Investigation of Time to Line Placement and Treatment Initiation in Pediatric Oncology patients Utilizing a Pediatric Vascular Access Team

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Abstract

Background: Once diagnosis of malignancy is made in pediatric patients, it can be important to initiate therapy to prevent delay in benefits derived from treatment. These patients require provision of central vascular access to begin treatment. The aim of this study was to compare vascular access provision by a designated PVAT with surgical placement of central venous access in pediatric oncology patients. Methods: This was an IRB-approved retrospective medical record review of subjects diagnosed with an oncologic malignancy with inclusion criteria: ages 0-21 years of age, treatment for pediatric malignancy at the University of Maryland Children's Hospital between 1/1/2017-12/31/2019. Results: We identified 69 patients who met the inclusion criteria with 39% (n=27) having undergone line placement by PVAT. The mean time from consult to line placement was 10 hours (SD = 9) in the PVAT group vs 76 hours (SD = 56) in the surgery group ($p < 0.0001$). There was a statistically significant difference in length of procedure, with PVAT placement requiring less time (27 +/- 12 minutes) vs surgical placement (48 +/- 19 minutes), p=0.0005. Conclusion: At our institution, having a PVAT in house has allowed for more efficient line placements, decreased length of time to provision of access and transition to placement of surgical lines when more stable. This allows for not only patients to receive care faster, but also to have lines placed in shorter times while optimizing patient safety.

Introduction:

Once a diagnosis of malignancy is made in pediatric patients, it can be important to initiate therapy as soon as possible to maximize benefits of therapy and minimize adverse outcomes. Depending on the diagnosis, adverse outcomes associated with a delay in therapy can include complications from hyperleukocytosis, mass effect from solid tumors, and progression of malignancy. Importantly, initiation of therapy often requires central vascular access. However, despite the lifesaving nature of vascular access in pediatric cancer patients, success rates for achieving it have not improved over time[1].

Obtaining Central vascular access comes with complications and risks. More than 15% of patients who receive a central line will develop a bloodstream infection, which has been attributed to 90,000 deaths and $5 billion in national healthcare costs[2]. Moreover, pediatric patients with cancer have a 40-fold and 10-fold increase in central line-associated blood stream infections and vascular occlusions, respectively[3]. Improving central line placement and maintenance, thereby reducing associated infections, is imperative.

In children's hospitals, patients often have central venous catheters placed in the operating room under general anesthesia by pediatric surgery or interventional radiology. In addition to the risks of general anesthesia, logistical hurdles include scheduling an operating room, accommodating the availability of pediatric surgeons/interventionalists, and coordinating anesthesia consent and examination prior to the procedure.

A 2019 study found insertion of a peripherally inserted central catheter (PICC) in the operating room, as opposed to at the bedside, to be an independent predictor of central-line associated bloodstream infections (CLABSIs) in younger children[4]. Transitioning PICC insertions from the operating room to the bedside represents a worthwhile target for improving central line outcomes.

Performing central vascular access placement at the bedside also presents challenges. A higher number of attempts for intravascular access leads to increased stress, anxiety, pain, bruising and infections[5].When hospitals cannot keep pace with the demand for IV access due to failed initial attempts, patients end up on an emergency list for access, which often leads to delayed treatment start times, prolonged periods without food or drink, and complications of bleeding, pneumothorax, line malposition, venous occlusion, and death. Provision of central venous access should, ideally, be performed during daytime hours by experienced staff due to the critical nature of the procedure. However, this standard becomes difficult to uphold when vascular access provision is limited to an emergency or out-of-hours service[5].

Despite studies showing PICC insertions by a vascular access team (VAT) to be safe and effective, there has yet to be a direct comparison in the literature of surgically placed vascular access with vascular access by a PVAT in pediatric oncology patients. The aim of this study is to compare vascular access provision by a designated pediatric VAT (PVAT) with pediatric surgical placement of central venous access in pediatric oncology patients. The investigation compares time to placement of vascular access and initiation of therapy by both methods and analyzes associated outcomes and complications.

Methods:

This was an IRB-approved retrospective medical record review of subjects diagnosed with an oncologic malignancy with inclusion criteria: ages 0-21 years of age, treatment for pediatric malignancy at the University of Maryland Children's Hospital between 1/1/2017-12/31/2019. Complications examined included infection, bleeding, pain, pneumothorax, replacement of line and other non-specific side effects. New oncology diagnoses included soft tissue tumors, leukemias, lymphomas, hemophagocytic lymphohistiocytosis, relapsed malignancies, neuroendocrine tumors, and bony malignancies. We performed bivariate analyses comparing variables between patients who had line placement by PVAT compared to surgical placement. Analyses were performed using SAS 9.4.

Results:

We identified 69 patients who met the inclusion criteria with 39% (n=27) having undergone line placement by PVAT. Surgical placement occurred for 55% (n =38), with interventional radiology (IR) or other placement making up the remainder 6% of patients (n=4). The mean age was noted to be younger in the surgical group (8.6 +/- 6 years) in comparison to the VAT group (13 +/- 6.3 years), $p = 0.0061$. There were no significant differences noted when patients were stratified based on race or sex assigned at birth.

The mean time from consult to line placement was 10 hours (SD = 9) in the PVAT group versus 76 hours (SD = 56) in the surgery group ($p < 0.0001$). There was a statistically significant difference in length of time of the procedure, with PVAT placement requiring less time (27 +/- 12 minutes) versus surgical placement (48 +/- 19 minutes), p=0.0005. Also notable was the difference in type of lines placed between groups. While most lines placed by the PVAT group were noted to be PICC lines, surgical placement consisted of exclusively central venous lines (CVLs) ($p< 0.05$). As expected, 100% of surgical lines were placed in the OR, while only 54% of lines placed by PVAT were placed in the OR ($p<0.05$).

Compared to complications of surgical line placement, the complications experienced by our PVAT team were largely related to need for revision of line placement, although not frequent enough to be statistically significant. There was no significant difference between the mean number of attempts between the two groups. There were no significant differences in the time to start of treatment between the two groups.

Discussion:

Data show that having a PVAT for central line insertions demonstrates good safety profiles, successful

insertion, and low complication rates. PVATs can also avoid certain logistical hurdles. PVAT providers generally have more availability and flexibility than pediatric surgeons, allowing for greater ease of scheduling. Additionally, avoiding the operating room eliminates the need for general anesthesia and decreases total costs.

A PVAT dedicated to placing PICCs at the bedside can ameliorate many of the challenges associated with obtaining central vascular access in children and infants. Vascular access services at other hospitals have been shown to uphold patient safety and increase the number of successfully placed PICCs, thus reducing the need for patients to undergo additional sedation procedures and decreasing the length of their hospital stays[2]. A 2009 study found a nurse-inserted pediatric PICC program to have a high success rate; nurse-inserted PICCs could be inserted safely with minimal anesthesia and low post-insertion complication rates[6]. A 2010 study showed that when a VAT was introduced at the authors' institution, the number of out-of-hour, emergency central line insertions fell despite an overall increase in workload. This is particularly significant given that elective central line insertion takes much less time than emergent central line insertion. Thus, increased elective insertions not only decreases patients' stress and overall time in the hospital but also allows for more supervised teaching of junior staff[5]. More recently, a 2019 study similarly demonstrated that implementing a VAT led to a lower number of access attempts and an overall increase in IV success rate[2].

Based on our results, many pediatric oncology patients at our institution require line placement by PVAT or surgery and only a few required IR placement. This likely is generalizable to most pediatric hospitals. PVAT was able to provide access in shorter times compared to surgical placement, decreasing the coordination challenges that are associated with OR scheduling, consistent with prior studies. PVAT central line placement occurred faster than surgical placement. It is difficult to draw conclusions on the complications experienced in these patients given that most pediatric oncology patients require a central venous line for treatment, noting that PVAT line placement required the insertion of a second line whereas surgical placement did not.

At our institution, having a PVAT in-house has allowed for more efficient line placements, decreased length of time to provision of access and transition to placement of surgical lines when the patients were more stable. A PVAT allows for patients to receive more expedited care, but also to have lines placed in shorter times while optimizing patient safety. Going forward, this team should be considered an essential asset to every pediatric hospital and implemented wherever possible.

Conflict-of-interest statements

The authors have no conflicts of interest to disclose.

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Tables:

Table 1 Patient Demographics

N (%) or Mean (SD)	First line placed by Surgery N=38	First line placed by VAT N=27	p-value
Race Black White Asian Hispanic Other	**14 (37%) 15 (39%) 0 5 (13%) 4 (11%)**	**8 (30%) 10 (37%) 2 (7%) 5 (19%) 2 (7%)**	**0.4714**
Sex Male Female	24 (63%) 14 (37%)	20 (74%) 7 (26%)	0.3537
Mean (SD) Age, years	8.6 (6)	13 (6.3)	**0.0061**

Table 2 Time Differences Between Groups

N (%) or Mean (SD)	First line placed by Surgery N=38	First line placed by VAT N=27	p-value
Mean (SD) time from consult to line placement, hours	76 (57)	10 (9)	**<.0001**
Mean (SD) Length of Procedure time, minutes	48 (19)	27 (12)	**0.0005**
Time to start treatment Within 7 or fewer days Within 3 or fewer days Within 1 day or less	35 (95%) 29 (78%) 25 (68%)	20 (91%) 16 (73%) 12 (55%)	0.5861 0.6217 0.3172
Delay in treatment	1 (3%)	0 (0%)	0.3956

Table 3 Complications

N (%) or Mean (SD)	First line placed by Surgery N=38	First line placed by VAT N=27	p-value
Continuous: Mean (SD) number of attempts	1 (0)	1.2 (0.4)	**0.0113**
Type of 1st line placed PICC CVL ePIV PIV	0 (0%) 38 (100%) 0 (0%) 0 (0%)	26 (96%) 0 (0%) 1 (4%) 0 (0%)	**<0.0001**

N (%) or Mean (SD)	First line placed by Surgery N=38	First line placed by VAT N=27	p-value
Need a 2nd line Yes No	0 (0%) 38 (100%)	5 (19%) 22 (81%)	**0.0058**
Complications None Yes	36 (95%) 2 (5%)	21 (78%) 6 (22%)	**0.0402**

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