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Decreasing Central Venous Catheter Usage for the Hemodialysis Patient

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Decreasing Central Venous Catheter Usage for

the Hemodialysis Patient

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Abstract

***Problem*:** The central venous catheter (CVC) usage rate in a large urban dialysis clinic was 34.5% and the Centers for Medicaid and Medicare Services (CMS) goal is 10.7%. CVC usage is a quality metric monitored by CMS to assess whether dialysis facilities are providing quality services which can impact reimbursement for the clinic. Failure to meet this metric can result in a penalty of up to 2% in reimbursement. The purpose of this quality improvement project was to determine if an interdisciplinary team (IDT) approach to vascular access planning and care influenced the CVC usage rate by 10% in three months.

***Methods*:** An observational descriptive design with a retrospective medical record review was used to evaluate the effectiveness of interventions aimed to decrease CVC utilization rates in a large urban dialysis clinic. This pilot study evaluated an IDT approach to permanent vascular access coordination and was completed between June through August 2021.

***Results*:** Pre-implementation of the IDT approach there were (N=57) patients dialyzed through a CVC and post-implementation there were (N=59). The monthly CVC usage was compared to the CMS performance goal of 10.7%. A Pearson chi-square test was performed (x^2(1)> = 1.775, p = 0.183), and resulted in no statistical significance, but was clinically significant with lowering the CVC usage rates to 29.31% from 34.50%.

Implications for practice: An IDT approach may be adopted over a longer time to assess CVC usage rates before starting hemodialysis by addressing patient barriers (i.e., no insurance, referrals to vascular surgeons).

Decreasing Central Venous Catheter Usage Rates for the Hemodialysis Patient

In the United States, more than 37 million people are diagnosed with end-stage renal disease (ESRD) and in many cases, they need dialysis to sustain their life. Patients can choose hemodialysis (at home, or in the center) or peritoneal dialysis as a treatment modality. Approximately 726,000 people are on hemodialysis (Centers for Disease Control and Prevention [CDC], 2019), and 14, 344 people are on peritoneal dialysis (United States Renal Data System [USRDS], 2020). A kidney transplant may be an option if certain criteria (i.e., controlled blood pressure, optimal weight for age, and lab values) are met to be placed on a kidney transplant list, which can take up to five years or more. As aforementioned, of the number of people who are on hemodialysis, 80% of those patients initiate hemodialysis with a central venous catheter (CVC) as the primary access type (Al-Balas et al., 2017). A CVC is a thin tube tunneled under the skin and inserted into a large vein, usually the subclavian or internal jugular, and allows for emergent hemodialysis treatment (CDC, 2019). CVC placement provides immediate access which takes less than an hour to insert and removal takes less than an hour to complete. For patients who require emergent dialysis, CVCs are usually inserted in the hospital setting and patients are discharged from the hospital to an outpatient dialysis clinic where they will either begin the process of permanent vascular access placement, choose a home or peritoneal dialysis modality for the continuation of treatment, or apply for kidney transplantation. Once inserted, the CVC can be accessed and de-accessed frequently for hemodialysis treatments. Even though CVCs are commonly placed, patients dialyzing with a CVC face many challenges including inadequate lab values, longer treatment times on the machine, possible bloodstream infections, catheter dysfunction (i.e., clotting, dislodging, blockage), thrombosis, and central vein stenosis (Bream, 2016).

High CVC usage rates are concerning because of the overwhelming complications associated with patients dialyzing through a CVC. Patient quality of life and mortality is dependent on the type of access used for hemodialysis (Cohen et al., 2015). The Centers for Medicare and Medicaid Services (CMS) recommends a CVC usage rate of 10.7% or lower because it decreases the risk for mortality (CMS, 2019). A noticeable concern was the CVC utilization rate in a large urban dialysis clinic was 34.5% with an organizational regional goal of 13% which is 2.3% higher than CMS's goal of 10.7%. The pilot study aimed to utilize an IDT approach to lower the CVC usage rate by 10% in three months.

CMS governs the dialysis clinic for reimbursement payment and leads the End-Stage Renal Disease Quality Incentive Program (ESRD QIP). The ESRD QIP program assesses whether high-quality services are provided and links a portion of payment directly to the performance of quality-of-care measures. If certain performance standards are not met, then dialysis clinics are reimbursed at a lower rate (CMS, 2020). CMS uses 14 metrics to evaluate quality and if the performance score is sixty to one hundred, then their performance is deemed to be quality. One of the performance measures which accounts for 58% of the total score is the type of vascular access used to treat patients who fall under the clinical care subdomain. Performance scores ranging from zero to sixty have not met standards and could be assessed a reimbursement penalty of up to two percent (CMS, 2020).

The pilot study was of interest because of the high number of African American patients that were dialyzed per month in a large urban dialysis clinic with a CVC. The high CVC utilization rate may have been contributed to the inconsistency of not having a vascular access coordinator (VAC), staffing turnover rates, and the lack of an interdisciplinary team (IDT) (i.e., medical director (MD), social worker (SW), facility administrator (FA), nephrologist, and registered nurse/clinical coordinator (RN/CC)) approach to patient care. Nevertheless, the type of vascular access used for hemodialysis has a bearing on the quality of life and can play a big role in performance scores as it relates to reimbursement (CMS, 2020; Cohen et al., 2015).

The purpose of the pilot study was to increase the facilitation of African American patients having an arteriovenous fistula (AVF) or arteriovenous graft (AVG) placed as the primary permanent vascular access. The pilot study evaluated the effects of an IDT approach to vascular access planning which included barriers to receiving an AVF or AVG. The evidence-based practice (EBP) framework used to guide the study was the IOWA Model. The pilot study aimed to utilize an IDT approach to lower the CVC utilization rate in a large urban clinic by 10% over three months. The primary outcome measure of interest was the CVC utilization rate per month over three months. The secondary outcome measures of interest were the number of patients who had a CVC removed, and the number of patients who had an AVF and/or AVG placed within one month over three months. Study question: In African American adults 19-85 years of age receiving hemodialysis with a CVC, what is the effect of an IDT approach on CVC usage rate for hemodialysis patients over three months?

Review of Literature

A literature review was performed using search engines including Medline EBSCO, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Science Direct, and Google Scholar from the years 2014 through 2020. The search included keywords such as end-stage renal disease (ESRD), chronic kidney disease, hemodialysis, vascular access, a central venous catheter (CVC), arteriovenous fistula (AVF), arteriovenous graft (AVG), interdisciplinary team (IDT), and social determinants of health (SDOH). A search of the CINAHL database yielded 159 results while Medline EBSCO yielded 78 results. The Science Direct database yielded 1,805 results with the exclusion of encyclopedias and book chapters. Google Scholar yielded 6,630 results. No Boolean operators were used for the search. Inclusion criteria included: African American patients 19-85 years of age with a CVC as the primary access who may also have a maturing AVF/AVG, a diagnosis of ESRD, a candidate for vascular access surgery, three or fewer previous access surgeries, and controlled co-morbid conditions (i.e., congestive heart failure (CHF), chronic obstructive pulmonary disease (COPD), and Diabetes). Exclusion criteria included: non-African American, less than 19 and older than 85 years of age, acute kidney injury (AKI) diagnosis, not a candidate for vascular access surgery, three or more previously failed vascular access maturations or permanent vascular surgeries. A total of twelve publications were selected for the literature review. The number of articles selected from each search engine are as follows three from CINAHL, five from Medline EBSCO, two from Science direct, and two from Google scholar.

ESRD is a slowly progressing condition that affects minorities at a faster rate and compared to Caucasians, African Americans are 3.7 times more likely to be diagnosed with the disease (Christianson et al., 2018). Once a diagnosis has been made, either a temporary or permanent vascular access is placed to initiate hemodialysis. A CVC is often the first vascular access placed for outpatient hemodialysis due to ease of insertion, and immediate access for use; however, an AVF is the gold standard in vascular access placement due to long years of access survival, fewer complications with usage, and access patency (Lee, 2017). AVFs are associated with fewer hospitalizations, lower costs, lower infection rates, and mortality rates but incur higher costs for maintenance due to the possibility of numerous surgical interventions (Cohen et al., 2015). Lee (2017) explained disparities exist in the first vascular access placed to initiate hemodialysis in patients with lower socioeconomic status. The type of access placed at the initiation of hemodialysis drastically impacts patient health outcomes and quality of life (Lee, 2017). As aforementioned, an AVF is the standard for vascular access placement and they are placed at a higher rate for patients who have been under nephrology care and have been diagnosed with ESRD (Goldfarb-Rumyantzev et al., 2014), consequently, Shah et al. (2018) states African Americans are more likely to receive no pre-dialysis care. Over 50% of patients with nephrology care before an ESRD diagnosis still initiate hemodialysis with a CVC (Lee, 2017). The gap in pre nephrology care and vascular access placement to initiate dialysis may be related to a lack of education regarding vascular access options, patient denial of kidney failure, in addition to planning and timing of vascular access referral by the nephrologist (Lee, 2017).

The type of permanent vascular access placed for outpatient hemodialysis impacts mortality and is dependent on factors such as patient preference, age, education level, geographic location, insurance type, gender, and existing comorbid conditions

(Bhattacharya et al., 2015; Lee, 2017; Shah et al., 2018). The factors stated above impact the timely removal of a CVC. Women have lower rates of AVF placement than men, and African Americans, in general, utilize AVFs less frequently than whites (Shah et al., 2018). Patibandla et al. (2014) explained that AVF failure rates are higher in the elderly, and African Americans living in urban areas have lower odds of AVF placement predialysis. Regardless of demographics, the type of insurance coverage is also important to make referrals and assist in the timely scheduling of vascular access appointments with the surgeon.

Erickson et al. (2018) posit patients without insurance before a diagnosis of ESRD experience delays in permanent access placement because of Medicare ineligibility until several months after starting hemodialysis and are less likely to start treatment with an AVF or AVG. Patients can establish care with a vascular surgeon based on the type of insurance coverage they receive. Several Medicare and Medicaid plans are accepted by the vascular access surgeon’s practice however, some hospitals where the surgery will be performed will not accept certain insurance plans (Erickson et al., 2018). In addition to insurance disparities, geographic location has been associated with lower rates of AVF placement in metropolitan areas (Goldfarb-Rumyantzev et al., 2014). Geographic location is important for patients to access resources and transportation to appointments. Goldfarb-Rumyantzev et al., (2014) explained that geographic location has been associated with barriers such as vascular surgeon availability, distance to the closest vascular access center, patient compliance, and health literacy. Optimizing the care of ESRD patients receiving dialysis by eliminating barriers in vascular access placement, geographic location, and insurance coverage promotes longer life expectancy and better quality of care.

Exploring patients' reasons for permanent vascular access refusal should include addressing patient concerns and providing patient education when planning to transition from a CVC to an AVF or AVG to make the process simpler and increase compliance. Griva et al. (2019) identified the top four reasons for permanent access refusal as fear of needles, perceived cannulation pain, previous negative surgical experience, and failed AVF or AVG surgery. Other reasons for permanent access refusal mentioned are perceived body image, waiting for a kidney transplant, older age, physician approval of CVC utilization, and no bleeding post dialysis treatment with a CVC (Griva et al., 2019). Consequently, if the patient has negative perceptions of a permanent vascular access placement and is comfortable with having a CVC often deters patients from communicating and collaborating with the IDT to move forward in the process of receiving an AVF access placement. Involving patients in vascular access planning promotes active participation, shared decision-making, independence, and compliance. The identified reasons listed above assist the IDT to develop an individualized patient approach to vascular access planning and care.

The relationship established between the patient and IDT provides early education about different vascular access options, referral to surgeons, and dangers associated with long-term CVC use. Evidence shows one additional visit per month from the nephrologist or nurse practitioner (NP) during the first ninety days can increase vascular access surgery by at least 5% (Bhattacharya et. al., 2015). An additional visit allows early referral for AVF or AVG placement which potentially decreases the number of days patients dialyze with a CVC (Bhattacharya et al., 2015). The use of AVFs and vascular access care has dramatically improved since the implementation of the quality improvement project the Fistula First Breakthrough Initiative (FFBI) by the ESRD Network and CMS in 2003. CMS sets the AVF prevalence rate to 66% as the national standard.

Initially, the goal of FFBI was to collect, analyze, and provide education to increase AVF use to 40% in prevalent hemodialysis patients and 50% in incident patients while reducing CVC rates (Lee, 2017). The FFBI shifted to Fistula First, Catheter Last and addresses issues related to vascular access care primarily through vascular access education and 13 change concepts. The concepts are a step-by-step outline to address barriers and topics relevant to the placement and continued utilization of a functional AVF while stressing the importance of a patient-centered approach. A patient-centered approach focuses on ensuring the right access for the right patient which takes life expectancy, vascular anatomy, and quality of life into consideration. Furthermore, engaging in a patient-centered approach to permanent vascular access placement will decrease the aforementioned barriers and eliminate unnecessary surgeries and numerous interventional procedures (Lee, 2017).

The financial impact of AVF placement is linked to frequent surgical access interventions to promote maturation resulting in higher costs. On average, the cost per patient who initiates hemodialysis with a mature functioning AVF is approximately $6,500 compared to $16,500 for patients with a CVC (Hirth & Segal, 2018). The cost does not include surgical interventions related to AVF maturation failure. AVGs have higher success rates when placed but require more surgical interventions and often fail after use. According to Al-Balas et al. (2017), the cost of access-related procedures and resulting complications is higher in patients who have an AVF versus AVG placed. CVCs result in more procedural costs, hospitalizations, infections, and utilization of more resources (Shah et al., 2018).

Vascular access planning and outcomes should consider a patient-specific approach as an AVF may not be the optimal access for every patient (Cohen et al., 2015). Vascular access planning and care is a tedious process that involves care coordination from several interdisciplinary team members for each patient. The use of a VAC with specific duties has been shown to improve AVF rates significantly while decreasing the use of AVGs and CVCs. The VAC is an individual with years of dialysis experience who can organize, multitask, and work independently to coordinate all aspects of permanent access placement (Al-Balas et al., 2017). Patient and staff education about care and maintenance is an important aspect of maintaining the life of the vascular access. In a study conducted by Bhattacharya et al. (2015), the use of a multidisciplinary vascular access improvement program providing distinct vascular access protocols, algorithms, a database, and direct communication with nephrologists and vascular access surgeons increased AVF use by 15%.

The framework used to guide the study was the Iowa Model of Evidence-Based Practice to promote quality care. This model guided the IDT in making decisions about clinical and administrative practices that affect quality healthcare (Melnyk & Fineout-Overholt, 2019). A large urban dialysis clinic was evaluated and challenged by the quality metric of decreasing CVC usage rates to meet the organizational regional goal (13%) and CMS's goal (10.7%). The alarming number of patients dialyzing through a

CVC was a problem-focused trigger and was an organizational priority to meet the quality standard from CMS to lower the rate. Despite this large urban clinic having an IDT team in place that focuses on missed treatment and hospitalization rates but does not focus on vascular access. With this in mind, an IDT approach that focuses on vascular access placement was a priority for the clinic. A team of stakeholders included the MD, FA, SW, and a DNP student implementing an IDT approach on vascular access placement to evaluate and understand the effect of an IDT approach on CVC usage rates for African American adults 19-85 years of age receiving hemodialysis through CVC over three months. The literature search provided sufficient evidence to support the pilot study which was initiated. An IDT approach has been shown to increase AVF and AVG utilization and decrease CVC rates (Lok &Woo, 2016).

The literature emphasized the importance of an individualized patient approach to permanent vascular access planning and coordination. An additional visit a month from the NP or nephrologist per week in the first ninety days has been shown to increase the AVF rate as well as the use of a VAC (Cohen et al., 2015). Studies conducted by (Bhattacharya et al., 2015; Goldfarb-Rumyantzev et al., 2014; Lin et al., 2018; Lok & Woo, 2016) illustrated barriers in vascular access care are prevalent due to patient preference, insurance, geographic location, age, gender, and lack of education. Central venous catheter utilization is associated with mortality but is often the first access utilized despite pre nephrology care before outpatient hemodialysis treatments begin. Vascular access disparities can be addressed through an IDT approach, educating patients, earlier referral, and close follow-up. The FFBI provides a framework to address barriers to permanent vascular access placement which can increase AVF prevalence and reduce

CVC use (Lee, 2017). Gaps in the literature were the cost of vascular access surgeries related to AVF maturation and the use of AVGs in patients who initially fail vascular access placement.

Methods

Design

An observational descriptive design with a retrospective medical record review was used to evaluate the effectiveness of interventions aimed to decrease CVC utilization rates for African Americans. This pilot study evaluated an IDT approach to permanent vascular access coordination and was completed over three months between June 2021 through August 2021.

Setting

The setting was a large urban dialysis clinic with a total of 14 employees which includes a SW, a dietician, three nurses, and eight patient care technicians with 22 dialysis stations dialyzing 64 patients six days a week. African Americans represented 99% of the total patient population dialyzed at the clinic.

Sample

A convenience sample of 116 patients dialyzing through a CVC was included in the pilot study. Inclusion criteria were African American patients aged 19-85 with a CVC as the primary vascular access for hemodialysis who may also have a maturing AVF/AVG, a diagnosis of ESRD, a candidate for vascular access surgery, three or fewer vascular access surgeries, and had controlled co-morbid conditions (i.e., congestive heart failure (CHF), chronic obstructive pulmonary disease (COPD), and Diabetes). Exclusion criteria were non-African American, less than age 19 and older than 85 years of age, diagnosis of acute kidney injury (AKI), not a candidate for vascular access surgery, three or more previously failed vascular access maturations or permanent vascular surgeries.

Procedures

A team of stakeholders including the MD, FA, SW, the nephrologist, the NP, and a DNP student began meeting bi-weekly in November 2020 to discuss implementing an IDT approach to address barriers to early permanent vascular access placement, since high CVC usage was a problem-focused trigger. Through a retrospective medical record review, information about patients with a CVC needing permanent vascular access placement was collected.

Data Collection and Analysis

A data collection instrument was used to obtain demographics such as age, gender, ethnicity, zip code, and payer status. Other data collected were permanent vascular access type, any previous vascular access surgeries, reasons for permanent access placement refusal, reasons for CVC removal delays, and the type of insurance coverage carried. No personal identifiers were utilized for the study and each patient was assigned a number to ensure confidentiality. On a password-protected computer, information was stored and discarded after the study. Descriptive statistics were used for data analysis.

Approval Process

Approval from the FA at the organization was granted. Other approvals granted were from the doctoral committee, graduate school, and the university institutional review board (IRB). There was minimal risk linked to the study as it a was retrospective medical record review of the number of patients who had a CVC removed or an AVF or AVG placed from June 2021 through August 2021.

Results

In June, July, and August of 2020 before implementation of the IDT, a total of (*N*=57) patients were dialyzing through a CVC, (*n*=1) patient had their CVC removed. In June, July, and August of 2021 after the implementation of the IDT, a total of (*N*= 59, 100%) patients were dialyzing through a CVC. In June 2021, (*N*=19, 32.20%) patients were dialyzing through a CVC, (*n*=9, 47.37%) patients had permanent vascular access placed while *(n*=0) patients had their CVC removed. In July 2021, (*N*=22, 37.35%) patients were dialyzing through a CVC, (*n*=13, 59.09%) patients had permanent vascular access placed. In August 2021, (*N*=18, 30.51%) of patients were dialyzing through a CVC, (*n*=1, 5.56%) patients had a CVC removed while (*n*=10, 55.56%) patients had permanent vascular access placed (see Appendix A and B). Pre and post-IDT implementation, there was a total population of (*N*= 116, 100%). There were (*n*=76, 65.5%) males and (*n*=40, 34.5%) females which were represented in the study. Patients ages 20 to 39 (*n*=15, 12.9%), ages 40 to 49 (*n*=16, 13.8%), ages 50-59 represented (*n*=30, 25.9%), ages 60-69 (*n*=37, 31.9%), and patients 70 years of age and older represented (*n*=18, 15.5%) of the sample (see Appendix C). Patients utilizing Medicare and Medicaid combined represented (*n*=55, 47.4%), patients utilizing Medicaid only (*n*=36, 31%), Medicare only (*n*=10, 8.6%), Veteran's insurance combined with Medicare (*n*=3, 2.6%), Veteran's insurance only (*n*=6, 52%), Private Pay insurance only (*n*=3, 2.6%), and Private Pay combined with Medicare (*n*=3, 2.6%), (see Appendix D). The monthly CVC usage was calculated pre and post-IDT implementation to understand how the large urban dialysis clinic met the CMS performance goal of 10.7% CVC usage per month. The clinic's monthly CVC usage rate for June 2020 was 32.08%, July 2020 was 33.33%, August 2020 was 35.85%, June 2021 was 34.5%, and July 2021 was 28.07%, and August 2021 was 29.31% (see Appendix E). This large urban dialysis clinic was consistently above the goal of 10.7% by an average of 33.75% pre and post IDT 30.6% monthly, however, the monthly CVC usage rate of 34.5% was slightly lower.

To understand if implementation of an IDT approach on CVC usages rates for hemodialysis patients 19 to 85 years of age was effective in lowering the current CVC usage rate of 34.5%, a Pearson chi-square test was performed. Based on an α= 0.05, an IDT approach to permanent vascular access placement was not statistically significant (x^2(1)> = 1.775, *p* = 0.183) (see Appendix F). There was no statistical significance between payer status and CVC removal (x^2(6)> = 1.840, *p*= 0.934) (see Appendix F). There was statistical significance between zip code and payer status (x^2(48)> = 78.353, *p* = 0.004) (see Appendix F), and access placement and payer status (x^2(6)> = 14.802, *p* = 0.022) (see Appendix F).

Discussion

In adults 19 to 85 years of age receiving HD with a CVC, the effect of an IDT approach on CVC usage rates for hemodialysis patients over three months did not show any statistical significance, however, the post-IDT CVC usage rate was trending down and by August 2021 was 29.31% which is clinically important. This rate was not within CMS's national goal of 10.7% or less, but there was a decrease in the CVC usage rate overall.

The strengths of this study were the intentionally chosen population of African American patients and convenient sampling. The results were important because these patients are at higher risk for access maturation failure, morbidity, mortality, and poor health outcomes due to low socioeconomic status and an IDT approach could potentially decrease these risks. Limitations of the study included the availability of vascular access surgeons in the region, the time the pilot study was initiated (during the COVID-19 pandemic), and patient insurance impediments. While the IDT approach to permanent vascular access placement results showed no statistical significance, the monthly CVC usage rate showed some benefits to having an IDT team such as timely scheduling of appointments and a slight increase in the amount of permanent vascular accesses placed. Patient barriers such as transportation to appointments, fear of being cannulated with needles, insurance delays, and the requirement to obtain cardiac clearance before vascular access surgery remained factors in the IDT approach being successful. Implications for future practice could be education on risk factors of long-term CVC usage before starting HD, addressing patient challenges associated with permanent vascular access placement, insurance verification within the first week of HD, referrals to vascular access surgeons within the first 30 days of treatment, and permanent vascular access placement within the first 90 days of treatment. Recommendations for further study might warrant adopting an IDT approach in more HD clinics and include other ethnic backgrounds (i.e., Asian and Hispanics) in the study.

Conclusion

In summary, the introduction of an IDT approach to CVC usage rates was not statistically significant ($p = 0.183$), but it was clinically significant. It is reasonable to assume CVC usage rates improve with the implementation of an IDT approach. The intervention could be useful and implemented in other dialysis clinics to address patient barriers to permanent vascular access placement and improve CVC usage rates. Overall, patients on HD dialyzing through a CVC is not desirable but is widely practiced and more interventions to decrease CVC usage rates are warranted to meet and comply with CMS goals and standards.

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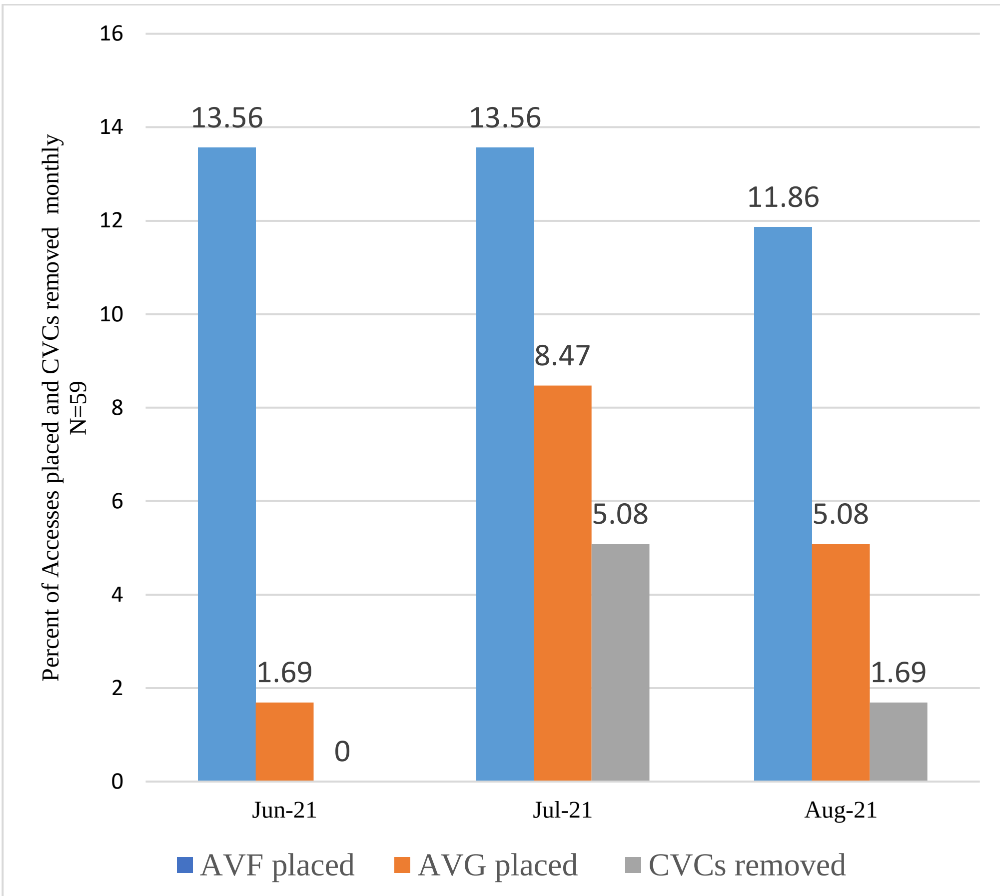
Appendix A

Figure 1

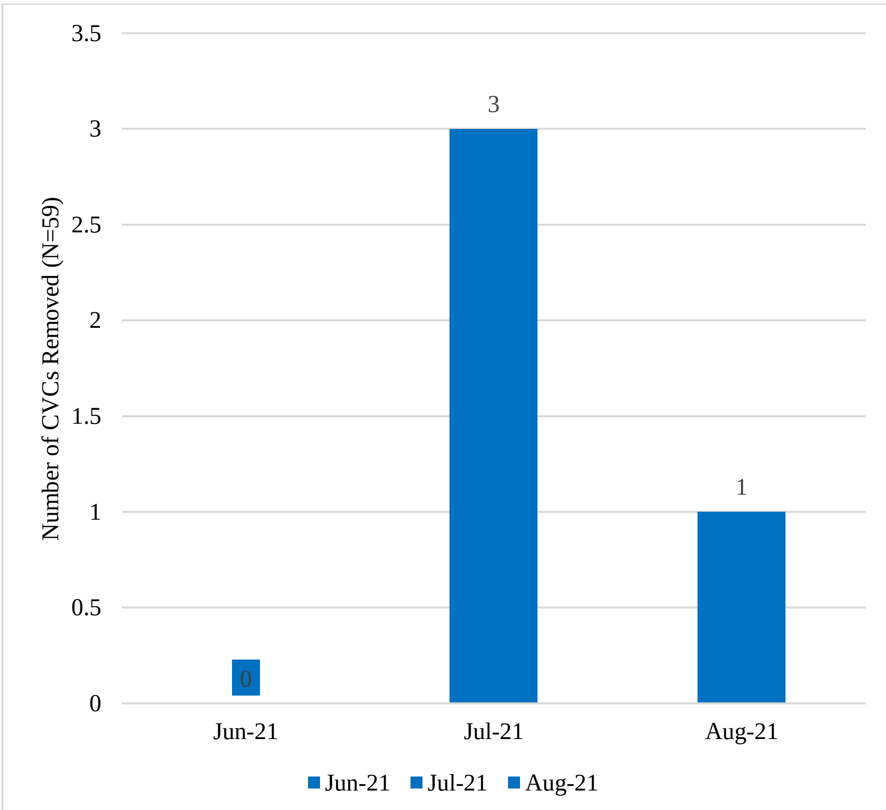
Permanent vascular access placement and CVC removal by month.



Appendix B

Figure 2

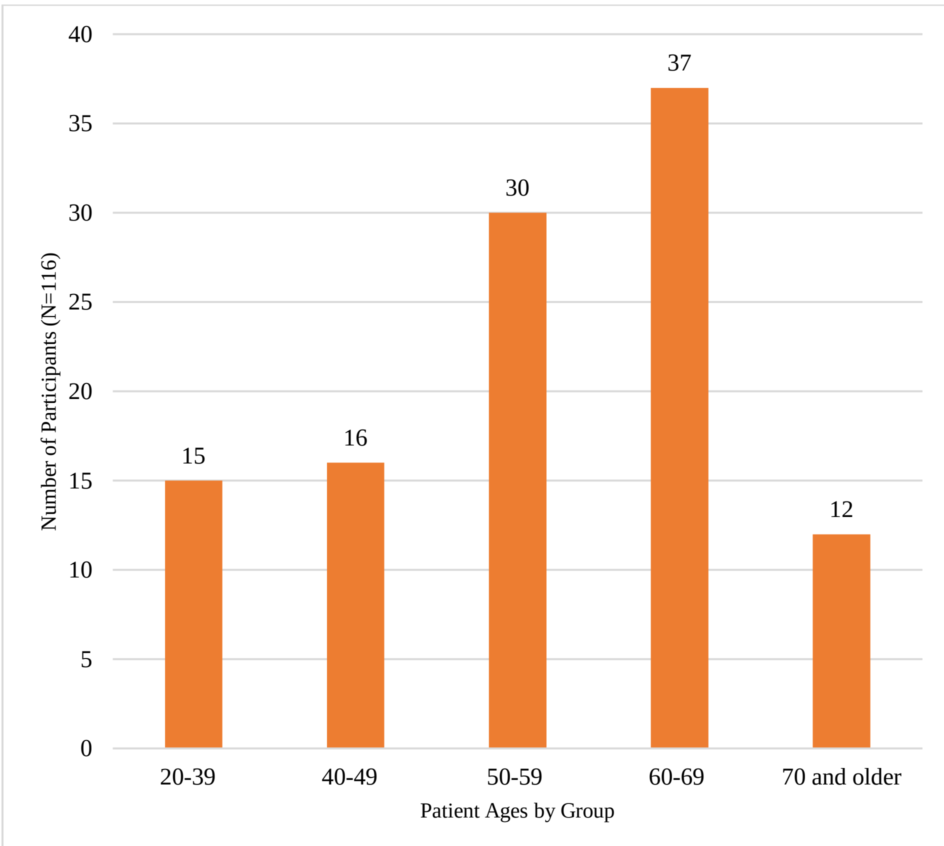
Number of CVC removals per month



Appendix C

Figure 3

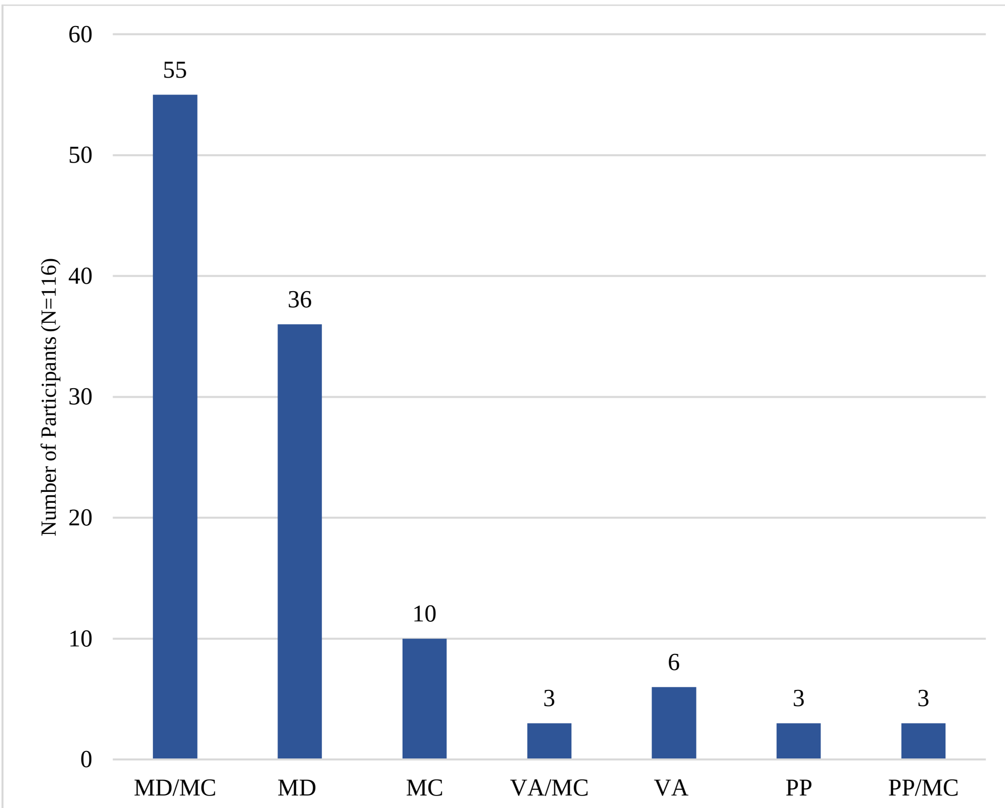
Number of Study Participants by Age



Appendix D

Figure 4

Insurance payer status

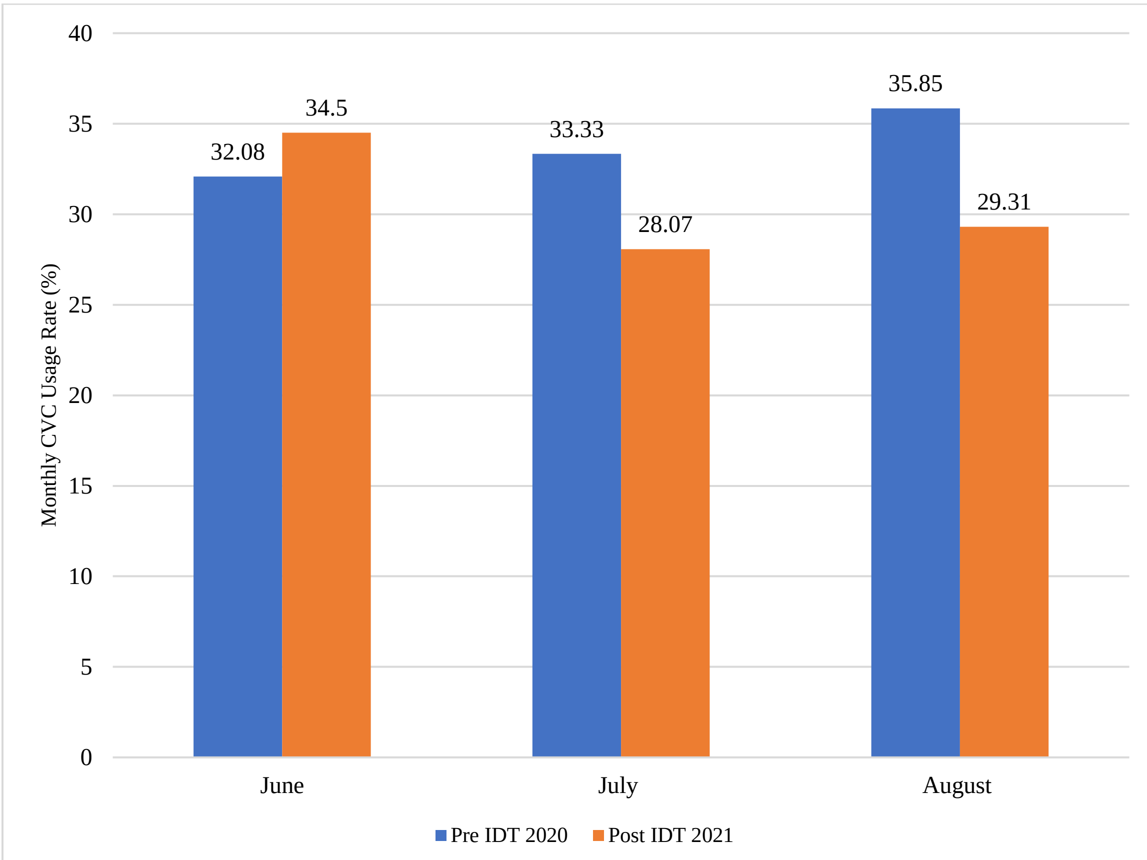


Note: MD/MC corresponds to Medicare and Medicaid coverage, MD is Medicaid only, MC is Medicare only, VA/MC corresponds to Veteran's insurance with Medicare, VA is Veteran's Insurance only, PP is private pay, and PP/MC is private pay with Medicare.

Appendix E

Figure 5

Monthly CVC usage rate



Note: The monthly CVC usage rate before IDT implementation is displayed by the blue bars and after IDT implementation is displayed by the orange bars. *Note:* The monthly CVC usage rate for the clinic was obtained as it is compared to CMS goal.

Appendix F

Table 1

Pearson Chi-Square Test for CVC Removal Post IDT Implementation

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.775[a]	1	.183		
Continuity Correction[b]	.766	1	.382		
Likelihood Ratio	1.902	1	.168		
Fisher's Exact Test				.364	.193
Linear-by-Linear Association	1.760	1	.185		
N of Valid Cases	116				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 2.46.
b. Computed only for a 2x2 table

Note. N = 116. The value of the test statistic is 1.775. The footnote for this statistic pertains to the expected cell count assumption (i.e., expected cell counts are greater than 5): 2 cells had an expected count less than 5, so this assumption was not met. The corresponding p-value of the test statistic is p = 0.183.

Table 2

Payer Status and CVC removal

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.840[a]	6	.934
Likelihood Ratio	2.297	6	.891
Linear-by-Linear Association	.483	1	.487
N of Valid Cases	116		

a. 10 cells (71.4%) have expected count less than 5. The minimum expected count is .13.

Note. N = 116. The value of the test statistic is 1.840. The footnote for this statistic pertains to the expected cell count assumption (i.e., expected cell counts are greater than 5): 10 cells had an expected count less than 5, so this assumption was not met. The corresponding p-value of the test statistic is p = 0.934.

Table 3

Zip Code and Payer Status

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	78.353[a]	48	.004
Likelihood Ratio	81.162	48	.002
Linear-by-Linear Association	1.606	1	.205
N of Valid Cases	116		

a. 57 cells (90.5%) have expected count less than 5. The minimum expected count is .03.

Note. N = 116. The value of the test statistic is 78.353. The footnote for this statistic pertains to the expected cell count assumption (i.e., expected cell counts are greater than 5): 57 cells had an expected count less than 5, so this assumption was not met. The corresponding p-value of the test statistic is $p = 0.004$.

Table 4

Access Placement and Payer Status

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	14.802[a]	6	.022
Likelihood Ratio	19.487	6	.003
Linear-by-Linear Association	3.494	1	.062
N of Valid Cases	116		

a. 9 cells (64.3%) have expected count less than 5. The minimum expected count is 1.47.

Note. N = 116. The value of the test statistic is 14.802. The footnote for this statistic pertains to the expected cell count assumption (i.e., expected cell counts are greater than 5): 9 cells had an expected count less than 5, so this assumption was not met. The corresponding p-value of the test statistic is $p = 0.022$.