A Retrospective Chart Review Comparing Ultrasound Guided Verses Landmark Intravenous Access

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Abstract

In 1984, Ultrasound-Guided (USG) Intravenous (IV) access was first used to place central venous catheters (CVC) in real-time. This led to increased success rates, reduced procedural times, decreased site associated complications, and a standard of care. As USG technology and teaching methods for CVC placement have improved, studies suggest this technique could also be translated into peripheral intravenous (PIV) placement. A retrospective chart review was conducted at an emergency department within a large healthcare facility to determine the reliability of USG PIVs when compared to landmark PIVs. The principal investigator reviewed the charts of adult inpatients admitted into the hospital from the Emergency Department (ED) comparing those who acquired landmark IV verses USG IV access to assess overall reliability. The data included IV survival rates, success rates, and site complications. 30 landmark and 17 USG PIVs were reviewed. Among the landmark PIVS, survival rates and success rates could not be measured. No site complications for landmark PIVs could be found. Among the USG PIVs, survival rates of only three could be found out of 17. No success rates could be measured. Only four site complications or reasons for PIV discontinuation could be found, including two counts of occlusion, one expiration, and one catheter damaged. In conclusion, due to limitations and lack of data found in this review, significance between variables could not be determined.

Keywords: ultrasound-guided peripheral venous access, landmark peripheral venous access, ultrasonography, site complications

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According to the Centers for Disease Control and Prevention (CDC), 130 million people check into the ED every year. 16.2 million are admitted as inpatients with the vast majority requiring intravenous access during their stay. Out of all these patients, roughly 150-200 million PIVs are placed nationwide making it the most used procedure in the ED (CDC, 2018). Although, landmark PIVs can be essential for treating the sick, they do not come without complications or room for improvement. Landmark PIVs have been associated with site complications such as phlebitis, infiltration, extravasation, and infection. Insertion of landmark PIVs require a level of competency by the executant that can be affected by the patient anatomy. In turn, the first pass success rate of landmark IV placement can never be a guarantee. When landmark PIV attempts fail too many times, it can delay care or result in more invasive procedures, such as CVC placement[1] (Patel et al., 2019; Poovelkunnel et al., 2020). USG PIV placement is a method increasingly used in EDs for patients deemed difficult sticks who may otherwise require a CVC. In hopes of reducing the incidence of CVC placement, the purpose of this project is to determine the overall reliability of USG PIV when compared to landmark PIVs.

Background

In 1984, the USG IV access was first used to place CVCs in real-time (Pare et al., 2018). This led to increased success rates, reduced procedural times, decreased site associated complications, decreased procedural accidence, and a standard of care for CVCs (Pare et al., 2019; Zerati et al., 2017). As USG technology and teaching methods for CVC placement have

[1] When compared to PIVs, CVCs are associated with increased rates of infection, thrombosis, and longer hospital admissions resulting in higher costs for both patients and hospitals (Patel et al., 2019).

improved, it is reasonable to suggest this technique could also be translated into PIV placement (Pare et al., 2018).

Currently, there is no gold standard for USG PIV use, which could reflect its novelty and suggest a need for more research (Pare et al., 2018). As we know it today, landmark PIV therapy has been around for almost a century and has been the mainstay for venous access (Millam, 1996). The first portable US machine did not become available for use until 1975, which was first recorded being used for PIVs in 1999 (Woo et al., 2002; Keyes et al., 1999). Thus, the USG method is much younger when compared to landmark PIVs and is now finding its purpose in PIV placement. With landmark PIV insertions being dependable and low risk procedures, it is reasonable to question the necessity for ultrasonography (Sou et al., 2017). However, with PIVs being the most used procedure in the ED, its improvement in quality, though it may only be a slight improvement per insertion, can have a sizeable impact overall. Hospitals who have adopted USG PIVs have experienced higher patient satisfaction with increased success rates and even reduced pain during insertion (Sou et al., 2017).

The Difference Between Ultrasound-Guided and Landmark Peripheral IVs

Materials

When comparing materials needed to place landmark peripheral IVs verses ultrasound-guided peripheral IVs, most of them are identical (tourniquet, disinfectant swab, IV catheter, securing device, saline flush, and extension tubing). When using USG PIVs, the only added materials are longer IV catheters and the addition of a portable US machine, which also needs access to electricity to operate. The longer IV catheters allow for deeper vein access only viewable on a portable US machine (Gottlieb et al., 2017; Levey et al., 2021).

Technique

Landmark PIV. When using the landmark technique, the clinician places a tourniquet on the preferred arm of a patient. By using the naked eye and touch, the most patent vein is identified and selected for insertion. Selected veins are most commonly located on the hand,

forearm, antecubital (bend of the arm), and upper arm (Beecham & Tacklin, 2021). The area is then cleaned with the disinfectant swab and allowed a brief moment to dry. At around a 45-degree angle, the IV catheter is inserted into the skin at the central most visible portion of the vein. After insertion, to ensure proper placement, a “flash” of venous return in the tubing should occur (Levey et al., 2021). This allows for a small amount of blood to flow between the needle and catheter into a small chamber of the device where it can be visualized (Beecham & Tackling, 2021). The IV catheter is then inserted slightly further to get passed the needle’s bevel or angled tip made to sharpen the needle. The clinician is now clear to advance the catheter without advancing the needle and device. After attaching the extension tubing, a successful IV placement is confirmed by administering the saline flush. While administering the saline flush, very little or no resistance should be felt, acute swelling at or above the site should not occur, and intense complaints of pain from the patient should not happen (Levey et al., 2021; Soria et al., 2021).

USG PIV. When using USG PIV, the clinician positions a portable US machine at eye level. A tourniquet is place on the preferred arm of the patient. Sterile propylene glycol gel is placed on the arm to reduce static and improve visualization on the US monitor (Gottlieb et al., 2017). The handheld doppler attached to the portable US machine is placed on the arm so veins can be visualized on the US monitor. The depth the monitor visualizes is typically set to 3.1 centimeters. This allows for deeper veins to be identified and selected for placement that would otherwise be unpalpable. Using the doppler in contact with the skin, the clinician adds gentle downward pressure over vessels determining if it collapses, being a vein, or has a pulse, being an artery, which would not be used for peripheral access (McMenamin et al., 2020). After confirming it is a vein, more pressure is applied to fully collapse the vein to ensure no clot is present. Once the clinician selects a patent vein, they cleanse the area with the disinfectant swab, line up the IV catheter just before the doppler, then inserts it into the skin. The clinician then keeps his or her eyes on the monitor as they guide the tip of the IV catheter to the vein.

Once the IV catheter has entered the central most portion of the vein, it is then advanced further down the canal of the vein until a drop in resistance is felt. The catheter is then advanced while holding the needle and device in position. The propylene glycol gel residue is carefully wiped off with a clean towel to allow the securing device to stick to the skin. A successful USG PIV placement is confirmed by placing the US doppler above the IV site and visualizing the vein while a saline flush is administered (Munshey et al., 2020). The IV will have a “flash” in the chamber when the catheter is in place, but checking for this is not necessary if the catheter residing within the vein can be visualized on the US monitor. The vein should remain intact without any suspicion of infiltration (Gottlieb et al., 2017).

Site Complications

Common site complications associated with PIVs include phlebitis, infiltration, and extravasation (Favot et al., 2019; Gottlieb et al., 2017; Levi & Sivapalaratnam, 2020; Mandal & Raghu, 2019). Phlebitis is vessel wall inflammation causing redness, pain, and edema at the site as a result of friction from the catheter over time (Mandal & Raghu, 2019). Infiltration and extravasation are used to describe a dislodged IV catheter passing fluid to the surrounding tissue. Infiltration leakage of non-irritating fluid, whereas extravasation is the leakage of irritating fluid (Favot et al., 2019; Levi & Sivapalaratnam, 2020).

Problem Statement

For patients admitted as inpatients from the ED, how does the effectiveness and safety of the USG method compare to the landmark method for PIV placement?

Search Methodology

Databases searched for literature were Google Scholar, Hackelmeier Memorial Online Library, and PubMed per recommendation by the Catholic university in which this project will be submitted. The search terms and phrases, “ultrasound guided vascular access,” “ultrasound guided peripheral access,” “emergency department,” “ultrasonography,” “central venous catheter,” “landmark peripheral venous access,” “barriers to ultrasound guided peripheral

access," "ultrasound guided peripheral phlebitis/infiltration/extravasation," and "peripheral vascular access" were used. Out of 43 articles found, 24 were selected related to ultrasound guided vascular access and landmark peripheral access. Age of participants within an article's sample pool was not considered for this literature review. Also, size and location of the facility where the study was conducted, and age of patients were not considered. Inclusion criteria were articles had to be published within the last 5 years dated between 2016 and 2021 and were written in the English language or had been translated to the English language. Exclusion criteria were articles pertaining to IV placement in the internal jugular vein, subclavian vein, or arterial access.

Literature Review

Outcome Measurement Selection

To make this literature review as thorough, yet simple, as possible, the selection of outcome measurements was based on commonalities seen among articles. The outcome measurements include barriers to USG PIV implementation, patient outcomes/safety, site complications, and IV success/survival rates. The selection of specific site complications for measure was based on those showing the highest incidence rates. These include phlebitis, infiltration, extravasation, and infection.

Barriers

There are a multitude of barriers to implementing the USG PIV method. Some of these barriers include ultrasound (US) machine availability, staff resistance, and cost (Archer-Jones et al., 2020; Schmidt et al., 2019). US machine availability can be a significant barrier to utilizing USG PIVs, because multiple patients may need venous access in a timely manner and only one portable US machine resides in the entire department (Archer-Jones et al., 2020). This makes the landmark method much more tempting to try on a patient with known difficult access with the interest in saving time rather than a successful first pass insertion. When patients are deemed as difficult sticks, the USG method is successful 90% of the time (Beecham & Tackling, 2021).

Nurses and providers who are reluctant report that they fear losing their skills in the landmark technique. Also, some nurses and providers report simply not feeling the need for USG PIVs even when an US machine is available (Schmidt et al., 2019). The time and practice required to setup the equipment and master the skill is also a significant barrier to utilizing the USG PIV method (Archer-Jones et al., 2020; Schmidt et al., 2019).

Another major barrier to implementing USG PIV is the cost of a portable US machine. The cost of a portable US machine can range anywhere from $8,000 to $55,000 per unit (Morata et al., 2017). Landmark intravenous catheters are slightly cheaper than what is needed for higher success rates utilizing USG PIVs, which use tubing almost twice the length (Bahl et al., 2019). When considering the additional cost of the longer catheter tubing and upfront portable US machine costs, studies show traditional peripheral intravenous placement costs roughly $32 per attempt at an average of 3.7 attempts to successfully place, whereas USG PIVs is around $45 per attempt averaging only 1.7 attempts. Therefore, USG PIVs have the potential of being more cost-effective when considering the reduced attempts typically needed for placement. The average cost would save $41.90 per patient along with improved customer satisfaction (Beecham & Tackling, 2021; Morata et al., 2017).

Patient Outcomes/Safety

Traditional peripheral IVs are frequently used in emergency departments and patients prefer USG PIVs over landmark IVs (Galen & Southern, 2018). Failed attempts can result in pain, anxiety, and site complications. Furthermore, subsequent attempts increase the probability of occurrence (Archer-Jones, 2020; Van Loon et al., 2018). Studies show about 26% of patients need multiple attempts to successfully place landmark PIVs. A meta-analysis shows the USG PIV first pass success rate is more than double when compared to landmark peripheral IVs, which can ultimately reduce negative outcomes, including satisfaction for patients (Archer-Jones, 2020). In a study with a sample size of 839, no complications related to infection were developed via USG PIVs (Duran-Gehring et al., 2016). Other studies also showcase an

absence or a substantial reduction in complications associated with bloodstream infection or thrombosis (Balceniuk et al., 2020; Scoppettuolo et al., 2016).

Site Complications

Phlebitis

Without differentiating landmark verses USG PIVs, the incidence of phlebitis is around 30% (Lv & Zhang, 2019). Factors that are associated with increased rates of phlebitis include the administration of drugs, blood products, larger catheter gauges, and insertion during emergent situations (Mandal & Raghu, 2019). The average time from the initiation to removal due to phlebitis is around 83.5 hours (Lv & Zhang, 2019; Mandal & Raghu, 2019, Vinograd et al., 2018). Decreased rates of phlebitis follow when the catheter tip was inserted at an angle less than 5.8 degrees (Tanabe et al., 2016).

Infiltration/Extravasation

A study where contrast was administered to patients 29,508 times, 291 being placed via US guided technique, there were 74 (0.25%) occurrences of extravasation. There were 12 (4.1%) instances of extravasation with the US PIV and 62 (0.21%) with landmark PIVs. This shows an 3.9% higher risk of contrast extravasation with US guided IVs when compared to landmark IVs (Favot et al., 2019). The higher extravasation rate can be attributed to an inadequate catheter length not fully within the vein causing them to dislodge (Bridey et al., 2018). In another study, infiltration was the most common reason for IV failure. The failure rates for landmark IVs ranges between 19-25%, USG PIVs ranged from 45-56% (Blanco, 2019).

Infection

Probe covers and adhesive films have been used by hospitals to further reduce the incidence of infection when using USG PIVs. More studies are needed to adequately demonstrate if these added interventions make any difference. Regardless, two studies show no difference in infection rates when comparing landmark PIVs and USG PIVs (Bridey et al., 2018; Gottlieb et al., 2017).

When comparing longer verses shorter catheter tubing, one study showed no instances of infection (Bahl et al., 2020). In another study with a sample size of 71, who all received USG PIVs, only one instance of bloodstream infection was recorded (Fabiani et al., 2016). This is likely due to infection rates having a stronger correlation to how long a PIV remains idol in a vein (Alexandrou et al., 2018). Regardless of tubing size or insertion method, routinely replacing or removing PIVs every 72 to 96 hours is recommended to reduce chances of infection (Takashima et al., 2021). This is coupled with adequate surveillance and early identification of site infection so PIVs can be removed before complications worsen (Alexandrou et al., 2018).

IV Success and Survival Rate

Success Rate

There are significantly high first pass success rates utilizing USG PIV (Archer-Jones et al., 2020; Asao et al., 2019; Bahl et al., 2019; Balceniuk et al., 2020; Duran-Gehring et al., 2016; Maizel et al., 2016; McCarthy et al., 2016; Morata et al., 2017; Stolz et al., 2016; Van Loon et al., 2018; Vinograd et al., 2018). Also, it takes much less time to achieve venous access with USG PIVs (Bahl et al., 2019; Maizel et al., 2016). From the time the catheter needle touches the skin to stabilized placement, the USG technique takes an average of 16.4 to 39.s seconds, whereas the landmark technique takes an average of 30.1 to 70.4 seconds (Maizel et al., 2016). Reduced insertion times utilizes the USG technique are particularly true for patients with difficult access (Gottlieb et al., 2017).

There are variances in technique and competencies, which plays a part in successful attempts (Liu et al., 2018). One study shows USG PIVs being inferior with 65% being successful within the first two attempts when compared to landmark PIVs at 84% (Otani et al., 2018). The difference, when compared to other studies, is the technique used to place USG PIVs. This study measured the success rate of USG PIVs using two operators, one inserting the catheter and the other visualizing and manning the US machine (Otani et al., 2018). On the contrary, a significant number of studies show high success rates when only one operator inserts the USG

PIV (Archer-Jones et al., 2020; Asao et al., 2019; Bahl et al., 2019; Blanco et al., 2019; Balceniuk et al., 2020; Duran-Gehring et al., 2016; Maizel et al., 2016; McCarthy et al., 2016; Morata et al., 2017; Stolz et al., 2016; Van Loon et al., 2018; Vinograd et al., 2018). Some show success rates as high as 78.4 %, 90%, even 100% (Asao et al., 2019; Bahl et al., 2019; Blanco et al., 2019).

Survival Rates

The longer the catheter, the longer the PIV survival rate. In a prospective study using two catheters varying in length, one being a standard long gauge catheter of 4.78 cm and the other an extended dwell measuring 6 cm, they found the longer catheter survived almost three times longer than the shorter. The median survival rate of the longer catheters was 4.04 days, whereas the standard long catheters lasted 1.25 days (Bahl et al., 2019). As the percentage of catheter dwelling inside the vein increases, the likelihood of site complications resulting in PIV removal decreases (Pandurangadu et al., 2018). Other studies show USG PIVs surviving even longer reaching up to 6 days. In this particular study, the majority of these were discontinued not from site complications, but from no longer being needed (Vinograd et al., 2018).

Theoretical Framework

Dr. Ian Graham and colleagues' *Knowledge-to-Action* (KTA) model is a framework based on the creation of knowledge and applying it. The use of the word "action" as opposed to "practice" is to promote a wider scope of users and not solely clinicians. The KTA model encompasses seven phases: identify the problem; adapt the knowledge; assess barriers; select, adjust, and implement interventions; monitor knowledge use; evaluative outcomes; and sustain knowledge use. It can be visualized as a funnel where broader and more generalized inquiries start at the mouth and tailored accordingly throughout the process until the knowledge is adopted and implemented (White et al., 2016). For this retrospective chart review, the following five of the seven phases will be used as a framework:

Identify the problem

With PIV placement being the most used procedure within the ED, can success rates, survival rates, and site complications be reduced utilizing the USG method?

Adapt the Knowledge

As chart reviews were conducted, variables were included, excluded, or altered dependent on what can be seen and what was pertinent to the data.

Assess Barriers

Limitations to this retrospective chart review were identified dependent on what was found within the data. Some barriers included what clinicians have or have not charted or what can be viewed through a student login.

Select, Adjust, and Implement Interventions

Site complications, success rates, and survival rates mentioned previously was the focal point of this review, but additional variables discovered in the process were included as they may or may not be significant and/or meaningful.

Evaluate Outcomes

Target variables regarding USG and landmark PIVs were compared to illustrate what is significant and/or meaningful.

Goals, Objectives and Expected Outcomes

The main goal of this retrospective chart review is to determine if USG verses landmark PIVs show better success rates, survival rates, and less site complications. For the large healthcare facility this review is being conducted, another goal is to set a benchmark for USG PIV use. Lastly, it is expected this review will encourage the large healthcare facility to implement more studies, policies, and/or trials to further assess the value of USG PIVs.

Project Design

The principal investigator conducted a non-experimental retrospective review with a convenience sample. Per the large healthcare facility, patient consent was not required as it

was a standard of care meaning this study utilized existing data where subjects could not be identified. This project was not funded by any entities. There were no prior IRB approvals. During the month of June, the goal was to select and review 30 adult patient charts who had USG PIV and 30 adult patient charts who had a landmark PIV between January 1st and May 1st of 2021. This data was collected by the principal investigator alone. To maintain confidentiality, patients were deidentified and substituted with numerals in the order they were selected. Sensitive data was kept on an Excel sheet in a password protected hard drive.

Methods

Quality Measures

Before this retrospective chart review could be submitted to the IRB, various steps had to be completed to improve patient confidentiality and overall quality. To enhance patient confidentiality, extensive Collaborative Institutional Training Initiative modules were completed through both the Catholic university and large healthcare facility. The project proposal was presented to the healthcare facility's research committee, revised, then presented a second time to the same committee before being approved for submission to the IRB. This project was submitted to and approved by the IRB at the healthcare facility and the Catholic university.

Project Site and Population

Data from patients admitted as inpatients from the ED was collected from a large hospital which staffed 335 beds and had a 77 bed ED. The ED treats approximately 150 to 250 patients per day where an average of 10% of those patients are admitted. Within this ED, USG PIVs are placed for patients daily.

Inclusion and Exclusion Criteria

Inclusion criteria were adult patients 18 years and older, who were admitted from the ED into the hospital and had either a landmark or USG PIV placed at some point during their stay. Exclusion criteria were pediatric patients 17 years and younger, obtained a PIV prior to their

arrival to the ED, PIVs placed during a code blue event[2], had IVs placed in the internal jugular vein, subclavian vein, or artery, protected populations (prisoners), or inpatients who were direct admits bypassing the ED.

Sampling Procedures and Sample Size

Due to delays on receiving data from the analytics request, the data collection was implemented during the entire month of August. The data report pulled 509 PIVs placed on patients admitted as inpatients from the ED into the hospital between January 1st and May 1st of 2021. The charts were not pulled per patient, but rather per PIV. This means the charts of patients who had multiple PIVs placed during their stay were pulled an additional time per PIV. The intended sample size was 30 landmark and 30 USG PIVs. Out of 509 charts, well over 30 landmark PIVs were available, but only 17 USG PIVs were available for selection. Charts were listed in chronological order, so to help prevent a patient's chart from being pulled multiple times, starting from January, every eighth chart was selected until 30 landmark PIVs were selected. Selecting every eighth chart allowed for the widest gap between 30 charts while stretching across the entire timeframe. Since only 17 USG PIVs met inclusion criteria, all were selected for review.

Data Collection

To ensure patient confidentiality, the principal investigator collected data in a locked private room within the healthcare facility using the hospital's computer. Each selected chart was reviewed using a student login provided by the healthcare facility. An Excel spreadsheet was used to input yes/no information associated with patient demographics and PIV measurements including, admission length of stay, gender, age, incidence of site complications, PIV success rates, and PIV survival rates.

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[2] An emergency code used to alert staff of a patient experiencing a critical status. Some examples include cardiac or respiratory arrest (Gadhoumi, 2021).

Data Analysis

To measure landmark verses USG PIVs, variables would have been compared using Pearson's Correlation Coefficient. However, once the retrospective review reached this phase, enough data was missing to be insufficient for measurement. This was validated by a statistician from the healthcare facility, who also stated more data was needed for analysis.

Results

30 landmark and 17 USG PIVs were reviewed. There were 14 (46.7%) females who had landmark and 13 (76.5%) who had USG PIV placement; and 16 (53.3%) males who had landmark and 4 (23.5%) who had USG PIV placement. Average age of patients with USG PIVs was 59.059 years and 60 years for patients with landmark PIVs. The average admission length of stay for patients with USG PIVs was 249:16 hours (hrs.) and 81:01 hrs. for patients with landmark PIVs (see Appendix A). Data was missing or unobtainable for success rates for all 30 landmark PIVs and all 17 USG PIVs. Data was missing or unobtainable for survival rates for all 30 landmark PIVs and 14 USG PIVs. The three remaining USG PIVs showed survival rates of 4:55 hrs., 21:35 hrs., and 31:31 hrs. averaging 19:34 hrs. Data was missing or unobtainable for site complications for all 30 landmark PIVs and 13 USG PIVs. The four remaining USG PIVs showed 2 counts of occlusion, 1 count of catheter damage or other, and 1 count of expiration. Due to amount of missing data, Pearson's Correlation Coefficient could not be implemented. No incidences of phlebitis, infiltration, extravasation, of infections were found (see Appendix B).

Discussion

Limitations

Sample Size

Due to the significantly lower sample size of USG PIVs, the protocol for selecting charts for review could not be implemented consistently for both landmark and USG PIVs. In an attempt to make both variables comparable, all USG PIVs that met inclusion criteria were included, which hinders the validity of this comparison. If the protocol was applied to the USG

PVIs in the same way as the landmark PIVs, the USG PIV sample size would have been significantly smaller.

Missing Data

Limitations of this retrospective review was predominately a lack of data available and/or usable to measure success rates, survival rates, and site complications. This could be a result of the student login used to conduct chart reviews having reduced access. The student login was also crosschecked by a clinical nurse specialist who also confirmed the obscure layout it showed when compared to a typical employee login.

If not a lack of access, the missing data could be a result of untraceable charting or a fault within the electronic charting system. No prior studies have been conducted comparing landmark verses USG PIVs within this large healthcare facility, therefore needed variables for measurement within the charting system may not be marked in any way for tracking. When reviewing charts, the only way to view reasons for removal of a particular PIV, the employee charting its removal would have to be extra prudent by manually charting an additional comment.

Success Rates. The goal with success rates was to look at how many times an executant charted a failed attempt before charting the first successful PIV placement. This could have been altered and simplified to just measuring how many successful first-pass placements were made for both landmark and USG without counting failed attempts of each chart. However, only successful attempts for both landmark and USG could be found. The executant would have to have been prudent in charting their failed attempts while indicating whether a landmark or USG was used. This was a major limitation in finding significant outcomes. There is an “attempts” selection that can be charted for each PIV placement where the executant can disclose this, but it is unclear whether this variable is inaccessible to the student login, untraceable, or uncharted. Hence, the success rates were not applicable for all 47 PIVs (see Appendix B).

Survival Rates. This measurement was simple in wanting to show the amount of time between when the PIV was placed and discontinued. Out of 47, only three PIV had documented date and time of discontinuation. Aforementioned, 44 PIVs showed survival rates between 116 and 203 days. When spot checking all 509 charts, none had survival rates less than 116 days. Per policy within the healthcare facility, the max amount of time a PIV can be in place is 96 hrs. Alternatively, survival rates of 24 hrs., 48 hrs., 72 hrs., and 96 hrs. could have been shown to measure this in a simpler fashion. Assuming the vast majority are not discharged home with PIV still in place, 44 PIV survival rates are not applicable (see Appendix B). If a patient happens to get discharged home with a PIV still in place, the healthcare facility has protocols to remove the PIV by having the patient return to the hospital. However, documentation of this scenario could not be seen. If a patient has deceased, all PIVs are untouched until cleared by the coroner. In this scenario, executant either failed to chart PIV removal, left the PIV in place per coroner's instruction, or this documentation is untraceable. Whether a patient was deceased or alive was not a variable for this review. Nevertheless, roughly half of the patients for each group had documentation of being deceased while showing survival rates well beyond date and time of death. The most likely scenario is the date and time of PIV removal becomes untraceable at some point during the patient's stay.

Site Complications. The goal was to compare which PIV group had more incidences of phlebitis, infiltration, infection and/or extravasation. Alternatively, if these variables were missing, any extraneous site complications documented were substituted. Extraneous site complications found were documented as "occluded," "expired," and "catheter damage" (see Appendix B). However, there were not enough alternative site complications to show any statistical significance. Within the charting system, there are options to select a reason for removal, but this was either uncharted or untraceable. The extraneous site complications that could be viewed were the result of the executant being prudent in manually charting in the "comments" section of the PIV. Knowing this healthcare facility has exceptional surveillance in

identifying site complications promptly and replaces PIVs consistent with evidence-based practice, the likelihood of having minimal site complications is a possibility. However, documentation of a PIV being “expired” would validate this. With the average admission length of stay being 10.3 days for USG and 3.3 days for landmark, documentation should have been seen an average of 2.5 times for USG PIVs (see Appendix A). Similar to the success rates and survival rates, site complications were either uncharted or untraceable.

Data Validity

Access to the actual charts used in this study were not approved by the IRB for the clinical nurse specialist to view, therefore user error could not be entirely ruled out. Alternatively, an addendum could have been an option to allow the clinical nurse specialist to validate limitations or user error within the charts used for this retrospective review. Due to time constraints, the addendum could not be completed prior to the due date of this project.

A second analytics request was submitted in June of 2021 within the healthcare facility to verify whether the initial data report was accurate or not. Unfortunately, the analytics team has not sent the second data report to this day. When contacted, they mentioned the reason for delay had to do with being overloaded with analytics requests that needed to be completed prior to this one. Understanding missing data points in the first analytics report, this second analytics request would have had great value in crosschecking the data. A final attempt for a third analytics request was submitted in August of 2021. However, this report was never received.

Potential Bias

With the principal investigator being an employee who often places both landmark and USG PIVs every shift, excluding these PIV placements was decided. However, through the eyes of the student login, the name of the executant was not visible unless it was manually typed into the comments. Ethically, principal investigator’s employee login could not be exploited for this retrospective chart review. However, it could have lifted the limitation of what was accessible regarding success rates, survival rates, and site complications.

Future Directions

To be able to conduct this retrospective chart review successfully in the future, ways to track success rates, survival rates, and site complications would have to be established prior to execution. With USG PIV being such a novelty when compared to landmark PIVs, perhaps a prospective study would be more appropriated. Another consideration for its success would be to allow adequate time for the analytics team to run a more formal data report. Also, a different or additional principal investigator should be considered to reduce the chance of user error when conducting this study.

Conclusion

Being the most commonly used procedure in the emergency room, improvements on success rates, survival rates, and site complications related to PIVs should be sought after (CDC, 2018). This retrospective chart review suggests the need to establish how and if outcome variables can be traceable for future studies. Also, a much longer timeline for collecting data should be considered to ensure an adequate amount of data can be collected. Although the results of this retrospective chart review were inadequate, the literature review shows promise in the application of USG PIVs as an alternative to landmark PIVs.

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Appendix A

Table 1

USG PIV	Admission Length (Hours)	Age	Gender
1	40:55	20	F
2	209:56	51	F
3	458:51	59	M
4	101:21	67	M
5	144:48	71	F
6	7:32	67	M
7	752:23	67	F
8	752:23	67	F
9	752:23	67	F
10	139:16	53	F
11	139:16	53	F
12	139:16	53	F
13	68:51	88	M
14	156:12	74	F
15	154:27	41	F
16	154:27	41	F
17	65:18	65	F
Total	4237:35		4 Male; 13 Female
Average	249:16	59.059	23.5% M; 76.5% F
Landmark PIV			
1	53:48	95	F

2	28:44	67	M
3	47:57	65	M
4	0:03	79	M
5	344:59	49	M
6	20:15	56	M
7	78:06	48	F
8	56:37	24	F
9	298:27	52	F
10	51:28	26	M
11	29:42	68	F
12	151:15	62	M
13	7:43	74	F
14	53:58	68	F
15	30:57	44	M
16	50:25	63	M
17	43:28	54	M
18	42:36	31	F
19	31:24	37	F
20	307:42	49	F
21	27:50	65	M
22	27:53	N/A	M
23	118:51	80	F
24	23:43	59	M
25	73:47	60	M
26	134:03	72	M
27	144:48	71	F

28	61:02	28	F
29	52:16	62	M
30	36:51	93	F
Total	2430:38		16 Male; 14 Female
Average	81:01	60	53.3% M; 46.7% F

Appendix B

Table 2

USG PIV	Site Complications	Survival Rate (Hours)	Success Rate
1	N/A	N/A	N/A
2	Catheter Damage	N/A	N/A
3	N/A	N/A	N/A
4	N/A	N/A	N/A
5	N/A	N/A	N/A
6	N/A	N/A	N/A
7	N/A	N/A	N/A
8	Expired	N/A	N/A
9	Occluded	N/A	N/A
10	N/A	N/A	N/A
11	Occluded	4:56	N/A
12	N/A	21:35	N/A
13	N/v	N/A	N/A
14	N/A	N/A	N/A
15	N/A	N/A	N/A
16	N/A	31:31	N/A
17	N/A	N/A	N/A
Total	N/A	Not Applicable	Not Applicable
Average	N/A	19:34	Not Applicable
Landmark PIV			
1	N/A	N/A	N/A
2	N/A	N/A	N/A

4	N/A	N/A	N/A
5	N/A	N/A	N/A
6	N/A	N/A	N/A
7	N/A	N/A	N/A
8	N/A	N/A	N/A
9	N/A	N/A	N/A
10	N/A	N/A	N/A
11	N/A	N/A	N/A
12	N/A	N/A	N/A
13	N/A	N/A	N/A
14	N/A	N/A	N/A
15	N/A	N/A	N/A
16	N/A	N/A	N/A
17	N/A	N/A	N/A
18	N/A	N/A	N/A
19	N/A	N/A	N/A
20	N/A	N/A	N/A
21	N/A	N/A	N/A
22	N/A	N/A	N/A
23	N/A	N/A	N/A
24	N/A	N/A	N/A
25	N/A	N/A	N/A
26	N/A	N/A	N/A
27	N/A	N/A	N/A
28	N/A	N/A	N/A
29	N/A	N/A	N/A

30	N/A	N/A	N/A
Total	Not Applicable	Not Applicable	Not Applicable
Average	Not Applicable	Not Applicable	Not Applicable