Pediatric peripheral intravenous (PIV) insertion can be a difficult task. Many hospitals look to their more experienced staff nurses or to IV nurse specialists/teams to routinely achieve PIV access. The skill and success rate of the individual achieving access as well as the number of attempts made are variables that influence patient satisfaction. When evaluating various models for PIV access, cost effectiveness as well as patient satisfaction should go hand in hand. Determining the most successful model needs to be individualized to each hospital population. The model should define the practice standard for PIV insertion attempts and the desired success rate.

**Review of Literature**

The literature addressing PIV insertions is vast and primarily addresses topics such as technique, cleaning of the insertion site, dressings, and catheter size and type. Unfortunately, the literature specifically addressing pediatric PIV insertion success is limited and is mostly associated with IV nurse specialists/teams.

The focus of these articles frequently is the role of IV nurse specialists/teams and the financial impact of such teams, not the IV insertion success rates. Because of differing study goals, it was difficult to determine a success standard in which to compare. Again, although the focus of existing literature was primarily the role of IV nurse specialists/teams, frequently the title of the professional placing the PIV was identified and, subsequently, his or her success rate was calculated.

Frey (1998) explored the financial impact of an IV nursing team and, to determine the impact of such a team, the PIV insertion success rates of various groups were calculated and compared. This study reported the RN staff nurses to have a 44% success rate compared to physicians (95%) and IV nurse clinicians (98%), thus concluding that RN nursing staff have the least desirable success rate. Frey’s study also measured the amount of time required to obtain PIV access and found the average time to be 20 minutes, with a range of 2-90 minutes. A report by Millam (1993) calculated a PIV insertion success rate of 90% when attempted by an IV nurse specialist. Costentino (1984) used seven IV nurse specialists for IV placement. A 100% success rate was reported for these seven individuals within three attempts at placement. Furthermore, it was reported that these seven IV specialists achieved a 91.4% success rate on the first attempt at insertion followed by 98.6% in two attempts. Individually, the IV specialists’ success rates ranged from 84.7% to 95%. A study by Brown (1984) found that IV nurse specialists were more successful at IV insertion than non-IV nurse specialists (83% and 50%, respectively). These studies, both adult and pediatric, all support the use of IV nurse specialists/teams.

It is often taken for granted that nurses with greater experience have greater success (Brown, 1984). When a patient presents as a difficult candidate for access, the more experienced staff are usually the resources used. Friedland and Brown (1992) reported the success rate of nurses with at least 5 years of experience to be 74%-86%. It could be hypothesized that IV nurse specialists often are more experienced with PIV insertions. Again, these studies placed their focus on IV nurse specialists/teams and the impact of such specialists/teams.

This study focused not on the need for IV nurse specialists/teams, but on the number of PIV attempts and the calculated success rates for this pediatric population. Thus, for the purpose of this study, the impact of IV nurse specialists/teams was not examined. However, in the absence of other data in the literature, the reported success rates were used as study comparisons, and the comparisons were later used to define acceptable practice standards at the study hospital.

**Methods**

This prospective study consisted of a non-randomized sample of 249 total IV placements. The PIV insertions included both initial placements and replacements. This specific Midwest Children’s Hospital has 72 medical/surgical patient beds. The clinical nurse specialist collected data...
on all PIV insertions in the medical/surgical area. The inpatient medical/surgical RN staff nurses and patients were used as study participants. The data were collected on three separate occasions over 20 months by self-report. All staff was educated and asked to complete an audit tool after each IV attempt or successful placement. The researcher, a clinical nurse specialist, provided education of the data collection tool during staff meetings, change of shift report, Medical/Surgical staff newsletter, and one-to-one teaching. Staffing numbers and patient census during the study periods remained consistent. Additional data collected included number of PIV cannulations per day, number of attempts to successfully achieve access, and time the insertions occurred.

The practice at this hospital was for the RN directly providing patient care to be responsible for IV cannulation. In accordance with manufacturer recommendations as well as infection control guidelines, only one needle is used per IV stick. Prior to cannulation, the skin is prepped with one alcohol wipe. DuraPrep® may be used for children greater than 1 year of age if desired by the individual placing the IV. After cannulation, a t-extension is attached to the catheter hub and approximately 3 cc preservative free normal saline is flushed to determine patency. Once in place and patent, the IV is secured in place with a 2 x 3 inch occlusive dressing and additional tape as needed. The acceptable practice standard did not include routine IV site changes or dressing changes. At the time of this study, there were no IV nurse specialists/teams in place.

During staff orientation, approximately 2-4 hours are devoted to IV cannulation. This orientation time allows a review of anatomy and physiology, pediatric equipment, pediatric specific interventions, and policy and procedure. Practice time with a manikin arm and scalp is also provided. During RN orientation, the orientee is expected to view, assist, and attempt IV insertions at the discretion of his or her preceptor. Additionally, RN orientation is a time in which the orientee and the preceptor can seek out and select appropriate opportunities and progress at an individualized rate. For example, during orientation the RN is given the opportunity to spend a day in surgery with an anesthesiologist performing PIV starts. The orientee is expected to first observe and assist other staff performing IV insertions and then progress to self performance of IV insertion at the discretion of his/her preceptor. Prior to completion of orientation, the new RN will be competent at performing PIV insertion on patients across the pediatric spectrum to include various ages and developmental levels. Validation of competency occurs when the orientee has reviewed and verbalized understanding of any corresponding policies and procedures, and possesses the knowledge and ability to perform IV cannulations in a safe and acceptable manner including the components of accountability and professionalism.

Measure

The primary data collected for this study included the number of PIV cannulations per day, the number of attempts required to successfully obtain peripheral IV access, and the time of day that the insertions occur. Supplemental data collected included the patient diagnosis, patient age, identification of the individuals placing PIVs, and the amount of time required for successful IV insertion.

The data collection occurred on three different occasions over 20 months. The first was July 1999, followed by October 1999, and finally March 2001. The data collection tool consisted of patient name, date of birth, age, gender, diagnosis, admission date, and patient’s admission unit. The tool also included the date and time of IV insertion, duration of prior IV if applicable, amount of time spent to achieve IV access (assessing for access as well as procedural time for successful placement), total number of attempts, who attempted, catheter size, infusate, and any comments (see Figure 1).

**July 1999.** July 1999 was the initial data collection period. The data was collected over 11 days and included 41 total PIV placements. Of the 41 PIV insertions, 46% were initial IV starts and 54% were restarts. The average number of PIV insertions per day was 3.73. The medical/surgical RN staff were responsible for successfully placing 37 (90%) of the 41 insertions, all of which were obtained within one and four attempts. The remaining four (10%) were placed after using RN resources from other areas of the hospital (PICU RN and NICU RN obtained two insertions each) (see Figure 2). The average number of attempts per patient was 2.78. Forty seven percent (47%) of the IV insertion were successful on the initial attempt, 62% within two attempts, 90% within four attempts, and 98% within six attempts (1 patient required seven attempts). Prior IV duration ranged from 90 minutes to 7 days. At the time of this data collection, the tool did not specify time of day in which the IV was placed, catheter size, time required for placement, staff participation, and staff level of experience. Patient ages ranged from 4 days to 12 years with a mode age of 4 years.

**October 1999.** Prior to the next data collection period, this hospital changed PIV catheters to a safety PIV cannula. Data were again collected. It is recognized here, the difficulty of comparison to previous data because
of this change. Data collection was over 30 days in October 1999 to include 64 total PIV insertions. The percentage of initial PIV insertions and replacement IV insertions were 47% and 53%, respectively. On average, 2.13 PIVs were inserted per day. All but one patient had access achieved in five attempts (one patient required eight attempts). Of the 64 total insertions, medical/surgical RN staff placed 51 (80%), PICU 8 (13%), NICU 4 (6%), and NNP 1 (1%) (see Figure 3). The average number of attempts per patient was calculated at 2.109. Fifty-five percent of the PIV insertions were made on the first attempt, 69% within two attempts, and 93% within four. The time of day in which PIVs were placed was examined and defined as either day shift (7a-7p) or night shift (7p-7a). This revealed 57.8% of peripheral IV insertions occurred during the day shift and 42.18% during night shift. The peripheral IVs were placed using a 22-gauge (40.29%) or 24-gauge (59.71%) insyte catheter. The duration of cannulation was 20 minutes to 7 days. The amount of time spent to identify access site and achieve successful placement was 22 minutes, ranging from 2 to 60 minutes. The patient ages during this collection period were 4 weeks to 20 years with 3 years occurring most frequently.

The data were examined in further detail than the previous data. Eighty-seven percent or 47 medical/surgical RN staff participated. Seven did not have an opportunity during this study period to attempt PIV access. The years of experience were an additional measurement with this data collection group. The average length of experience was 65 months or 5.416 years, with a range from 1 week- 23.25 years.

March 2001. Last, a 28-day audit of all PIV insertions was performed in March 2001. The total number of PIV insertions totaled 144. Sixty percent were initial insertions, and 40% of the IV insertions were restarts. There was a calculated average of 5.14 IV insertions per day. The number of attempts required for successful insertion was collected. Thirteen patients required four to seven attempts to achieve successful PIV placement; after three unsuccessful medical/surgical RN staff attempts, one patient required multiple attempts by both a pediatric surgeon and a pediatric intensivist. Medical/surgical RN staff was able to obtain PIV access in 124 (86%) of their patients during this study period. The NICU RN staff was used for 11 (7%) IV insertions, the PICU for 6(4%), and the remaining 3 (3%) patients by an anesthesiologist, a surgeon, and an intensivist (see Figure 4). This revealed an average of 2.16 attempts/patient. The insertion data was divided into successful placement with one attempt, 57%; two attempts, 70%; and four attempts, 90 % (130/144). The time of day was divided fairly equally between day shift (7am-7pm) and night shift (7 pm-7 am) 46% and 54%, respectively. During this study period, peripheral access was achieved using 18-24 gauge safety needles (18 gauge, 0.8%; 20 gauge, 1.4%; 22 gauge, 24.8%; and 24 gauge, 73%). This study again examined the duration of the previous IV as well as the amount of time to successful placement. Prior IVs lasted a duration of only minutes to 6 days. The average time to successful placement was 23.69 minutes (range 3-180 minutes). The age ranges of patients were from 3 days to 18 years, and the most frequently occurring ages were 5 months and 2 years.

Of the medical/surgical RN staff, 84% participated. There was 12 medical/surgical RN staff that did not perform or attempt an IV start during this study period. Staff experience was again collected. Experience ranged from 1 month to 24.9 years, with a mean month of service of 62.95 months (5.25 years). The median month of service was 34 (2.83 years). The mode of experience was 14, 26, and 34 months.
Discussion

The total number of cumulative peripheral IV starts during the three study periods was 249. The calculated average number of PIV insertions per day was 3.67. The average number of attempts to successfully obtain PIV insertion was 2.35. Cumulatively, 53% of all medical/surgical PIV insertions are successful on the first attempt at cannulation, 67% within two attempts and 91% within four attempts (see Figure 5). PIV insertions were distributed equally on day shift and night shift. The time at which the IV cannulations occurred averaged 51.9% during day shift and 48.9% during night shift. The patient ages during the study ranged from 3 days to 20 years. Medical/surgical RN staff experience remained stable during all three study periods at roughly 5 years.

Again, the literature does not report a national standard for pediatric PIV success. Additional studies should be performed and data gathered to assist the individuals performing pediatric PIV cannulation to develop a standard to strive for and measure oneself against. This study could serve as a template for further studies to document an acceptable practice standard for PIV placement success.

Without an established standard, this study data was extrapolated and used as a guide for revision of the previously existing standard at the study hospital. Furthermore, an acceptable practice standard was defined. This Children’s hospital supports the medical/surgical RN staff as the selected individuals to obtain PIV access for the patients they care for. The defined standard is for medical/surgical RN staff to achieve PIV access within four attempts at cannulation. If the four attempts at PIV placement are exhausted, the attending physician is notified and he or she determines the necessity of further interventions and by whom.

Because of the strong support in the literature for IV nurse specialists/teams, these data were examined to evaluate the need/feasibility and the potential impact both financially and clinically of such a position. At this hospital, it was determined that no benefit would be provided. It might be inferred that the benefit of such IV specialists/teams would depend upon hospital practice standards, hospital size, patient population, number of PIV cannulations, number of employees, and years of employee experience. This study found the success rates of the medical/surgical RN staff is comparable with that found in the literature including the rates reported for IV nurse specialists/teams. The number of attempts and the success rates need to be monitored on a routine basis.

Conclusion

Despite study limitations (e.g., the use of self-report, the hospital’s change from a PIV catheter to a safety PIV cannula), this study provides a foundation for pediatric PIV insertion standards. The basis of this practice standard is supported by the literature as well as what was found in this study. It may be hypothesized that increased IV success could correlate with increased satisfaction. Further correlation between experience and cannulation success as well as patient satisfaction and cannulation success is warranted.

References