal of a MSU scholarly project is to be published. I will attempt to have my findings published in a Nephrology related journal. There will be NO information shared or published that will be specifically identified to a specific person.

Right to Refuse or Withdraw:
This is a reconfirmation that your participation is voluntary and you have the right to withdraw your participation at any time. Choosing to participate or not will not affect your care at St. Peter’s Hospital.

Whom to Contact:
If you have any questions, you can ask them now or later. If your wish to ask a question later you may contact me, Alice Luehr at 461-4389 or aluehr@bresnan.net or my project chair, Teresa Seright.

This approval has been reviewed and approved by the St. Peter’s Hospital’s HIPAA Compliance Committee and the Montana State University IRB committee. These committees’ task is to make sure that this project’s participants are protected from harm. If you wish to find out more about these committees you may contact them at:

- St. Peter’s Hospital HIPAA Compliance/Ethics Committee – St. Peter’s Hospital: Attn: Barb Slunaker 2475 Broadway, Helena, MT 59601 (406) 444-2178
- MSU Institutional Review Board (IRB) - Montana State University P.O. Box 173610, Bozeman, MT 59717-3610 (406) 994-6783

Part II: Certificate of Consent:

I have been asked to participate in Alice Luehr’s DNP scholarly project titled *Use of Ultrasound Guidance during Cannulation of Arteriovenous Fistulas or Arteriovenous Grafts.*

AUTHORIZATION: I have read the above and understand the discomforts, inconvenience and risk of this study. I also agree that my health information can be collected and used by the researchers and staff for the research study described in this consent form.

I, ___________________________ (name of subject), agree to participate in this research. I understand that I may later refuse
to participate and that I may withdraw from the study at any time. I have received a copy of this consent form for my own records.

**Signature of Participant ________________________________**

**Date __________________________ (Day/month/year)**

**Statement by the researcher/person taking consent**

I have accurately read out the information sheet to the potential participant, and to the best of my ability made sure that the participant understands that the following will be done:

- Confidentiality of the person completing the survey and of accessed medical records will be maintained.
- The care the participant receives will not be impacted by his/her participation or withdraw from participation.
- Results of the project will be shared with the participants.

I confirm that the participant was given an opportunity to ask questions about the project, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

**A copy of this ICF has been provided to the participant.**

**Print Name of Researcher/person taking the consent:**

______________________________

**Signature of Researcher /person taking the consent**

______________________________

**Date __________________________(Day/month/year)**
APPENDIX G

PATIENT QUESTIONNAIRE
Use of ultrasound guidance for cannulation of AVF and AVGs

Patient Evaluation

<table>
<thead>
<tr>
<th>Cannulation: Putting the needles into the access</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Uncertain</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 My access is easy to cannulate (access with the needle).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 I become anxious when thinking about having my access cannulated.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 I have more than 1 missed cannulation attempts per week.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>4 Cannulating my access is painful.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>5 Cannulation skills vary among staff.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 I am familiar with the ultrasound machine used to assist in cannulation of dialysis access.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 If the ultrasound machine is used during cannulation, it makes cannulating my access less painful.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 If the ultrasound machine is used during cannulation, there are less missed attempts.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 If the ultrasound machine is used during cannulation, there is less bruising of my access.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 The staff is proficient at using the ultrasound machine.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Do you use Emla (numbing) cream on your access?  

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Question</td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>11</td>
<td>Does the nurse inject lidocaine (numbing shot) prior to putting in your needles?</td>
</tr>
<tr>
<td>12</td>
<td>Number of missed needles you have had</td>
</tr>
<tr>
<td>13</td>
<td>Number of times your access was bruised due to missed cannulations</td>
</tr>
<tr>
<td>14</td>
<td>Number of times ultrasound was used to aid in cannulation of your access</td>
</tr>
<tr>
<td>15</td>
<td>Number of times your dialysis treatment was cut short due to needle issues</td>
</tr>
<tr>
<td>16</td>
<td>Number of times you had to come in on your normal day off to get your treatment due to needle issues</td>
</tr>
</tbody>
</table>

**Additional Comments:**

________________________________________________________________________
________________________________________________________________________
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APPENDIX H

STAFF QUESTIONNAIRE
Use of ultrasound guidance for cannulation of AVF and AVGs

Staff Evaluation

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>In the last 7 workdays, I have had _______ missed cannulations in ________ attempts.</td>
</tr>
<tr>
<td>2</td>
<td>Number of times ultrasound guidance was used during the missed cannulation attempts: _____________</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cannulation: Putting the needles into the access</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Uncertain</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Cannulation skills vary among staff.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>I am familiar with the ultrasound machine used to assist in cannulation of dialysis accesses.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>If the ultrasound machine is used during cannulation it makes cannulating accesses less painful.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>If the ultrasound machine is used during cannulation there are less missed attempts.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>If the ultrasound machine is used during cannulation there is less bruising of accesses.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>The staff is proficient at using the ultrasound machine.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>There is adequate training on how to use the ultrasound machine.</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>10</td>
<td>There are policy and procedures in place regarding the use of ultrasound guidance</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>I am proficient at using the ultrasound machine during cannulation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>I am proficient at cannulating AVFs and AVGs</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

### In the last month

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Number of missed cannulations you have had</td>
</tr>
<tr>
<td>13</td>
<td>Number of times you have bruised and access due to missed cannulations</td>
</tr>
<tr>
<td>14</td>
<td>Number of times you used ultrasound guidance to aid in cannulation of accesses</td>
</tr>
<tr>
<td>15</td>
<td>Number of times one of your assigned patient’s dialysis treatments was cut short due to needle issues</td>
</tr>
<tr>
<td>16</td>
<td>Number of times one of your assigned patients had to come in on his/her normal day off to get his/her dialysis treatment due to needle issues</td>
</tr>
</tbody>
</table>

### Additional Comments:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
APPENDIX I

ULTRASOUND-GUIDED CANNULATION OF

DIALYSIS ACCESS POLICY AND PROCEDURE
Policy: Ultrasound-guided Cannulation of Dialysis Access

Procedure:

INDICATIONS FOR USE

1. The “Rule of 6’s” should be applied to optimal arterial venous fistulas (AVF) with the AVF being at least 6 weeks post creation, no more than 6 mm deep, and have a greater than 6 mm diameter. Blood flow rate through the fistula should also be greater than 600 mL/minute.
   a. The portable ultrasound machine can determine depth, diameter, and characteristics (stenosis, collaterals) of the AVF.

2. Ultrasound guided cannulation should be used in the following scenarios
   a. Access diameter 6 mm to 10 mm
   b. Access deeper than 6 mm which can be due to swelling or edema at access site
   c. Presence of collateral veins
   d. History of multiple unsuccessful attempts
   e. Upon the very first cannulation attempt

PRECAUTIONS AND KEY POINTS

1. Nationally 62.5% of the hemodialysis populations have AVFs
2. The failure rate of an AVF less than 6 months post creation is 20 to 40%
3. Loss of primary AVF patency is affected by patient age, use of tobacco, location of access, presence of peripheral vascular disease, and AVF blood flow rate less than 650 mL/min
4. Negative patient experiences with cannulation can impact continued and successful use of AVFs
5. Missed cannulations result in damage to the AVF, possible decrease in life expectancy of the AVF, patient fear of cannulation, and delayed treatment.
6. Frequent missed cannulations and resulting hematomas are associated with an increased placement of Central Venous Catheters (CVC). CVCs are associated with a high infection rate.

7. Ultrasound guided insertion of CVCs is the “gold standard”

PROCEDURE

1. Gather equipment
   a. Portable ultrasound machine
   b. Disposable gel cap
   c. Supplies needed to initiate hemodialysis treatment
   d. Local anesthetic (optional)

2. Prepare for initiation of hemodialysis treatment
   a. Prepare access per policy and procedure
   b. Position ultrasound machine for a clear view with patient’s arm in a comfortable position
   c. Turn on ultrasound machine and apply gel cap to probe
   d. Dim lights to better visualize ultrasound machine screen

3. Ultrasound guided Cannulation
   a. Don PPE
   b. Apply tourniquet to AVF
   c. Orient probe directly over AVF – Using a “C” grip on the probe avoids applying too much pressure on the access thus distorting it
   d. Determine skin entry site
   e. Determine depth of AVF at insertion site
   f. Determine diameter of AVF at insertion site
   g. Prep insertion site per policy and procedure
   h. Center probe on target insertion site
   i. Scan and center target on image
   j. Adjust image depth to center lumen of AVF on image
   k. Adjust gain to brighten image
   l. Insert needle in alignment with the probe centerline as close to the probe as possible.
   m. Insert needle at a 20 to 35 degree angle
   n. After tip of needle is placed at the insertion site watch the ultrasound screen not the needle
   o. Apply quick forward motion to penetrate the skin
   p. Tilt the probe so that it is aligned 90 degrees to the needle
q. Advance the needle identifying the location of the needle tip until blood return in noted
r. Lower the angle of the needle and continue to advance needle, moving the probe to keep the needle tip within view
s. Maintain the needle tip within the center of the lumen redirect as needed
t. Tape needle securely per policy and procedure
u. Document per policy and procedure

4. Cleaning procedure
   a. After use the ultrasound system and probe must be cleaned per manufacturer’s recommendations and returned to a clean area.

RELATED DOCUMENTS:


Approved by:
APPENDIX J

ULTRASOUND-GUIDED CANNULATION OF
DIALYSIS ACCESS TRAINING AND COMPETENCY
This was presented in a PowerPoint presentation.

Slide two: Objectives

- Upon completion of this presentation participants will:
  - Be able to describe the factors associated with access survival
  - Be able to describe appropriate characteristics of AVFs and AVGs that would necessitate ultrasound-guided cannulation
  - Be able to explain how to use the bedside ultrasound machine
  - Be able to demonstrate ultrasound-guided cannulation
  - Be able to identify potential advantages or complications of ultrasound-guided cannulation

Slide three: Introduction

- Historically, there was no structured training for ultrasound-guided cannulation.
- Introducing a policy and procedure, training program, and competency program positively affected patient outcomes.

Slides four through eight: Dialysis Access

- Use of AVFs is associated with improved patient outcomes compared to central venous catheters (CVC).
- Nationally 62.5% of patients have AVFs.
- The failure rate of a “new” AVF is 20% to 40%. This is due to:
  - Lack of maturation
  - Thrombosis
  - Failure of first cannulation attempts
-is Ischemia
-is Infection

- Loss of primary AVF patency is also affected by:
  - Older patient age
  - Tobacco use (smoking)
  - Location of AVF (Upper arm more desirable than forearm)
  - Peripheral vascular disease
  - AVF blood flow less than 650 mL per minute

- Negative patient experience with cannulation can impact continued and successful use of AVFs.
  - Fear of cannulation pain
  - Fear of infiltration
  - Fear of multiple attempts

- Increased patient age and cannulation of new AVFs are both risk factors for infiltration.

- With the aging dialysis population and increased use of AVFs it is inevitable that there will be more “difficult accesses/sticks.”

- Missed cannulations result in:
  - Damage to AVF or AVG
  - Possible decreased life expectancy of the access
  - Delayed treatment

- Cannulation techniques impact AVF survival.
“Same site-itis” is associated with significantly greater access failure compared to rope and ladder or buttonhole techniques.

- Buttonhole technique is associated with higher infection rate than rope and ladder technique.
- Frequent infiltrations/hematomas are associated with increased placement and use of CVCs.

- Ultrasound guidance for insertion of CVCs is the gold standard and leads to increased first-time successful cannulation and reduced complications.
- Ultrasound-guided cannulation of AVFs is becoming more widespread but lacks high-level evidence based support.

Slide nine: Access Characteristics

- The rule of 6s should be applied to optimal AVF cannulation. The AVF should be:
  - At least 6 weeks post creation
  - Have a blood flow of at least 600 ml/min
  - No more than 6 mm deep
  - Have a diameter greater than 6 mm

Slides ten and eleven: Access Characteristics Necessitating use of Ultrasound-Guided Cannulation
• The bedside ultrasound machine can determine the depth and diameter of the AVF.

• The characteristics (path, presence of collaterals) of the AVF can also be determined by the bedside ultrasound machine.

• The blood flow through the AVF can be determined by Doppler ultrasound.

• Indications for ultrasound use:
  o Diameter 6 to 10 mm
  o Access deeper than 6 mm (can be due to edema/swelling)
  o Presence of collateral veins
  o History of frequent multiple unsuccessful attempts
  o Upon very first cannulation attempt

Slide 12: Ultrasound

• Provides real time assessment of vasculature prior to attempting cannulation.

• Provides depth and diameter of vessel.

• Provides ability to visualize the vascular, which can assist in identifications of tortuous curves or stenotic areas.
Slides 13 and 14: Advance Mode Display

Gain: The image gain can be adjusted to amplify the signal which brightens the image. Increasing gain will brighten the targeted structure along with the non-targeted structures.

Image depth: The depth button toggles between 1.0 cm, 2.5 cm, and 4.0 cm depths. Adjusting the depth also adjusts the focus of the ultrasound. For optimal viewing, adjust the depth so that the AVF is centered on the image.
Slide 15: Transverse vs Longitudinal Imaging

- Transverse
  - Can see diameter
  - Facilitates one operator technique
  - Easier to control angle of needle insertion

- Longitudinal
  - Can be used to reposition the needle within the access
  - Can be used to determine the pathway of the access

Slide 16: Longitudinal Approach to Map Access

- Creates a visual map of access anatomy
- Useful for deep or edematous accesses
- Can be used for AVFs and AVGs
Slide 17: Longitudinal Approach to Map Access

- Procedure:
  - Attach gel cap to probe.
  - Do not apply too much pressure to avoid distorting the access.
  - Orient probe directly over access starting at arterial anastomosis.
  - Move probe proximally over access.
  - Mark access with marker as probe is moved along access.
  - After access marked, turn probe to transverse position and note depth and diameter of access.
  - May take a picture (obtain patient consent) of access for future reference.

Slide 18: Choosing Insertion Site in Relationship to Probe

- Determining skin entry site
  - Depth
  - \(45^\circ\) angle of insertion is \(\tan=1\)
  - AVF typical angle of insertion is 25 to 30°

Example:

- Depth of access = 5mm (0.5 cm)
- Angle of insertion 45° (tan=1)
- Width of probe from beam to edge of Prevue Site Rite is 4mm

\[ L = (5 \times 1) - 4 = 1\text{mm} \]

What this means: The skin entry site needs to be very close to the probe.
Slide 19: Identifying the Needle Tip

- Once the needle tip is in the access, change the angle of the probe so that it is 90° to the needle.

![Diagram of needle tip identification](image)

Fig. 3 Identification of the needle tip by dynamic scanning. By adjusting the probe perpendicular to the needle shaft, the echogenicity of the shaft (dotted line) markedly increases. With the forward movement of the probe, the ultrasound image changes as indicated (inset, A to C). Strictly speaking, the precise location of the needle tip is between B and C.

Slides 20 through 23: Site-Rite Prevue: Procedure

1. Complete pre-dialysis access care.
2. Obtain needed supplies and ultrasound machine.
3. Patient should be seated comfortably.
4. Adjust height of cannulator’s stool to comfortable level.
5. Move ultrasound machine so that it is within the cannulator’s line of site.
6. Dim the lighting to allow for better visualization of the screen and reduce glare.

7. Attach pinpoint gel cap to probe.

8. Apply tourniquet to AVF.

9. Scan AVF/AVG to evaluate access prior to cannulation - note depth and diameter.

10. Determine target insertion site.

11. Prep site per policy and procedure.

12. Place probe on target insertion site.

13. Scan and center target on image.

14. Adjust image depth to center lumen of AVF on image.

15. Adjust gain to brighten image.

16. Insert the needle in alignment with the probe’s center line.

17. After tip of needle is placed on the insertion site watch the ultrasound screen, not the needle.

18. Apply quick forward motion to penetrate the skin.

19. Tilt the probe so that it is aligned with the needle.
20. Advance the needle, identifying the location of the needle tip until blood return is noted.

21. Lower the angle of the needle and continue to advance the needle, moving the probe to keep the needle tip within view.

22. Maintain the needle tip within the center of the access lumen, redirect as needed.

23. Tape needle securely.

Slide 24: Common Complications:

- Any change in cannulation success rate should be investigated—a change in blood flow, suggesting stenosis, may be the culprit.
- Misjudgment of depth may lead to scraping the back wall of the access.
- Hematoma formation can change the structure and position of the access.

Slides 25 through 28: Tips

- Always plug in power adapter since the battery life is unpredictable.
- Clean ultrasound machine after use.
- Keep your eyes on the screen not the insertion site.
• Stick quickly through the skin and then use the screen to guide the needle into the access.
• Use your wrist or finger to stabilize your probe hand.
• Immature AVFs may be elliptical in shape rather than round.
• Immature AVFs should be cannulated with 17g needles; the pump speed should not exceed 200 mL/min. Pressures should not exceed ≥250 mmHg.
• AVFs less than 6 months old are twice as likely to suffer infiltration than those older than 6 months.

Slides 29 through 31: Questions

1. What is the Rule of 6s?
   a) AVF is at least 6 weeks post creation.
   b) AVF is less than 6mm deep.
   c) AVF’s diameter is greater than 6mm.
   d) AVF’s blood flow is greater than 600 ml/min.
   e) All the above.

2. What AVF characteristics make it appropriate for ultrasound-guided cannulation?
   a) Diameter is 6 to 10 mm.
   b) It is deeper than 6mm.
   c) There are collateral veins present.
   d) There is a history of frequent, multiple, missed attempts.
   e) It is the first time the AVF has been cannulated.
   f) All of the above.
3. The right-hand scale on the screen image shows the depth of the AVF. T/F

4. The “Gain” feature
   a) Brightens the image when increased.
   b) Amplifies the signal.
   c) Is of no use.
   d) Both a and b.

5. Transverse imaging can be used to
   a) Note the diameter of the AVF.
   b) May be easier for a single operator.
   c) Makes it easier to control the angle of the needle insertion.
   d) All of the above.

6. Longitudinal imaging can be used to
   a) Reposition the needle tip in the lumen.
   b) Determine the pathway of the needle.
   c) Map the AVFs pathway.
   d) All of the above.

7. Always use a gel cap on the US probe. T/F

8. To help guide the needle into the center of the lumen once the needle tip is in the AVF, tilt the probe so that it is at a 90-degree angle to the needle. T/F

9. Watch the screen, not the needle, when you start to advance the needle. T/F

10. After each use of the US machine,
    a) Clean machine with appropriate cleaner.
b) Keep it unplugged.

c) Store the probe in the basket.

Slide 32: References


