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Difficult Intravenous Access in Pediatrics: Improving First Attempt Success Rates

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PRACTICUM: Quality Improvement and Outcomes Management-K9B

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Abstract

Problem: This project aims to improve the success rate of peripheral intravenous catheter insertion on the first attempt from 50% to 60% with the implementation of the Difficult Intravenous Access (DIVA) clinical assessment and escalation tool, developed by the Queensland Children's Hospital of Australia.

Context: Inserting a peripheral intravenous catheter is the most common invasive procedure during hospitalization. Obtaining vascular access in children may require multiple attempts due to their anatomical variations, smaller caliber veins, and the child's level of anxiety. Although a minimally invasive procedure, pediatric patients and their families often describe it as one of the most painful and stressful experiences endured during their inpatient stay. Up to 69% of first-attempt insertions fail, leading to delays in medical treatment and extended hospitalizations. Early identification and management of a child with difficult intravenous access can ensure prompt escalation and management, improving the patient and family experience.

Intervention: Implementing the Difficult Intravenous Access (DIVA) clinical assessment and escalation tool. Education on the use of the tool is the primary test of change for this quality work; establishing DIVA champions to support staff on the use of the tool; reinforce proper documentation of peripheral intravenous properties in Health Connect; educate and reinforce the use of analgesia/comfort measures for all peripheral intravenous starts on pediatric patients.

Measures: Measures for the Difficult Intravenous Access in Pediatrics project were designed to capture all peripheral intravenous access placed on the inpatient pediatric unit. The outcome measure is the percentage of patients with the successful placement of a peripheral intravenous catheter on the first attempt at cannulation. Process measures included adherence to the DIVA clinical assessment and escalation tool and the use of analgesia/comfort measures during peripheral intravenous catheter placement.

Results: The primary outcome measure target of a 60% success rate at first attempt/cannulation for peripheral intravenous access was not met. Fifteen out of forty-four peripheral intravenous access attempts were successfully placed on the first attempt, resulting in a success rate of 34%. There was 100% compliance with using the DIVA clinical assessment and escalation tool for all forty-four attempts captured. Analgesia or comfort measures during peripheral intravenous catheter placement were used 66%, just below the set target of 70%.

Conclusions: The main goal of providing a clinical assessment and escalation tool to help determine difficult intravenous access in pediatrics was achieved through implementing the DIVA key. Although the DIVA tool alone was insufficient to improve the overall success rate of peripheral intravenous access on the first attempt, it did help staff escalate to a confident or advanced inserter if the patient presented as a difficult intravenous access patient. The consistent use of analgesia or comfort measures for peripheral intravenous placement was also encouraged using the DIVA key.

Keywords: *difficult IV access, DIVA, difficult stick, pediatrics, and peripheral intravenous access.*

Difficult Intravenous Access in Pediatrics: Improving First Attempt Success Rates

Establishing peripheral intravenous (PIV) access is the most common invasive procedure performed in hospitals. This can be especially challenging in the pediatric population as their veins are intrinsically fragile and thin. Fever, dehydration, and other acute or chronic conditions can further complicate the placement of a PIV. The success rate at the first attempt is highly variable, often resulting in multiple attempts—causing pain and distress in children (Ehrhardt et al., 2018). Delayed PIV placement usually means a delay in treatment.

The insertion of PIVs can be time-intensive, with multiple attempts required for successful insertion. This can cause increased pain and anxiety for the patient, potentially contributing to an increased risk for the healthcare worker to needlestick injuries or blood exposure. Often failed attempts may lead to catheter placement in more vulnerable areas like the feet, wrist, and thumbs—increasing the risk of complications. This can be detrimental to clinical outcomes resulting in increased costs and inefficient use of resources (Bahl et al., 2021).

Successful PIV placement is dependent on many variables. This includes nurse experience with PIV placement, knowledge of appropriate venous access devices, and optimal anatomical site placement for PIVs based on age, type, and length of treatment prescribed. There is no formal education on vascular access for novice nurses beyond what is taught in nursing school.

Problem Description

The Pediatric ward and Pediatric Intensive Care Unit (PICU) are the author's practicum work areas of interest. There has been quality improvement work on preventing and treating PIV infiltrations and extravasations, but none regarding the placement of PIVs in pediatric

patients. Being in an acute care setting, the PIV is necessary for treating the various diagnoses admitted to these units. With no formal vascular access team, a limited number of expert pediatric nurses and clinicians can help when there is a pediatric patient with difficult PIV access. Although a few transport nurses are peripherally inserted central catheter (PICC) certified that are comfortable using ultrasound when attempting venous access, no other frontline pediatric nurse staff is trained in its use. This presents challenges when faced with a child with difficult PIV placement.

In an international survey of difficult intravenous access in children, it was revealed that more than half of children admitted into a healthcare facility required the insertion of a PIV to administer medical treatment. More than 50% of first attempt insertions fail (Schults et al., 2019). This current failure rate of approximately 50% at PIV placement on the first attempt is what the author would like to see improve in her microsystem. This 50% value will be used as it is a challenge to establish a true baseline for this work as the data extracted from the electronic medical record was not reliable.

In a recent case, an afebrile, two-month-old infant admitted to rule-out sepsis endured multiple attempts at a PIV during the overnight shift. Without access, intramuscular antibiotics were administered, further compounding the patient's pain and the parent's anxiety. Not to mention the stress this has on the nursing staff providing care.

The organization aims to eliminate patient harm and enhance the patient's care experience. Successful PIV placement promptly not only decreases the amount of time the child is subject to pain and stress, but it can also greatly influence the parent's perception of

quality of care, improving customer satisfaction and overall. This may also help decrease the length of stay if treatment can be initiated without delay.

This work would align with the national campaign by the Association for Vascular Access's Pediatric Special Interest Group, PediSig, to decrease the number of IV attempts in infants and children titled "One Million Pokes Saved," launched in August of 2016. The campaign aims to raise awareness of excess IV attempts and needle sticks by finding a solution to the problem—research, education, and clinical tool development (Hartman et al., 2018).

Available Knowledge

PICO Question

The PICO question used for the literature search and synthesis of evidence asked: In the Pediatric population (P), does the utilization of the DIVA (Difficult Intravenous Access) clinical assessment tool (I) compared to the current standard (C) help to decrease the number of failed IV attempts and improve the overall success rate of IV access on the first attempt (O)?

Literature Review

The following databases were used for the literature search: CINAHL, PubMed, and Cochrane Database of Systematic Reviews. The following keywords and phrases were used to guide the search: *difficult IV access, DIVA, difficult stick, pediatrics, and peripheral intravenous access*. The search included articles published after 2017, peer-reviewed, and in English. The initial search delivered 239 journal articles and six were found to be most relevant to the PICO question. These six articles were evaluated using the Johns Hopkins Evidence-Based Practice Research Evidence Appraisal tool (Dang & Dearholt, 2018). See Appendix A for Evaluation table.

Bahl et al. (2021) offered a systematic literature review to collate definitions of DIVA (Difficult Intra Venous Access) to arrive at an evidence-driven definition. This study was appraised as a Level III-A. After reviewing 121 academic journal articles, the proposed definition is “when a clinician has two or more failed attempts at PIV access using traditional techniques, and physical examination findings are suggestive of DIVA or the patient has a stated or documented history of DIVA.” This will be the working definition of DIVA to be used in this quality project.

Girotto et al. (2020) sought external validation of the DIVA and DIVA3 clinical predictive rules to identify difficult intravenous access in pediatrics. This cross-sectional study of children undergoing cannulation by nurses in a level III pediatric emergency room was appraised as Level II-A. The sample included 440 children. Using the DIVA and the DIVA3, patients who scored ≤ 4 , nurses predicted greater difficulty with IV placement in mild/moderately dehydrated patients. Those patients who scored ≥ 4 were associated with higher odds of difficult cannulation, consistent with the derivation study done by Yen et al. in 2008. This study provides validation for the DIVA assessment tool that will be used to help identify which pediatric patients are difficult to access or cannulate.

Hartman et al. (2018) did a two-cohort, pre-and post-implementation study to determine if a pediatric peripheral vascular access algorithm (PPVAA) led to differences in the first attempt and overall PIV access success. This study appraised at Level II B. Results did not show improved first IV attempt success or overall success. However, fewer nurses attempted IV access post-implementation as they were more apt to "stop the line" and consult more skilled clinicians.

Although more research is needed to assess an algorithm's value, it showed the importance of looking at PIV placement as a process versus a nursing task.

Ehrhardt et al.'s (2018) quality improvement initiative aimed to help to validate and test the DIVA tool to assist novice nurses in better assessing and identifying patients with difficult IV access. Their study was able to show a positive correlation between the use of the DIVA tool as well as identifying other preexisting conditions or anatomical variances that may contribute to DIVA, such as tough skin (tattoos and scars), frail/elderly skin, chemotherapy, IV drug use, and altered fluid status. This study was rated a Level III-A.

Overall, the body of evidence demonstrated that using a clinical assessment tool might impact identifying those pediatric patients with DIVA and using nursing judgment and escalation to a more skilled provider helped with the overall success rate of cannulation. With the primary goal of this project being to decrease pain by improving first attempt PIV access in pediatric patients, the overall patient care experience can be improved as well.

Rationale

Kotter's change model guided this quality improvement project. In this theory, there are eight steps to generate lasting change. These steps are establishing a sense of urgency, creating a guiding coalition, developing a strategy, communicating the vision of change, empowering broad-based action, generating short-term wins, consolidating gains to produce further change, and anchoring change into the culture (King et al., 2019; see Appendix B).

The sense of urgency for this work was already present in many recent cases of patients with difficult access. Key stakeholders were identified and understood the need for improvement. Early adopters included the PICC line nurses and those nurses with more than ten

years of experience. These nurses are considered experts in their PIV skills. Pediatric anesthesia and PICU intensivists skilled at PIV placement, with or without ultrasound, were also included.

This guiding coalition assisted staff in proceeding through each PDSA cycle. Once implemented, the next step was to highlight success during the training phase to generate short-term wins. This created buy-in from the staff and progress towards consolidating gains. Culture integration occurred when there were demonstrated positive outcomes from this project.

Specific Aim

The specific aim of this project is to increase the number of successful PIV cannulation of first attempt in the pediatric population from 50% to 60% by June 30th, 2022, with the utilization of the DIVA key clinical assessment tool and an escalation pathway.

Section III: Methods

Context

Establishing intravenous access is a common procedure in acute pediatric care. Yet, multiple attempts are often required before successful cannulation is achieved, increasing the pain and anxiety experienced by the patient. Successful PIV placement in a timely manner (or in a single attempt) can positively alter a parent or guardian's perception of the quality of care provided and improve customer satisfaction (Yen et al., 2008). Therefore, developing methods to help improve the success rate of PIV placement has its obvious benefits for both patients and medical staff alike. The setting for this quality improvement work is the Pediatric inpatient department and the Pediatric Intensive Care Unit (PICU). There is solid support for this project as it aligns with the organizational goal of reducing or eliminating patient harm.

Microsystem Assessment

The Pediatric department and the PICU provide a coordinated, multidisciplinary approach to improving the health and safety of ill pediatric patients. Pediatrics has a 26-bed capacity, and the PICU has eight beds available for critical care needs. The population served by these units ranges from one day of age to 20 years of age. All physicians and nursing staff have specialized training and education to provide care for acute as well as critical care to this patient population.

There is currently no standard workflow to assess and manage difficult PIV access in the pediatric population. Anecdotal review of patients with difficult PIV placement revealed that nurses did not have a formal way of assessing patients to predict the level of difficulty. Instead, nurses would try multiple attempts at cannulation and often, more than one nurse attempted PIV access. Although PIV placement was achieved, the number of attempts made was between three and six.

SWOT Analysis

A Strengths, Weakness, Opportunities, and Threat (SWOT) analysis was performed (See Appendix C). Strengths showed a commitment to increasing first attempt PIV success by staff and leadership and the need to provide an assessment tool and escalation pathway when a patient presents with difficult PIV access. It was agreed that a standardized workflow to manage these patients would benefit both patient and clinician.

Weaknesses encountered were the lack of advanced PIV inserters and/or a vascular access team. Currently, there are three PICC line trained nurses who are comfortable using

ultrasound but can only provide partial weekly coverage. Although there are staff with over ten years of experience in pediatrics, there are few expert-level PIV starters on each shift.

Opportunities identified were seeking best practices for DIVA management from other facilities and children's hospitals. In a recent staff survey on education needs for 2022, over 30 % of staff wanted education on PIV placement, including assessing anatomy and techniques for insertion.

Threats to the project include documentation and data collection. Upon completing a data review of all PIVs placed in the Pediatric unit from October of 2021 to March 2022, there is no consistency in how this was documented in the electronic health record. This made it difficult to establish an accurate baseline for this work. Availability of advanced inserters from nursing and anesthesiology was also noted to potentially impact the project's outcome.

Cost-Benefit Analysis

Goff et al. (2013) concluded that the median cost of pediatric IV insertions was \$41, and that 60% of the placements were obtained with the first attempt. Twenty-eight percent of children needed more than three attempts, which increased the cost to \$125. If these same numbers were calculated using Northern California nursing hourly rates (\$80/hr.) and supply cost (\$30 for medication and IV supplies), the median cost per insertion would be approximately \$120.00. For those needing three or more attempts, the average cost would be \$360.00. Increasing first attempt success rates would save \$240 per insertion. Not to mention any money saved by delays in treatment or care.

Implementation costs for this project are minimal. The cost for two-hour education to four DIVA champions at \$85.65 per hour is \$685.20. A return on investment is achieved by just three successful PIV placements on the first attempt. (See Appendix D).

Communication Plan

The project aim, goals and measures were presented both to senior nursing leadership during the Maternal Child Health PIRM on March 2nd, 2022, and to frontline nurses on April 1st, 2022, during the staff meeting. The project charter was presented, explanations for how the DIVA key is used and questions answered. Individual meetings were done with the nurse champions and leadership on the project to make sure that we are meeting project timelines and capturing the data needed.

Interventions

The DIVA key clinical assessment and escalation tool was developed by clinicians at the Queensland Children's Hospital of Australia to help predict and manage pediatric patients with difficult PIV access (Schults et al., 2022). Implementation of this tool will be the main test of change for this quality work. The interventions to be tested include the following: educate nurses on the use of the DIVA key and escalation tool; establish DIVA champions to support staff on use of the tool; reinforce proper documentation of PIV properties in Health Connect; educate and reinforce use of analgesia/comfort measures for all PIV starts. (See Appendix E).

Study of Interventions

The Diva key and escalation tool were utilized for every PIV start done on the pediatric unit. All other PIVs placed in the emergency department, operating room, outside hospital or emergency services were not included in this work. Documentation of the number of attempts

and the number of attempting clinicians for each PIV places were documented in the electronic medical record under PIV properties. Any medications used for analgesia or comfort measures were documented both on the DIVA Key tool as well as in the medication administration record (MAR). If anesthesia services are required to place a PIV on a pediatric patient, it was noted both on the DIVA Key tool. Further chart review was done as anesthesia enters a note as part of their workflow. To study the interventions, several PDSA cycles were performed.

PDSA Cycle 1: Four advanced inserters, including two PICC nurses are champions for this work. They were given an education on the project's goals, data collection, and PIV documentation audit in Health Connect. Plan to meet with team bi-weekly to assess work.

PDSA Cycle 2: Education provided to all staff on using and implementing the DIVA key and escalation tool in early April 2022. Documentation of PIV properties in Health Connect also reviewed to include the number of attempts and number of nurses attempting. Lastly, education provided to reinforce the use of analgesia or comfort measures for all PIV starts. Staff were encouraged to use topical 4% lidocaine cream, anesthetic vapor coolant spray or intranasal midazolam for cases with extreme anxiety.

Feedback from DIVA champions and frontline staff's use of the DIVA tool will be critical to making needed changes for future PDSA cycles. All data will be collected on weekly basis and analyzed monthly.

Measures

The outcome measure for this quality project is defined as the percent of patients with the successful placement of PIV on the first attempt/cannulation. Due to inconsistent documentation, there is no accurate baseline established for DIVA. Instead, the international average of 50% will be used (Schults et al., 2019). The goal is to increase the percentage of successful first attempt PIV access from 50% to 60%.

First process measure is the adherence to the DIVA key and escalation tool itself. This measure is defined by a total number of completed DIVA key audit tools divided by the total number of patients admitted requiring PIV access. This was done both via chart review and by DIVA key paper audit. Target compliance is 90%.

The second process measure is tracking the use of analgesia or comfort measures for PIV insertion. This is defined by the number of patients with documented use of analgesia or positions of comfort for PIV placement divided by the total number of patients admitted requiring PIV access. Target compliance of 70% is established as a goal.

The balancing measure is the number of PIVs placed by anesthesia. This included all PIVs placed in patients admitted to the unit requiring PIV access by anesthesia due to DIVA. Target established is less than five times per month.

Ethical Considerations

With the overall goal of minimizing pain and anxiety for pediatric patients undergoing PIV placement, this work is in line with the ANA code of ethics provision number 3: *The nurse promotes, advocates for, and strives to protect the health, safety, and rights of the patient* (American Nurses Association, 2015). It is out of compassion for the pediatric population that

their well-being is advocated for. Although PIV placement is often a necessary evil, it is within our power to provide care throughout the process to minimize any pain or discomfort.

The Jesuit value of *Cura Personalis*, to 'care for the whole self', is demonstrated in this work by bringing attention to the patient experience and having respect for their person, caring for them holistically—mind, body, and spirit.

This project has been approved as a quality improvement project by the University of San Francisco faculty using QI review guidelines and did not require IRB approval (see Appendix G).

Section IV: Results

The timeline for this quality improvement work started back in late March 2022, with the official start date of April 1st, 2022. Staff and the leadership team widely accepted use of the DIVA Key clinical assessment tool. The tool was utilized for every PIV placement that was done on the unit by staff nurses for pediatric patients. Nursing leadership and trained champions supported the work with their peers. From April 1st to June 22nd, a total 44 PIVs were placed by staff on pediatric patients.

The primary outcome measure of this project was to track the percentage of patients with successful placement of a PIV on the first attempt/cannulation. The target was set at 60%, a 10% improvement from the national average of a 50% success rate at first attempt. Fifteen out of forty-four PIV attempts were successfully placed on the first attempt. That is equal to a 34% success rate, well below the target goal. National data was used to establish a baseline for this work as the data for the author's microsystem was not available. Half or 50% of the PIV placements required two to three attempts for successful placement/cannulation.

The first of two process measures for this work included the percent adherence to the DIVA Key/escalation pathway. There was 100% compliance for all PIV placements (44 audits completed/44 PIV placements). The target was 90% for this measure. It was helpful to not only have champions and nurse leaders monitoring audits but the use of text messaging on Vocera phones and huddles to remind staff to complete a DIVA key with each PIV placement was key.

The second process measure that was of interest was the use of analgesia or comfort measures for PIV insertion. Use of topical lidocaine preparations, comfort positioning, or vapocoolant spray was encouraged to help with pain associated with PIV placement. Of the forty-four PIVs placed, 67% of the time some form of analgesia or comfort measure was used for PIV placement. This fell just short of the target goal of 70%. This was an encouraging result as it is an easy win to prepare patients prior to a PIV start utilizing medications we have available. Even when the need for a PIV is urgent and placement cannot be delayed letting topical medications absorb, comfort positioning was utilized in every event. It is recommended that a topical analgesic is considered in combination with comfort positioning.

Finally, the balancing measure established for this work was the use of the anesthesia team for difficult PIV placement. The goal was set to be less than five times per month. April saw four instances where PIV placement was escalated to an anesthesia team member. May and June did not utilize anesthesia for any of the PIV starts done on the unit. The average over the timeframe of this project was 1.88 times per month.

Using the data retrieved from the DIVA key audit tool, most patients fell into the medium risk category for acuity (45%), appearance of veins (61%), history with PIV placement (43%), and for the level of the patient's anxiety (68%). Most patients were aged three years

and up (43%) with only eleven patients at less than eighteen months of age/history of difficult IV placement, falling in the high-risk category. Most staff categorized themselves as 'confident' inserters in their ability (defined as an 80% first pass success rate). (See Appendix H).

V. Discussion

Summary

The implementation of the DIVA key clinical assessment and escalation tool was well received by staff. The DIVA tool assists staff to determine how and who should attempt PIV placement on pediatric patients. The tool helped nurses to consider the following attributes prior to attempting PIV access: the acuity of the patient, appearance of veins, history with PIV placements, the age of the patient and the patient's level of anxiety. In addition, the nurse considers their own ability and rates themselves as a developing, confident, or advanced inserter. The number of attempts at each PIV was documented and well as the number of providers attempting placement. An escalation pathway helps to give the bedside nurse criteria for when to seek an advanced, more experienced clinician to attempt PIV placement when warranted.

A secondary measure that was studied for this quality improvement project was the use of analgesia or comfort measures for all PIV placements to help with pain during the procedure itself. Staff made a continued effort to advocate and use various methods to ensure a less painful experience when planning a PIV placement. Prior to the start of this project, the availability of a vapocoolant spray was key in increasing the use of analgesia prior to PIV placement. It is a fast-acting topical spray that takes effect immediately. There is no wait time compared to a topical lidocaine creams that require a ten-minute dwell time to take effect. In

the middle of the project, supply chain issues had the vapocoolant spray on backorder. This impacted the use of analgesia as staff did not want to wait for topical lidocaine to take effect. A shipment finally arrived and was made available again towards the last 4 weeks of the project.

Although this project did not show that the DIVA key clinical assessment tool and escalation pathway had a significant effect on increasing the number of successful PIV insertions placed at first attempt at cannulation, it did offer a solid resource for staff to determine PIV difficulty or the presence of DIVA for any given patient. Using the low, medium, and high criteria, staff were better able to plan for who and what team should attempt PIV access, especially for those who were in high-risk category for DIVA. The emphasis on the use of procedural support with positioning, analgesia and distraction was also found to be helpful in decreasing pain associated with PIV cannulation. This study did not quantify the pain scores, but future work would benefit from including this information to document outcomes of such procedural interventions regarding decreasing painful experiences with the pediatric population.

With most nurses classifying themselves as 'confident' inserters (80% pass rate on first attempt) and the fact that only 34 % of all PIV placed took one attempt, it would be beneficial to the team to do a skills day on PIV insertion, techniques, and tips for success. A review of anatomy and optimal placements for PIVs based on age, size, acuity, and type of therapy needed. A hands-on clinical simulation lab would be beneficial to practice insertion techniques and would be included in the education plan as well.

Conclusion

Overall, the main goals of this quality improvement project were achieved: to provide a clinical assessment tool to determine difficult intravenous access (DIVA) in pediatrics; to have a standardized escalation pathway for DIVA; to ensure the use of analgesia/comfort measures are used with IV insertion; and to obtain prevalence data for DIVA in the Pediatric microsystem at a Santa Clara Medical Center.

Sustainability and spread of any improvement project are the hallmark of success. The end vision for this work is that the tool would become second nature and a critical thought process that would be used with every patient requiring a PIV for treatment. Instead of using a DIVA key paper audit with each PIV insertion, the tool can be a poster board resource that can be placed in the procedure room for quick reference or a hyperlink in the electronic medical record. The author would also like to use the data to create a business case for a pediatric vascular access team. Not only could they be a resource for DIVA but can also be utilized in all areas where pediatric patients are getting care and require PIV access (main operating room, emergency department, infusion clinics, etc.). They would have advanced training in the use of ultrasound to help with PIV/midline catheter insertions for those patients with a high risk for DIVA.

There still is much work to be done to help with increasing PIV success rates at first attempt/cannulation. The pediatric population has inherent challenges as the patient population ranges in size from one day old to eighteen years of age. Vein anatomy and structure is sensitive to fluid shifts and disease processes and makes it even more challenging for PIV insertions (Shults et. Al., 2019). Clinician skill variability will also be a constant challenge

as well with addressing DIVA at any given time. Availability of advanced inserters can vary between shifts and anesthesia may not be present to help when needed.

Like with previous studies done on clinical assessment tools for the identification of DIVA, this quality improvement project shows that early identification of DIVA is not sufficient to improve patient outcomes. Clinicians were vocal about needing more education on PIV insertion skills and training to manage a child who presents with DIVA, even with most describing themselves as 'confident' inserters. All in all, the DIVA key clinical assessment tool and escalation pathway is a promising instrument that is both comprehensive yet user friendly for pediatric health care teams to use.

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Appendix A

Evaluation Table

PICOT Question: How does the utilization of the DIVA tool affect the number of IV attempts and overall success rate of IV placement in the pediatric population?

Study	Design	Sample	Outcome/Feasibility	Evidence Rating
<p>Bahl, A., Johnson, S., Alsbrooks, A. M., Gala, S., & Hoerauf, K. (2021, October). Defining difficult intravenous access (DIVA): a systematic review. <i>The Journal of Vascular Access</i>, 11297298211059648. Advance online publication. https://doi.org/10.1177/11297298211059648</p>  <p>11297298211059648 (2).pdf</p>	Systematic Literature Review	121 studies included	<p>Provides an evidence-driven definition of DIVA or “difficult intravenous access”</p> <p>Identified common themes when describing difficult intravenous access.</p>	III A
<p>Ehrhardt, B., Givens, K. E., & Lee, R. (2018). Making it stick: Developing and testing the difficult intravenous access (DIVA) tool. <i>The American Journal of Nursing</i>, 118(7), 56-62. https://10.1097/01.NAJ.0000541440.91369.00</p>  <p>00000446-20180700-0-00029.pdf</p>	Qualitative Quality Initiative	<p>Phase 1: included 94 IV attempts</p> <p>Phase 2: 971 IV attempts</p> <p>Total: 1065</p>	<p>Use of DIVA tool gave novice nurses a reliable indication of the degree of difficulty of IV access.</p> <p>Led to policy change that limits the number of failed attempts to 2 per nurse and 4 per patient.</p> <p>Describes importance of a vascular access education program for novice nurses</p>	V A

Study	Design	Sample	Outcome/Feasibility	Evidence Rating
<p>Giroto, C., Arpone, M., Frigo, A. C., Micheletto, M., Mazza, A., Da Dalt, L., & Bressan, S. (2020). <i>External validation of the DIVA and DIVA3 clinical predictive rules to identify difficult intravenous access in paediatric patients</i>. <i>BMJ</i>. https://10.1136/emermed-2020-209658</p>  <p>762.full.pdf</p>	<p>Prospective Cross-sectional Study</p>	<p>440 children included</p>	<p>External validation of the DIVA and DIVA3 tool for use in pediatric patients. Results similar to that of the derivation cohort.</p> <p>Also identified factors to further refine the risk of DIVA; supporting escalation pathway.</p>	<p>III B</p>
<p>Hartman, J. H., Baker, J., Bena, J. F., Morrison, S. L., & Albert, N. M. (2018). Pediatric vascular access peripheral IV algorithm success rate. <i>Journal of Pediatric Nursing</i>, 39, 1-6. https://10.1016/j.pedn.2017.12.002</p>  <p>1-s2.0-S088259631730338X-main (1).pdf</p>	<p>2-cohort, pre/post-implementation, comparative design</p>	<p>721 PIV insertions, 419 pre-intervention, 302 post-intervention</p>	<p>Use of Pediatric Peripheral Intravenous Access Algorithm (PPVAA) did not show significant improvement in first attempt success or overall IV success.</p> <p>Fewer nurses attempted IV post-PPVAA, reflecting “stop-the-line” when IV access seemed futile.</p> <p>Algorithm may still be helpful in escalating patients to more experienced clinicians as needed.</p>	<p>III B</p>

Study	Design	Sample	Outcome/Feasibility	Evidence Rating
<p>Hartman, J. H., Bena, J. F., Morrison, S. L., & Albert, N. M. (2020). Effect of adding a pediatric vascular access team component to a pediatric peripheral vascular access algorithm. <i>Journal of Pediatric Health Care</i>, 34(1), 4-9. https://10.1016/j.pedhc.2019.06.004</p>  <p>effect of adding a Pediatric VAT.pdf</p>	<p>Prospective Comparative, 2-group design</p>	<p>596 IV attempts in a 12-month period (6 months pre/post)</p>	<p>Pediatric Peripheral Venous Access Algorithm (PPVAA) applied using a Vascular Access Team (VAT) improved IV access results in comparison to use of the PPVAA alone.</p> <p>Provides data on the value of a designated VAT as part of an algorithm.</p>	<p>III B</p>
<p>Schults, J., Rickard, C., Kleidon, T., Paterson, R., Macfarlane, F., & Ullman, A. (2019). Difficult peripheral venous access in children: An international survey and critical appraisal of assessment tools and escalation pathways. <i>Journal of Nursing Scholarship</i>, 51(5), 537-546. https://10.1111/jnu.12505</p>  <p>J of Nursing Scholarship - 2019 -</p>	<p>Cross-sectional international survey & systematic literature review</p>	<p>148 clinicians 5 clinical pathways reviewed</p>	<p>No standardized resource for identification & escalation of pediatric patients with DIVA.</p> <p>DIVA tool was the most common clinical assessment used; with few escalation pathways noted.</p> <p>Emphasizes the need to incorporate child or family preferences in those with DIVA.</p>	<p>III B</p>

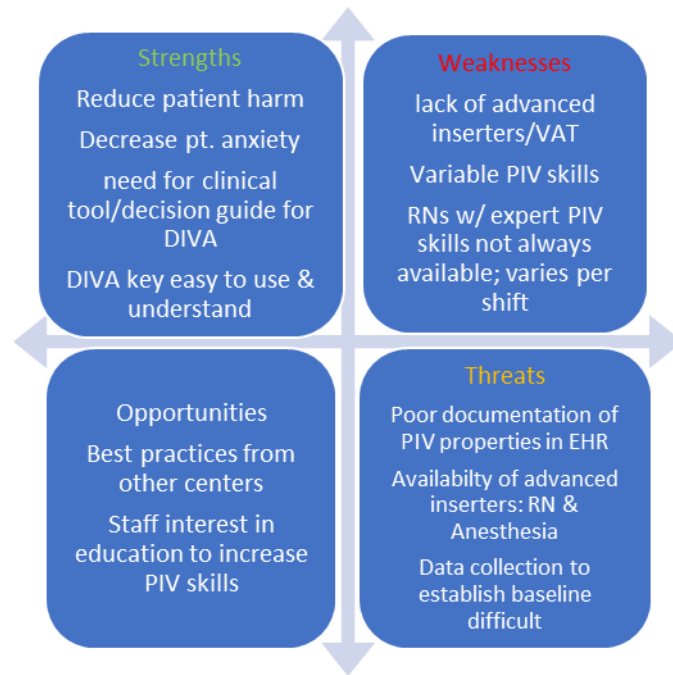
Appendix B



<https://online.visual-paradigm.com/diagrams/templates/kotters-8-step-change-model/john-kotter-model-of-change/>

Appendix C

SWOT Analysis of DIVA in Pediatrics QI project



Appendix D

Cost-Benefit Analysis

Variable	Cost	Est. Time	Cost
Nurse Cost	\$80/hr	15 min/PIV	\$60
Support Staff cost	\$40/hr	15 min/PIV	\$30
PIV supplies	\$10	10	\$10
Medication	\$20	20	\$20
Total	\$150/hr	15min/PIV	*\$120/PIV

3 or more PIV attempts=\$120 x 3=\$360

*Total cost = nurse cost (directly measured time × estimated hourly salary) + support personnel cost (directly measured time × estimated hourly salary) + fixed cost (supplies) + anesthetic cost

Reference

Goff, D. A., Larsen, P., Brinkley, J., Eldridge, D., Newton, D., Hartzog, T., & Reigart, J. R. (2013). Resource utilization and cost of inserting peripheral intravenous catheters in hospitalized children. *Hospital Pediatrics*, 3(3), 185-191

Appendix E
 DIVA Key Clinical Assessment Tool & Escalation Pathway

Always Consider Whether Intravenous Therapy is Necessary?

Pt. Sticker HERE

The DIVA Key

Difficult IntraVenous Access

Date: _____

	Low Risk	Medium Risk	High Risk
1. <u>A</u>cuity	No clinical urgency (>2h)	Time critical (<2h)	Urgent
2. <u>A</u>pppearance	Multiple visible/palpable veins	Few visible/palpable veins	Nil visible/palpable veins
3. <u>A</u>lerts	Previous easy access	Multiple attempts required in past	Documented alert and/or US guidance required in past
4. <u>A</u>dmittions	Previously well or mild illness	Multiple admissions and/or comorbidities	Severe comorbidities and prolonged hospital care
5. <u>A</u>ge	> 3 years	< 3 years	< 18 months History of prematurity
6. <u>A</u>nxiety	Minimal anxiety	Moderate anxiety	Severe anxiety and/or documented needle phobia

Clinician Self Assessment

7. <u>A</u>bility	Developing <100 paediatric insertions <50% first pass success Minimal US skills	Confident 100-800 paediatric insertions 50-80% first pass success Developing US skills	Advanced >800 paediatric insertions >80% first pass success Proficient US skills
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Insertion & Escalation Pathway
 Does your insertion ability = patient DIVA risk?

8. <u>A</u>scend	Developing Inserter From Treating Team 2 Attempts Max	Confident Inserter +/- Ultrasound Guided 2 Attempts Per Inserter	Advanced Inserter Preferably US Guided
-------------------------	--	---	---

Maximum 2 attempts per inserter from any ability level →
 After 4 insertion attempts **ESCALATE** to an **Advanced Inserter**

VAMS (7am-3pm)
Anaesthetist
PICU Reg
PICU Intensivist
TRANSPORT NURSE

Always Provide Procedural Support

Consider where appropriate

- 1) Numbing cream **Emla**
- 2) Sucrose or breast feed
- 3) Comfort position
- 4) Distraction

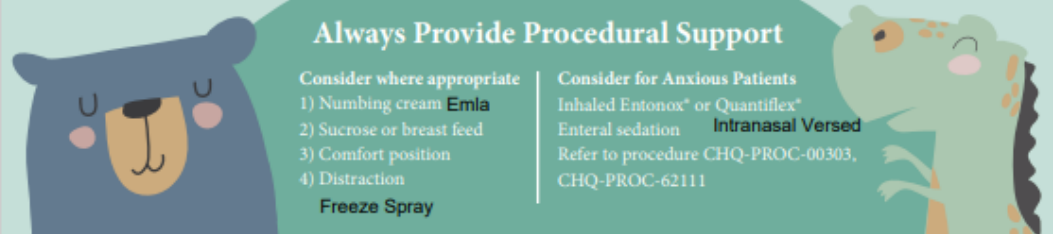
Freeze Spray

Consider for Anxious Patients

Inhaled Entonox* or Quantiflex*

Enteral sedation **Intranasal Versed**

Refer to procedure CHQ-PROC-00303,
 CHQ-PROC-62111



Appendix F Project Charter

Project Charter: Difficult Intravenous Access (DIVA) in Pediatrics: Improving first time success at peripheral venous access in children.

Global Aim: To standardize implementation of a clinical assessment tool and escalation pathway to assist with first attempt success at peripheral intravenous access in pediatric patients, to expedite care, decrease pain, and increase satisfaction with overall patient care experience in Pediatrics.

Specific Aim: To improve the success rate of PIV insertion on the first attempt from 50% to 60% with the implementation of the DIVA clinical assessment tool by July 2022.

Background:

Insertion of a peripheral intravenous catheter (PIV) is the most common invasive procedure performed during hospitalization. Obtaining vascular access in children may require multiple attempts due to their anatomical variations, smaller caliber veins and the child's level of anxiety (Naik et al., 2019). Although it is a minimally invasive procedure, pediatric patients and their families often describe it to be one of the most painful and stressful experiences endured in their inpatient stay (Schults et. al., 2021). Up to 69% of first attempt insertions fail, leading to delays in medical treatment and extended hospitalizations. Early identification and management of a child with DIVA can ensure prompt escalation and management, improving the patient and family experience (Schults et. Al, 2019).

Sponsors

Chief of Pediatrics	Y.V.
Assistant Chief of Pediatrics	J.C
MCH Medical Director	M.S.
Quality Leader	A.H.

Goals

To provide

1. Pediatric nurses with a clinical assessment tool to determine difficult intravenous access (DIVA) in patients.
2. To have a standardized escalation pathway for DIVA.
3. To ensure that analgesia/comfort measures are used with each IV insertion.
4. To obtain prevalence data for DIVA in Pediatric microsystem at Kaiser Santa Clara Medical Center.

Measures

Measure	Data Source	Target
Outcome		
% Patients with successful placement of PIV on first attempt/cannulation	Chart Review-Health connect	60%
Process		
% Of nursing staff adherence to using the DIVA key	Chart review-Healthconnect	90%
% Usage of analgesia or comfort measures with IV placement	Chart Review-Health connect	70%
Balancing		
Increased use of Anesthesia for IV insertion	Chart Review-Healthconnect Microsoft forms report	<5 x a month

Team

MD Co-Lead	J.C.
CNS/Educator	J.D.
Pediatric Educator	S.Y.
Quality Nurse	S.R.
Staff nurse champions	K.C., A.S., L.H., K.L., C.L.
ANM Leaders	B.H., S.C., N.H., K.R., D.S.

References

- American Association of Colleges of Nursing, (2022). *Clinical nurse leader*.
<https://www.aacnnursing.org/CNL/CNL>
- King, C. R., Gerard, S.O., Rapp, C. G. (2019). *Essential knowledge for CNL and APRN nurse leaders*. Springer Publishing.
- Naik, V. M., Mantha, S., & Rayani, B. K. (2019). Vascular access in children. *Indian journal of anaesthesia*, 63(9), 737–745. https://doi.org/10.4103/ija.IJA_489_19
- Schults, J. A., Kleidon, T. M., Gibson, V., Ware, R. S., Monteagle, E., Paterson, R., Charles, K., Keys, A., McBride, C. A., McTaggart, S., Lawton, B., Macfarlane, F., Sells, C., Rickard, C. M., & Ullman, A. J. (2022). Improving peripheral venous cannula insertion in children: a mixed-methods study to develop the DIVA key. *BMC health services research*, 22(1), 220. <https://doi.org/10.1186/s12913-022-07605-2>
- Schults, J., Rickard, C., Kleidon, T., Paterson, R., Macfarlane, F., & Ullman, A. (2019). Difficult Peripheral venous access in children: An international survey and critical appraisal of assessment tools and escalation Pathways. *Journal of nursing scholarship : an official publication of Sigma Theta Tau International Honor Society of Nursing*, 51(5), 537–546. <https://doi.org/10.1111/jnu.12505>

Appendix A of Project Charter

Measurement Strategy

Background (Global Aim) To standardize implementation of the DIVA key and escalation pathway for pediatric patients getting peripheral intravenous access by July 2022.

Population Criteria: Pediatric patients requiring a peripheral venous access during their hospital stay.

Data Collection Method: Baseline of 50% established using international average of DIVA prevalence in pediatric population (Schults, et al., 2019). This indicates a 50% success rate at intravenous cannulation on the first attempt. All PIVs placed on the unit will use a DIVA key for clinical assessment and the escalation tool prescribed as needed. Additional questions regarding analgesia use and escalation to an advanced user, including anesthesia will be determined both via the audit tool and thorough chart review of documentation. Will evaluate data every month and adjust plan as needed based on results.

Data Definitions

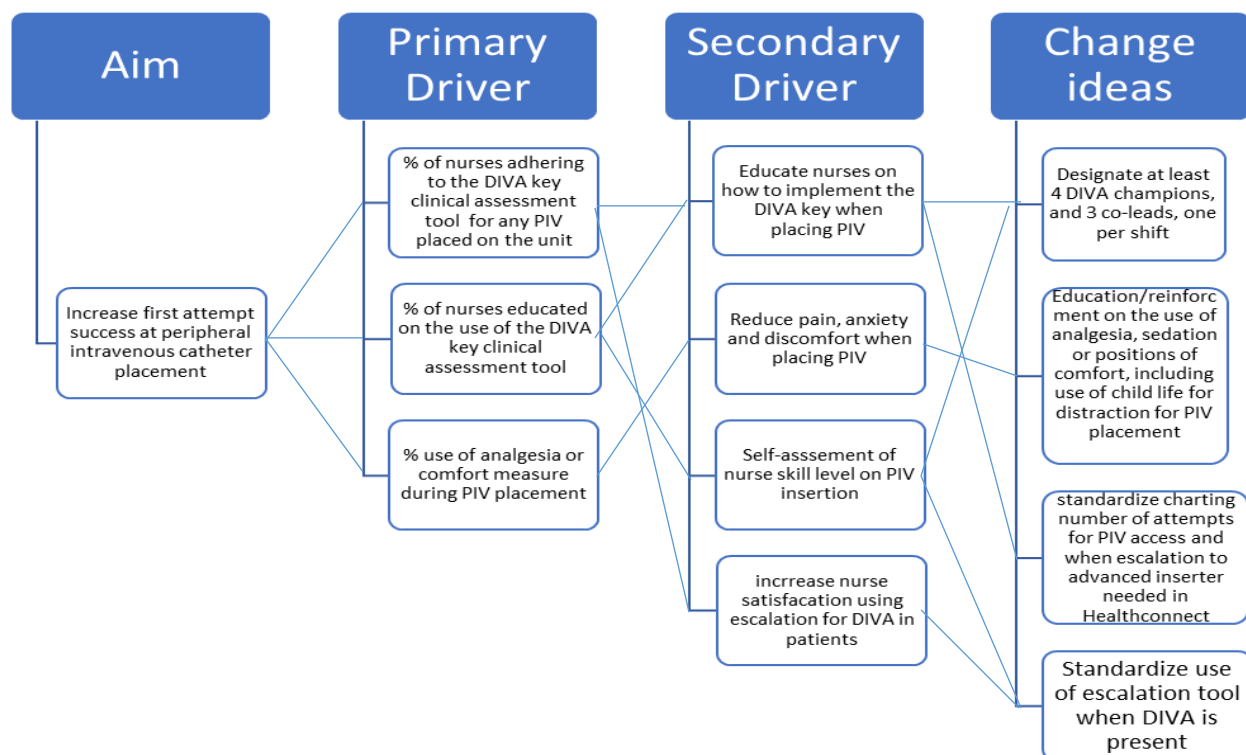
Data Element	Definition
PIV	Peripheral intravenous catheter
Successful PIV attempt on first pass	One attempt at IV cannulation with successful placement
Difficult Intravenous Access or DIVA	Intravenous catheter placement requiring more than one attempt.
DIVA Key/Escalation pathway	Difficult Intravenous Access Key
Analgesia or comfort measures	Use of 4% lidocaine gel, numbing spray or positioning of patient to maintain maximum comfort
Health Connect	Electronic Health Record used by Kaiser
MAR Report	Medication Administration Record report in Health Connect

Measure Description

Measure	Measure Definition	Data Collection source	Goal
% Of successful PIV attempts on the first try/cannulation	N=# patients with 1 attempt at PIV access D=# patients admitted requiring PIV access	Health Connect -chart audit DIVA key paper audit	60%
% of adherence to DIVA key/escalation pathway	N= # of completed DIVA key audit tools D=# patients admitted requiring PIV access	Health Connect-chart review DIVA key paper audit	90%

<p>% use of analgesia or comfort measures for PIV insertion</p>	<p>N= # patients with documented use of analgesia or position of comfort for PIV placement D=# patients admitted</p>	<p>Health Connect-Chart Review, MAR report Hardcopy of DIVA audit tool</p>	<p>70%</p>
<p># of PIVs placed by Anesthesia</p>	<p>N=number of times Anesthesia called to place PIV for inpatient pediatrics</p>	<p>Health Connect Chart Review, Anesthesia notes Hardcopy of DIVA audit tool</p>	<p><5 times per month</p>

Driver Diagram



Project Timeline

2022	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Microsystem Assessment								
Define Project								
Review Literature								
Develop AIM								
Create measurement, outcomes, process and balancing measures								
Develop charter								
Identify changes to test								
Driver diagram								
Complete charter								
Create DIVA team								
Educate nurses on use of DIVA key								
Review use of analgesia, sedation and comfort measures for PIV placement								
Educate nurses on escalation pathway when DIVA is present								
Review documentation of PIV properties to include # of attempts, # of RNs attempted in Health Connect								
Gather DIVA key audit data								
Review need for escalation to advanced inserter/anesthesia								
Run PDSA cycles								
Chart Audit documentation								
Present data in thesis & poster presentation								
Evaluation & ongoing performance improvement								

Changes to Test

1. Educate nurses on the components and use of the DIVA key and escalation tool.
2. Establish DIVA champions to assist and reinforce the use of the DIVA key to plan all PIV insertions that take place on the unit.
3. Educate and reinforce documentation of PIV properties, including number of attempts as well as number of clinicians that attempted, in Health Connect.
4. Educate and reinforce the use of adequate pain relief for PIV starts, sedation or use of distraction with assistance from Child Life Services.
5. Review DIVA escalation pathway with nurses to provide a standard workflow to escalate placement of PIV when DIVA is present.

CNL Competencies

The Clinical Nurse Leader (CNL) is essential in addressing the need to improve quality of care and patient outcomes in his or her specific microsystem. The CNL collects and evaluates patient outcomes, assesses cohort risk, and has the decision-making authority to change care plans when necessary (AACN, 2022). For this quality improvement project, the three CNL competencies (King et. Al, 2019) involved in the addressing difficult peripheral intravenous access in children include:

- Clinical outcomes manager: synthesize data, information, and knowledge on difficult intravenous access in children to evaluate and achieve optimal outcomes within the pediatric microsystem.
- Quality Improvement and Safety: direct quality improvement methods to promote safe, timely, effective, and efficient, patient-centered care. Use improvement strategies to guide the clinical team in quality improvement projects within the microsystem.
- Translating and Integrating Scholarship into practice: integrate theory, evidence and clinical judgement, research and interprofessional perspectives to improve practice and health outcomes for the pediatric patient population.

Appendix G

**CNL Project: Statement of Non-Research Determination Form****Student Name:** Daisy Portier**Title of Project:**

Difficult Intravenous Access in Pediatrics: Increasing First Attempt Success Rates

Brief Description of Project: : To standardize implementation of a clinical assessment tool and escalation pathway to assist with first attempt success at peripheral intravenous access in pediatric patients, to expedite care, decrease pain, and increase satisfaction with overall patient care experience in Pediatrics.

A) Aim Statement: To improve the success rate of PIV insertion on first attempt from 50% to 60% with the implementation of the DIVA clinical assessment tool by July 2022.

B) Description of Intervention:

1. Pediatric nurses with a clinical assessment tool to determine difficult intravenous access (DIVA) in patients.
2. To have a standardized escalation pathway for DIVA.
3. To ensure that analgesia/comfort measures are used with each IV insertion.
4. To obtain prevalence data for DIVA in Pediatric microsystem at Kaiser Santa Clara Medical Center

C) How will this intervention change practice? Evidence-based clinical assessment tool to use for predicting difficult PIV access (DIVA) in Pediatric patients and escalation pathway for nursing to use when DIVA is present.

D) Outcome measurements: See at 10% increase in number of pediatric patients with successful placement of PIV on first attempt/cannulation by July 2022.

Would also like to see pain/analgesia/comfort measures used for 70% of all PIV starts by July 2022.



To qualify as an Evidence-based Change in Practice Project, rather than a Research Project, the criteria outlined in federal guidelines will be used:
<http://answers.hhs.gov/ohrp/categories/1569>

This project meets the guidelines for an Evidence-based Change in Practice Project as outlined in the Project Checklist (attached). Student may proceed with implementation.

This project involves research with human subjects and must be submitted for IRB approval before project activity can commence.

Comments:

EVIDENCE-BASED CHANGE OF PRACTICE PROJECT CHECKLIST *

Instructions: Answer YES or NO to each of the following statements:

Project Title:	YES	NO
The aim of the project is to improve the process or delivery of care with established/ accepted standards, or to implement evidence-based change. There is no intention of using the data for research purposes.	x	
The specific aim is to improve performance on a specific service or program and is a part of usual care. ALL participants will receive standard of care.	x	
The project is NOT designed to follow a research design, e.g., hypothesis testing or group comparison, randomization, control groups, prospective comparison groups, cross-sectional, case control). The project does NOT follow a protocol that overrides clinical decision-making.	x	
The project involves implementation of established and tested quality standards and/or systematic monitoring, assessment or evaluation of the organization to ensure that existing quality standards are being met. The project does NOT develop paradigms or untested methods or new untested standards.	x	
The project involves implementation of care practices and interventions that are consensus-based or evidence-based. The project does NOT seek to test an intervention that is beyond current science and experience.	x	
The project is conducted by staff where the project will take place and involves staff who are working at an agency that has an agreement with USF SONHP.	x	
The project has NO funding from federal agencies or research-focused organizations and is not receiving funding for implementation research.	x	
The agency or clinical practice unit agrees that this is a project that will be implemented to improve the process or delivery of care, i.e., not a personal research project that is dependent upon the voluntary participation of colleagues, students and/ or patients.	x	
If there is an intent to, or possibility of publishing your work, you and supervising faculty and the agency oversight committee are comfortable with the following statement in your methods section: "This project was undertaken as an Evidence-based change of practice project at X hospital or agency and as such was not formally supervised by the Institutional Review Board."	x	



ANSWER KEY: If the answer to **ALL** of these items is yes, the project can be considered an Evidence-based activity that does **NOT** meet the definition of research. **IRB review is not required. Keep a copy of this checklist in your files.** If the answer to **ANY** of these questions is **NO**, you must submit for IRB approval.

*Adapted with permission of Elizabeth L. Hohmann, MD, Director and Chair, Partners Human Research Committee, Partners Health System, Boston, MA.

STUDENT NAME (Please print): Daisy Portier

Signature of Student: *Daisy Portier* DATE 4.11.22

SUPERVISING FACULTY MEMBER NAME

Signature of Supervising Faculty Member _____ DATE _____

Appendix H DIVA Key Audit Results

Total audits completed=44

3. Acuity of patient

[More Details](#)
[Insights](#)

- Low risk: No clinical urgency 13
- Medium risk: Time critical (less t... 20
- High risk: Urgent need for plac... 11



4. Appearance of veins

[More Details](#)
[Insights](#)

- Low risk: Multiple visible or pal... 15
- Medium risk: Few visible or pal... 27
- High risk: No visible or palpabl... 2



5. Alerts or history with PIV placements

[More Details](#)
[Insights](#)

- Low risk: Previous easy access 23
- Medium risk: Multiple attempts... 20
- High risk: Documented history ... 1



6. Age of patient

[More Details](#)
[Insights](#)

- Low risk: >3 years old 19
- Medium risk: < 3 years old 14
- High risk: <18 months/history ... 11



7. Level of patient's anxiety

[More Details](#)[Insights](#)

- Low risk: Minimal anxiety 15
- Medium risk: Moderate anxiety 21
- High risk: Severe anxiety and/or... 8



8. Clinician (Nurse) Self Assessment : ABILITY

[More Details](#)[Insights](#)

- Developing: <100 pediatric ins... 7
- Confident: 100-800 pediatric in... 30
- Advanced: >800 pediatric insert... 7

