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Peripheral IV Bundle

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Abstract

It is estimated that over 90% of hospitalized patients require IV access during their hospitalization. Peripheral IVs (PIVs), while less risky than central lines, are not without risk to the patients. Intravenous (IV) infiltration in pediatric patients is a very common complication associated with IV access, accounting for about 67% of IV catheter removals; a less common complication, but much more serious complication of a PIV can be a blood stream infection (BSI) which can account for up to 35% of BSIs seen in patients. BSIs are associated with increased length of stay, increased morbidity and can result in patient death. In addition, BSIs are estimated to cost approximately $30,000 per infection to treat. IV infiltrates result in pain for the patients, another painful procedure and in 11%-25% of severe cases can result in plastic surgery and long-term complications. The goal of this project was to evaluate if a Peripheral IV Bundle can decrease complications associated with PIVs; specifically, efforts were focused on preventing IV infiltrates and BSIs, as well as decreasing the number of IV starts a patient experiences during a hospitalization.

Results: Compliance with the new PIV bundle averaged 51% over the 5 month time frame, however did improve with each month. IV infiltrates rates decreased from the pre-implementation phase to the post-implementation from 19.16/1000 patient days to 15.87/1000 patient days (P=0.556). PIV duration increased from 71 hours pre implementation to 99 hours post implementation.

Background/Significance

It is estimated that over 90% of hospitalized patients require IV access during their hospitalization (Taylor, 2014). Peripheral IVs (PIVs), while less risky than central lines, are not without risk to the patients especially pediatric patients. Intravenous (IV) infiltration in pediatric patients is a very common complication associated with IV access, accounting for up to 78% of IV catheter removals (Major & Huey, 2016); a less common complication, but much more serious complication of a PIV can be a blood stream infection (BSI). PIVs can account for up to 35% of BSIs seen in patients (Rhodes, et al, 2016). BSIs are associated with increased length of stay, increased morbidity and can result in patient death. In addition, BSIs are estimated to cost approximately $30,000 per infection to treat (Raphael, Hazekamp, Samnaliev, & Ozonoff, 2018). IV infiltrates result in pain for the patients, another painful procedure and in 11%-25% of severe cases can result in plastic surgery and long-term complications (Chenoweth, Guo, & Chan, 2018).

The CDC found that PIV associated BSIs can be as high as 0.5/1000 line days compared to 1.14/1000 line days for CLABSI (Devries, Valentine, & Mancos, 2016). It is estimated that about 50% of patients who have a central line in place also have a PIV in place indicating that some CLABSIs could be caused by poor PIV site care (Devries, et al, 2016). Two Neonatal studies found that 30-37 hours is the average length of time a PIV can be in place before complications arise causing the catheter to be removed (Chenoweth, et al, 2018). Because of complications associated with PIVs, it is estimated that approximately 95% of PIVs are removed before therapy is complete, causing the patient to receive multiple PIV starts during the hospital stay (Chenoweth, et al, 2018).

Norton Children's Hospital's (NCH) Pediatric ICU (PICU) has dedicated time and attention to implementing evidence-based practices to help reduce patient harm and hospital acquired conditions (HACs). However, we continue to fall short in our goal of zero harm events for our patients; PIV site care has been identified as an area where we can improve. In 2018, we had 229 PIV infiltrates in the PICU alone, with almost 50% of patients having two or more infiltrates. In the last quarter of 2018, we had five patients with severe infiltrates requiring plastic surgeon consultation; three of them resulted in surgical intervention.

In addition to IV infiltrates, we have not been able to reach zero HAC events related to (CLABSI). While we were able to decrease our CLABSI rates from 11 in 2017 to 5 in 2018, we continue to see variation in our CLABSI rate from year to year. Also in 2018, we had eight patients in our care who had BSIs not associated with a Central Line. Of our five CLABSI in 2018, four of those patients had PIVs in place in addition to their central line.

To further explore these issues data were collected from January to April 2019 utilizing an infiltrate tracking form that the nurses or IV team completed with each infiltrate. This form asked for the size of catheter, age of patient, drug infusing, rate of infusion, stage of infiltrate, treatment given to the patient, and frequency of assessments. I relied on the nurses to complete this form in real time as documentation in EPIC does not reflect all of this information and often times information such as IV infiltrate staging was missing within EPIC documentation. After compiling data on 58 IV infiltrates during that time I found the following: 67% of infiltrates were associated with 24 gauge IV catheters, 50% of infiltrates occurred in patients <1 year of age, and lipids and IVFs were the most common drug infusing during infiltration, occurring in 24% and 27% of the infiltrates respectively. The data also showed that nurses had done an IV assessment within the previous hour on 82% of infiltrates and that Hyaluronidase was given as a

treatment in 37% of cases. Hyaluronidase is a drug injected into the tissue surrounding the infiltrate to neutralize the drug that infiltrated into the tissue. Most infiltrates were mild in severity with 27% being moderate in severity and only one documented case of a severe infiltrate. As a result of these findings, it was evident that we had room to improve the care of PIVs in the ICU and the outcomes of the patients.

The literature suggests that no single intervention will eliminate BSIs associated with PIVs, IV infiltrates, or even decrease painful procedures for patients. The interventions in place prior to the bundle implementation included using CHG to prepare the skin prior to an IV insertion, utilizing a securement device, utilizing alcohol impregnated caps on IVs, changing IV tubing every 96-120 hours and applying a transparent dressing that is changed when soiled or un-occlusive. Wearing sterile gloves was only done when drawing a blood culture and utilization of an IV start kit was optional. There was no method to educate the families on PIV site care and engaging them to speak up if they have concerns about the site. While Extended Peripheral IVs (EPIVs) had been available for many years, it was rarely done for ICU patients because the IV team was being consulted after the patient has already lost multiple IVs and had very little access remaining. Engaging the IV team sooner based upon the patient's predicted therapy was hoped to increase the number of successfully placed EPIVs in our patients.

Purpose Statement

The purpose of this project was to develop a PIV bundle that would decrease PIV infiltrations, IV attempts, and painful procedures patients experience during their stay and decrease the number of hospital acquired bacteremias patients acquire while in our care.

Literature Review

The literature supports several different interventions to improve PIV site care in order to decrease PIV complications. Nursing education was cited by Taylor (2015) as potentially having an impact on PIV site care and reduction of IV infiltrations, but this was the only study that utilized nursing education alone. In a study by Rhodes et al. (2016), the authors campaigned to increase awareness of PIV site complications, nursing education, improved documentation, alerts for PIVs inserted outside of the hospital setting to initiate removal within 24 hours, and a PIV insertion kit. Using this protocol, they were able to decrease their PIV associated *Staphylococcus aureus* BSIs by 50%. Major and Huey (2016) found that by combining staff education, IV securement, and family involvement through Get Well Network, IV infiltrates decreased from a rate of 13.5/1000 PIV days to 7.1 post implementation. A study by Rojas & Benish (2018) found that family education and involvement resulted in a 14% increase in the Touch/Look/Compare (TLC) assessment of IVs, as well as a 23% reduction in extravasation rates. This was accomplished by educating the families on PIV site assessments, as well as utilizing an interactive care network where questions regarding the IV site were sent to the family. If there was a family concern, a prompt was sent to the nurse leader to assess the IV site. Park, Jeong, Kim, Park and Jeong (2016) also found that they were able to significantly decrease IV infiltration rates when they educated the parents and had them assist in site observation.

Devries et al (2016) found that by developing a standardized IV start kit they were able to decrease overall BSIs by 37% and BSIs associated with PIVs by 19%. These kits consisted of chlorhexidine gluconate (CHG) skin prep; sterile gloves; IV catheters with integrated extension sets; CHG impregnated dressing, securement dressing, and alcohol caps. In the study by DeVries et al (2016), one hospital was able to decrease BSIs associated with PIVs by 66% over

15 months with the implementation of a PIV bundle. This bundle consisted of IV catheters with integrated extension tubing, a neutral needle free cap, alcohol caps, sterile gloves, transparent dressings, securement device, and CHG disk. Sterile gloves are indicated by the Centers for Disease Control (CDC) during PIV insertions where the site may be palpated after the CHG prep (CDC.gov).

The use of extended dwell peripheral IV (EPIV) was found in a study by Chenoweth and Chan, (2018) to decrease IV infiltrations, as well as the number of IV starts a patient experiences. These catheters are typically 6 or 8 cm. in length, making them longer than a PIV, but shorter than a peripherally inserted central catheter (PICC). These catheters are intended to last up to 29 days and could be considered for IV therapy requiring an extended period; these extended care catheters cannot be used with any type of vein irritating drugs. In this study, they inserted EPIVs into 432 neonates to evaluate if there were complications associated with EPIVs as well as their longevity. They found that average dwell time for an EPIV was 8.7 days compared to 30 hours for a PIV and that over 50% of EPIVs lasted through the duration of their therapy, compared to only about 5% of PIVs. There were no life-threatening complications associated with the EPIVs in this study (Chenoweth & Chan, 2018). It was concluded that EPIVs are a feasible option in the neonatal population to help decrease complications for PIVs, as well as decrease the number of painful procedures the patient experiences.

It is evident from the literature that there are many different interventions that could have an impact on IV infiltrate rates, infection rates, and the number of IV starts a patient experiences. After reviewing the literature, I implemented a combination of interventions including an attempt to increase the use of EPIV catheters which have been shown to have an impact on all three outcomes of concern. In addition, NCH did not have a formalized bundle focused on insertion

and maintenance of PIVs, so much of my work focused on developing a bundle for bedside nurses to reference incorporating many of the interventions found in the literature.

Evidence Based Practice Model

I used the Iowa Model of Evidence Based Practice to Promote Quality Care (Doddy, 2011) to guide me as I looked to develop a PIV bundle for the Pediatric Intensive Care Unit (PICU). This model was developed at the University of Iowa in 1990 as a guide for nurses to implement evidence-based practice to impact patient outcomes (Doddy, 2011). The model utilizes eight steps; 1) Identification of problem, 2) determination of priority within organization, 3) team development, 4) gathering and analyzing research, 5) critiquing and synthesizing the research, 6) determining if evidence supports a practice change; if not then the work is complete, if there is continue to step 7) implement pilot program and finally step 8) evaluate the pilot program to determine if system-wide implementation is warranted.

Applying the model, I found there was both a problem focused trigger and knowledge focused trigger for the organization to make this a priority. Our risk management team had noticed an increase in the severity and frequency of patient harm events related to PIV infiltrates. Additionally, we are part of the "Solutions for Patient Safety Collaborative", where there is on-going work related to peripheral IV infiltration and extravasation (PIVIE) prevention however our hospital had yet to join this team.

I first began my teambuilding within the PICU and then the team broadened to include others from outside of the PICU to look at a hospital wide approach. My project was focused on work within the PICU, so my team was comprised of our two clinical assistant nurse managers who collect quality data and provide bedside support to our nurses, our medical director, the IV team for the hospital, and other staff members who had an interest in PIVIE prevention. After

doing my literature review and synthesizing my findings, I shared what I found with our Unit Based Council team to see what was reasonable to implement within the PICU. Because many of the studies looked at different bundle components, it was hard to determine which bundle elements had the greatest impact on the outcomes we were targeting. Having already collected baseline data in early 2019, we did not pilot the change, but instead involved the key stakeholders who were bedside nurses and the IV team to ensure the bundle components we included could be implemented within the constraints of our existing system.

Methods and Procedures

Sample and Setting

The sample for the project were all patients who were admitted to the PICU during January 2020-May 2020. The inclusion criterion was the need for a PIV, which includes nearly all of our patient population. The setting was the PICU, a 26 bed pediatric ICU located within Norton Children's Hospital. Norton Children's Hospital (NCH) is Kentucky's only full-service, free-standing, tertiary care facility dedicated exclusively to children. NCH is a 265 bed, non-profit organization which is part of a larger Norton Healthcare (NHC) system and is affiliated with the University of Louisville's School of Medicine.

Intervention

Table 1 depicts the PIV bundle elements, both interventions that were already in place as well as the newly implemented interventions. The newly implemented bundled elements included making sterile gloves or reapplying CHG to the insertion site after palpation standard of care, as well as utilization of an IV start kit with each insertion to ensure the puncture site is not contaminated during the procedure. The other two new elements included utilizing a vascular

access algorithm upon admission to determine if the IV team should be consulted for an EPIV and educating and involving families in the assessment of PIVs. (Appendix A)

Table 1

Peripheral IV Bundle

*Use Non-Emergent Vascular Access Algorithm to assess if Patient is a candidate for Extended Dwell PIV, PICC or CVL upon admission or as condition changes.

*Hand Hygiene prior to starting procedure

*CHG to prep skin for PIV insertion

*Sterile gloves or re-prep for insertions where site is palpated after skin prep.

*IV start Kit for all IV starts

*Stat-lock securement device on all PIVs unless contraindicated by patient size

*Occlusive dressing in place-changed only when soiled or un-occlusive.

*Touch Look Compare (TLC) assessment performed every hour when IV fluids infusing
(Site must be visible to accurately assess)

TLC assessment with saline flush every 6 hours for saline lock.

*Alcohol caps used for all caps/tubing on PIVs

*IV Tubing for fluids are dated/timed and changed every 96-120 hours

*Educate/engage families on PIV infiltrate signs/symptoms and ask them to partner with nursing on IV assessments

Given that the IV team had a limited number of staff and that EPIVs could only be placed by this team, we wanted to ensure that this was a feasible option. The identified barrier to inserting EPIVs was the time lost waiting on supplies to arrive at the bedside; to combat this, EPIVs were stocked on the unit and then replenished after the EPIV was inserted ensuring stock

on the unit, but decreasing the time the IV team took to place the EPIV catheter. As the physicians did not feel it necessary to have a physician order to place an EPIV, the nurses could utilize clinical judgement along with the vascular access algorithm (see Appendix A) to request an EPIV.

Families were asked to assist with the Touch, Look, Compare (TLC) assessments and to alert a member of the health care team if they had concerns (see Appendix B), but this element did not replace the nursing assessments. The TLC assessment is performed hourly by nursing when a patient has running IVFs. The assessment consists of touching the site/extremity of the PIV to ensure the tissue is soft, warm and pain free, looking at the site to make sure the site is not reddened and comparing one extremity to the other to assess for swelling.

We educated the staff on the changes to the bundle elements in several different ways during the month of December to help ensure that the bundle elements were understood. The PICU unit-based practice council was first shown the final bundle, along with education tools to help them to answer questions and support staff on the unit. The unit holds weekly education sessions that are offered before each shift where we educated all staff on the new bundle elements. Information was also placed in the monthly Power Point staff meeting that is sent to all PICU staff. As well, the IV team leader shared the bundle with her team during their monthly staff meetings. Finally, posters were placed throughout the unit as a reference to the new bundle and informal education huddles were held in patient care areas the two weeks prior to bundle implementation.

It was also noted during the initial data collection period that many of the PIVs that were removed due to infiltration did not have a stage documented in the electronic medical record (EMR). The barrier identified was the EPIC documentation screens. The nurse was required to

go to two different locations in EPIC to document when an IV was removed for infiltration if they were going to include the staging. This resulted in many of the IVs being documented as removed due to infiltration, but no staging was documented because the nurse had to remember to go back and document the staging in a different area. Our EPIC analyst was consulted to help improve our PIV discontinuation documentation. We were able to have the staging documentation moved to the same location in EPIC where the nurse documented the IV being removed and the reason in an effort to improve accurate documentation of removed PIVs.

Measures and Data Collection

The new bundle compliance was monitored by the PICU clinical support assistant nurse managers (CS ANM). Monitoring was done via the Kamishibai card (K card) method allowing for staff involvement and real time feedback about areas of bundle non-compliance (Shea, Smith, Knobloch, & Safdar, 2018). This method of data collection utilizes the posting of a K card for each audit with the green (compliant observation) or red ("defects" founds) side showing. A "newspaper" is also posted in the unit, showing what areas of the bundle were non-compliant with each observation along with any reason for non-compliance that was noted in talking with the staff. The K cards change daily based upon that days' audits and the newspaper remains up for a month. (See Appendix C).

EPIC analysts built a PIV infiltration report that would pull each month showing the patients who had an IV infiltrate during their stay in the PICU. This report was used to collect PIV data during both the pre and post implementation phases of the project. Utilizing these reports patients were identified who had acquired an IV infiltrate while in the PICU and further data was collected by accessing each patient's record. Data collected on each patient with an infiltrate included: hospital length of stay (LOS), total number of infiltrates acquired during the

entire hospital stay, the number of IV attempts documented during the hospital stay, the duration of each PIV, the removal reason of each IV catheter, the size of each catheter, and the infiltrate stage if appropriate. Statistical analysis utilized the Mann-Whitney U test since there were 2 independent groups being compared with ordinal data for each group.

Results

Bundle Implementation

Pre-intervention data from July 2019-November 2019 was pulled and compared to post-intervention data from January 2020-May 2020. There were 131 K card Bundle audits done over the 5-month time span post intervention and compliance increased each month from 20% in the first month up to 61% at the end of month five with an overall bundle compliance over the five months of 51%. The most common "defect" in the bundle was performance of TLC assessments appropriately. The CS ANMs did not just ask nurses to describe the TLC assessment, but instead, went into rooms with the staff and watched them perform an assessment. The second most common "defect", occurring 28 times, was staff not utilizing the vascular access algorithm to determine the most appropriate access for their patient. These data were not surprising given that only four EPIVs were attempted during the post implementation phase of the PIVIE bundle.

Infiltration Rates

Table 2 shows the catheter size, sites, removal reason, infiltrate staging for both the pre and post-intervention period. All patients who acquired a PIV infiltrate while in the PICU during the pre and post time periods were included in the data analysis, for a total of 86 patients. In 2019, there were a total of 62 patients who acquired a PIV infiltrate while in the PICU with a total of 351 IVs inserted, for an average of 5.61 IVs/patient. In comparison, in 2020 there were

24 patients who acquired an IV infiltrate with a total of 108 IVs inserted, for an average of 4.69 IVs/patient.

Table 3
PIV Characteristics

Size	*n*	Pre	*n*	Post
24 Gauge	229	64.9%	45	41.7%
22 Gauge	85	24.1%	56	51.9%
Other	39	11.0%	7	6.5%
Sites				
Hand	123	34.8%	35	32.4%
AC	50	14.2%	14	13.0%
Scalp	21	5.9%	3	2.8%
Foot	71	20.1%	20	18.5%
Wrist	26	7.4%	5	4.6%
Saphenous/Ankle	32	9.1%	7	6.5%
Other	30	8.5%	24	22.2%
Reason PIV Removed				
Infiltrate	149	42.2%	41	38.0%
Occluded	36	10.2%	10	9.3%
Leaking	45	12.7%	11	10.2%
Patient Removed	24	6.8%	4	3.7%
Not Patent	29	8.2%	4	3.7%
Patient Discharged	13	3.7%	7	6.5%
Misc	45	12.7%	19	17.6%
Not Documented	12	3.4%	12	11.1%
Infiltrate Stage				
Stage 1	49	32.9%	18	43.9%
Stage 2	34	22.8%	8	19.5%
Stage 3	10	6.7%	3	7.3%
Stage 4	3	2.0%	1	2.4%
Stage 5	0	0.0%	0	0.0%
Not Documented	53	35.6%	11	26.8%
Average LOS		20.03		26.13
Total Attempts		316		125

Figure 1 shows the IV infiltrate rate/1000 patient days during the two time periods. The number of IV infiltrates/1000 patient days dropped after implementation of the PIVIE bundle from 19.16 to 15.87. However, this decrease was not statistically significant utilizing an independent-sample T-Test (T=0.616, *P*=0.556). While clinically significant, the number of moderate IV infiltrates/1000 patient days decreased post intervention, was not statistically significant (U=4, *P*=0.095). There were no severe IV infiltrates in the pre-intervention period as compared to 2.05/1000 patient days in the post intervention period resulting in no statistical significance (U=15, *P*=0.690).

Figure 1

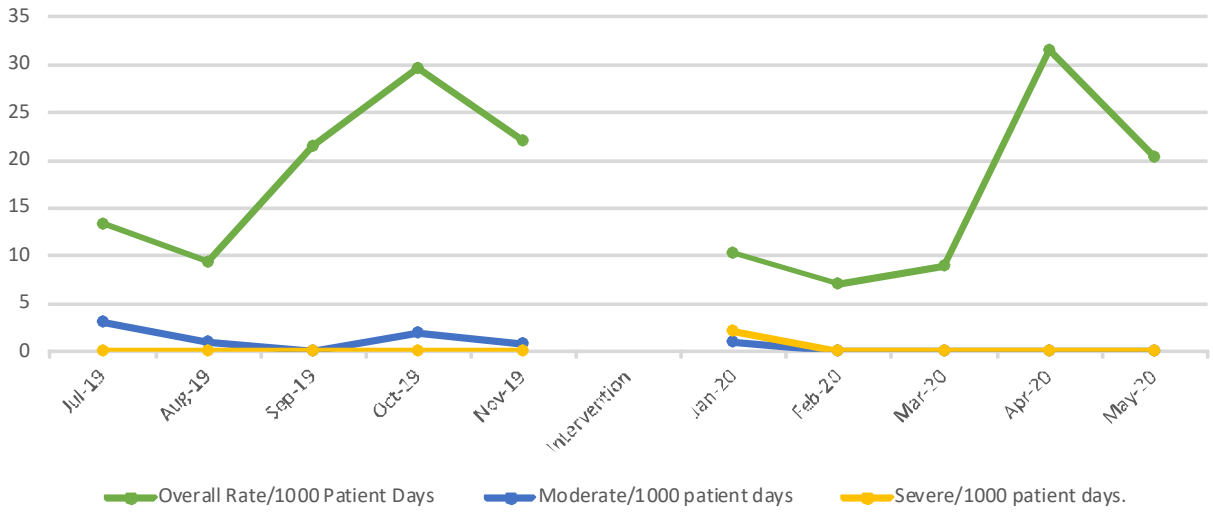

Table 2 compares data related to infiltrates, number of PIVs, and number of IV attempts from the pre and post intervention periods. Analyses were performed comparing the infiltrates/LOS, total number of IVs/LOS and the number of attempts/IV utilizing the Mann Whitney U test. Given that LOS varied for each patient depending on their diagnosis, comparison was made for infiltrates/LOS in addition to comparing the standard reporting method

of infiltrates/1000 patient days. Infiltrates/LOS increased in the post implementation period from 0.193 to 0.438 on average (U=715, *P*=0.334), however, this was not statistically significant.

Table 2
Summary of PIV Data

	Pre-Intervention	Post-Intervention	Significance
Total Number of Patients	62	23	
Total IV Catheters	353	108	
Infiltrates/1000 Patient Days	19.16	15.58	*P*=0.556
Infiltrates/LOS	0.193	0.438	*P*=0.334
PIVS/LOS	0.418	0.923	*P*=0.772
Attempts/IV	1.45	1.35	*P*=0.401
Average Catheter Duration	71	99	*P*=0.926
Average Attempts/Patient/Hospital Stay	7.24	4.72	*P*=0.035

IV Attempts

IVs/LOS also increased in the post implementation period from 0.418 to 0.92 on average (U=715, *P*=0.772), but not significantly. However, attempts/IV decreased from 1.45 to 1.35 (U=602, *P*=0.401). No significant difference was found during the pre and post intervention periods. The average number of IV attempts per patient was a dramatic decrease from the pre and post intervention periods, 7.42 to 4.72, and was a statistically significant decrease (U=475, *P*=0.035). However, many of the PIVs were missing attempt numbers, so these data may not be a true reflection of attempts. The PIV catheter duration increased from an average of 71 hours up to 99 hours from the pre to post intervention periods, however this was not a statistically significant change (U=2924, *P*=0.926).

EPIV Insertions

In 2019, there were 6 EPIV attempts with 5 successful EPIVs placed. These EPIVs ranged in duration from 4-10 days and two of the four were removed because of complications; one infiltrated and one had drainage. In comparison, there were only 4 attempts made in the post-intervention period with 3 successful placements. Catheter duration ranged from 4-12 days in this period with none of them being removed due to complication.

BSI rates

There were no patients in either the pre or post-intervention period who acquired a BSI with only a PIV in place. The number of patients who acquired a CLABSI with both a central line and PIV in place was also unexpectedly low during the project period. The ICU had zero CLABSIs from July-November 2019, which was different from the first 6 months of the year. During the post intervention period, the PICU had one patient (in January) who acquired a CLABSI and had peripheral IVs in place as well. This CLABSI was attributed to a mucosal barrier injury which is often seen in our oncology patient population and not related to care of the central line or peripheral IV. During the project period, many discussions were taking place on the unit about reducing all hospital acquired conditions and the unit had focused more energy around hand hygiene compliance and increasing awareness of the 5 moments of hand hygiene which may have impacted these results in a positive way.

Discussion

We have seen that care bundles have improved patient outcomes in many other areas of care including; Ventilator Associated Pneumonia (VAP), Catheter Associated Urinary Tract Infections (CAUTI), and CLABSIs. Therefore, a care bundle related to PIV care should only improve outcomes for patients who have PIVs in place. Development of the proper bundle

components is key. However, this bundle would need to be studied over a longer period of time to know if we have captured the proper components.

As with many new changes in care, auditing compliance and continued feedback is one of the most proven methods to improve compliance with the change. The K card process allows for real time feedback to the staff as to which specific areas are not compliant with the bundle, helping to improve compliance over time. Bundle compliance will likely continue to increase each month, with a goal of 90% or higher. Outcomes have shown the greatest improvement once 90% compliance is achieved (Shea, Smith, Knobloch, & Safdar, 2018). Improving TLC assessment techniques and utilization of the Vascular Access algorithm should result in higher compliance and in turn decrease IV infiltrates as well as IV starts.

PIV infiltrates are a common occurrence in the pediatric population, often resulting in more IV starts and possible long-term complications depending on the severity of the infiltrates. There are many barriers to catching IV infiltrates in the early stages such as nursing workload, IV site visibility because of securement methods and nurses' inability to accurately identify an infiltrate. Overall, the implementation of the PIVIE bundle in the PICU did not result in statistically significant changes in IV infiltrate rates or the number of IV attempts. While we did see an overall decrease in the number of IV infiltrates and an increase in catheter duration, these changes were not statistically significant, and the IV infiltrate decrease was not sustained as we actually saw a higher rate in April than in any of the pre intervention months.

While the unit had low BSI and CLABSI rates during the pre and post intervention periods, that is not true of the first six months of 2019. BSI and CLABSI prevention has been a focus of the ICU for over 10 years and while we have made great progress in decreasing these infections over the years, we continue to fall short of our goal of zero. Although the

interventions were not able to show a reduction in BSI or CLABSI rates, the interventions put in place has been shown to reduce these infection rates in other centers (Devries et al, 2016). It is believed that if the interventions implemented were continued over a longer period of time, a decrease in overall BSI rates will be seen.

Increased EPIV utilization was predicted to decrease the number of IV attempts patient's experience in addition to decreasing PIV infiltrates. However, EPIV insertions were very low. During the post implementation period, only 3 successful EPIV insertions occurred and 1 additional attempt was made during the 5-month post intervention period. This is actually fewer than the pre-intervention period when 5 insertions and 1 additional attempt occurred.

There are four key factors that could have impacted the low EPIV utilization. First, the IV team had vacancies on their team during the project period resulting in shifts without a team member to insert an EPIV. We have recently expanded our IV team and feel that with focused energy around EPIV insertions, IV infiltrate rates, as well as the number of PIVs during one admission, could decrease from the current average of 5-6 per patient. Second, blood administration is contraindicated in the size of EPIV catheters we currently utilize, making a PIV a better option for some patients. There are several options of EPIV catheters for adult patients, but pediatrics has limited catheter availability. There are currently attempts being made to create EPIV catheters as small as a 24 gauge, which is very similar to that of a PIV catheter. However, at the time of this project, the only available catheter required an introducer to access the vessel and the threading of the small catheter through the introducer, which requires specialized training, thus limiting those who could insert EPIVs. Third, new isolation precautions due to the COVID-19 pandemic, with limited caregivers permitted in patient rooms, is thought to impact low insertion rates. EPIVs were not essential if PIVs could be obtained by the bedside nurse.

Therefore, the IV team was discouraged to enter patient rooms unless IV access could not be obtained. Finally, the vascular access algorithm was not routinely used resulting in either no consult for an EPIV or a late consult where the patient had already had multiple IV attempts and had no sites remaining for insertion. Continued education regarding the vascular access algorithm and feedback to the bedside RNs when a consult for an EPIV was missed should result in increased utilization of the algorithm as well as increased insertion of EPIVs.

Limitations

There were many things that may have impacted the results of this project. However, two factors played a key role. First, the PICU population changed over the course of the project. In 2019, the PICU housed all pediatric ICU patients while in 2020, the cardiac patient population was moved to a separate unit. The cardiac intensive care unit (CICU) population is primarily post-operative cardiac patients who have a central line placed during their surgery. General PICU patients predominantly have PIVs utilized for the majority of medications. Central access is needed only for patients requiring vasoactive medications, long term antibiotics, or other vesicant drugs. In addition, many of the PIVs in cardiac patients are inserted in the operating room by anesthesia staff who are able to obtain larger IV catheters. Both factors may have resulted in lower infiltrate rates for cardiac patients in 2019 thus preventing a statistically significant decrease in 2020 when only looking at the PICU population.

Second, the census of the PICU was dramatically affected in 2020 because of COVID-19. During March and April of 2020, the PICU had an average daily census (ADC) of 14 and 9 respectively compared to 23 and 23 in 2019. This decrease was attributed to the cancellation of elective surgeries, the implementation of social isolation in our community, and the closure of

schools and many other public places. Along with the decrease in census, we had many patients who were admitted with new isolation precautions related to the pandemic, affecting the nursing workflow and causing delays in every hour assessments of PIVs.

Conclusions

We are continuing to work on PIV infiltrates as a hospital and are working toward a hospital wide bundle to roll out in 2020. Based upon the results of the PICU K card audits and outcomes, the focus of the house-wide bundle will include accurate hourly TLC assessments and expanding the use of EPIVs. The plan is for all nurses to receive mandatory education on proper TLC assessments as well as signs and symptoms of IV infiltrates with a goal of expanding the work over the next year.

While a statistically significant improvement was not seen in the key outcomes, the project drew attention to the number of IV insertions and the number of IV attempts patients endure during a hospital stay. Newer technology such as the IV Watch system (Doellman & Rineair, 2019), has emerged in the last few years aiding in earlier detection of PIV infiltrates. This technology utilizes infrared sensors to detect an infiltrate before it has external visible signs. While the results have been favorable, the costs of the equipment would be substantial to have it available for every patient with a PIV. However, future work on PIV infiltrate prevention could incorporate this technology and limit the human error factor of inaccurate assessments.

Future research should focus on both EPIV usage in pediatrics as well as PIVIE bundle implementation. The evidence is clear that some form of a PIVIE bundle is effective in preventing the number and severity of IV infiltrates. However, it is not clear which components are the key elements to impact these outcomes. As new EPIV catheters become available in pediatric sizes, studying their usage to reduce IV infiltrates and severity would be beneficial. As

more work continues within collaboratives such as Solutions for Patient Safety (https://www.solutionsforpatientsafety.org/), I believe the best bundle components can be identified.

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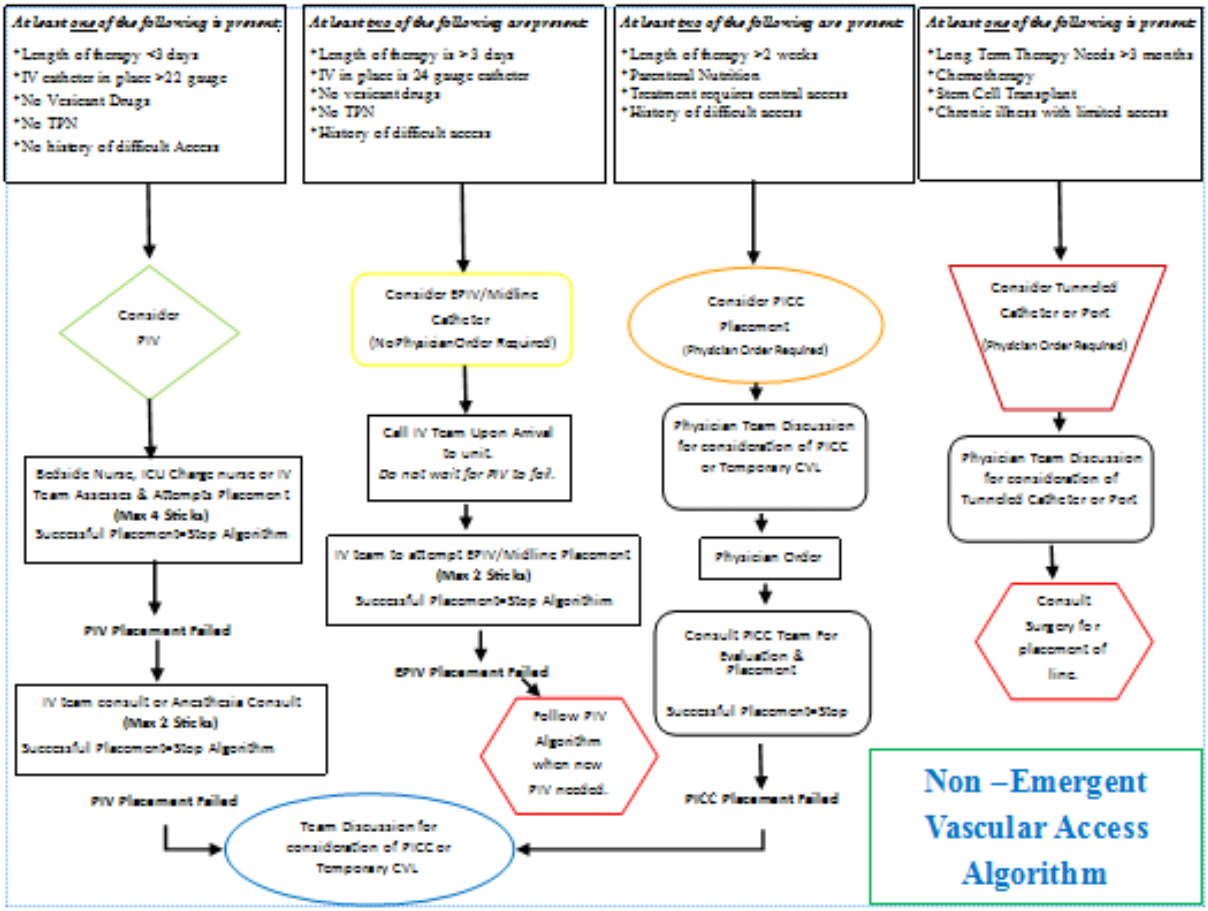
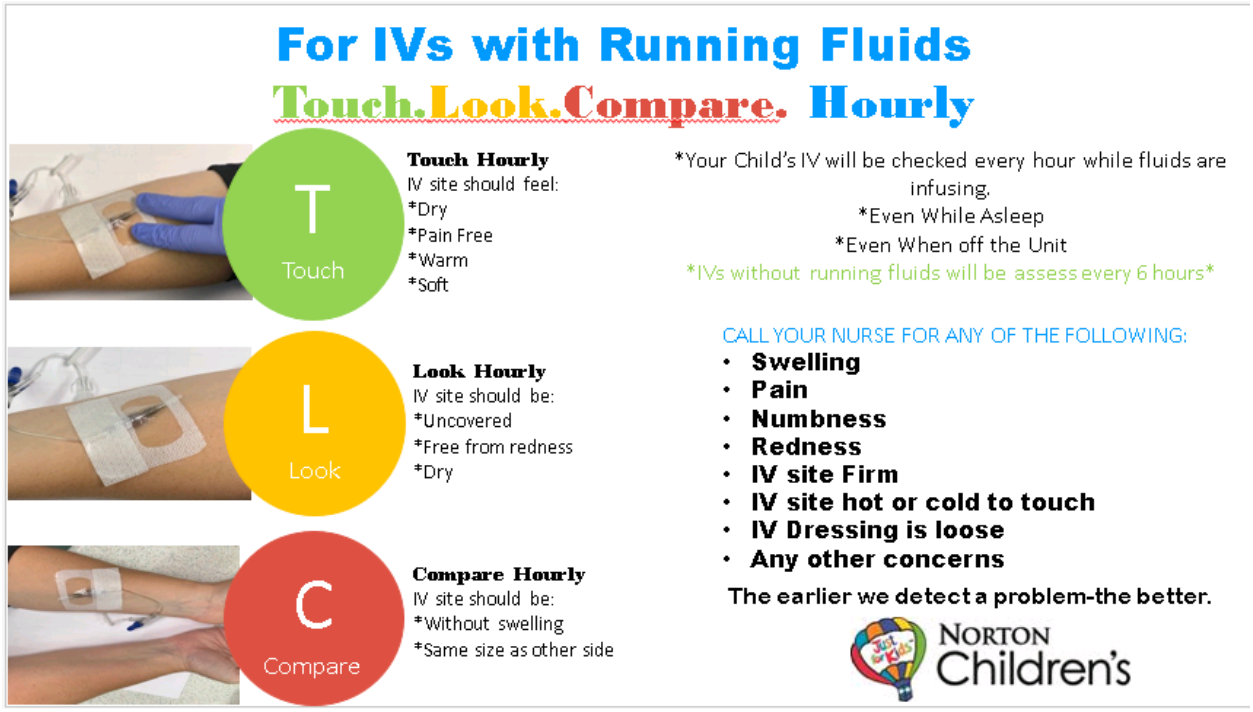
Appendices

Appendix A: Non-Emergent Vascular Access Algorithm



Appendix B: Family Education



Appendix C: K Card

PIVIE

Performance Expectations

Upon completion of your interaction/observation—

AUDIT CRITERIA: All must be met for audit to PASS

- Ask RN how often she is assessing her IV site?
- Observation of assessment:
  - Touch-did the nurse physically palpate the PIV site above, below & dependent surfaces where fluid may accumulate? *Ex: palm of hand for top of hand PIV*
  - *Look-did the RN inspect the site and dependent surfaces of the extremity?*
  - *Compare-did the RN compare the extremities side by side?*
- *Dressing is clean & occlusive dressing*
- *Alcohol caps present on all lumens*
- *Tubing dated/timed & within <120 hours old*

Additional Information:

- *Dressing is dated?*
- *Dressing is ≤ 7 days old?*
- *Dressing is not Tegaderm? (type)*
- *Line has securement device (type)*

FOLLOW-UP and DOCUMENTATION

If all components present,

Document your observation on the **Daily Audit Sheet** (in the day of month column and card number row). If someone else has already put initials in the box, just add your initials to the same box

Put a tic mark on the monthly **Percent of Compliance** under the corresponding week # in the Green row.

If all criteria present, then return this card to the appropriate slot with the **GREEN** side facing up/outward.

If all bundle components were not present, turn to the opposite side of this card.

Observation/interaction time should take <5 minutes to complete.

PIVIE

PIVIE

Performance Expectations

Upon completion of your interaction/observation—

AUDIT CRITERIA: Audit fails if 1 or more elements not done

◊ RN did not know to assess IV site q 1 hour for infusing fluids & every 6 hours for Hep Locked IVs.

◊RN did not do "touch" assessment appropriately

◊RN did not do "look" assessment appropriately

◊RN did not compare extremities appropriately

◊Dressing is not clean or occlusive

◊Alcohol Caps are not present on all lumens

◊Tubing is not dated/timed or is >120 hours old

FOLLOW-UP and DOCUMENTATION:

Document your observation on the **Daily Audit Sheet** (in the day of month column and card number row). If someone else has already put initials in the box, just add your initials to the same box

In the **Pareto Chart** document, find the name of the bundle matching the one on your card, put an X in the column(s) of the ***MISSING*** bundle elements.

In the **Kamishibai Kaizen Newspaper** document, enter the date and card#, the bundle component that was missing, and what was learned from the RN as to why the component is missing (barriers, habits, awareness, etc). Do not enter anything in the remaining columns.

If one or more criteria were not met, then return this card to the appropriate slot with the **RED** side facing up/outward.

Observation/interaction time should take <5 minutes to complete

PIVIE