PERIPHERAL INTRAVENOUS CATHETER PROBLEMS IN INFANTS AND CHILDREN PRESENTING FOR ANESTHESIA AND SURGERY

PAUL A. TRIP†, SUSAN THOMAS**, ANNA CLEBONE***, MARK M. GOLDFINGER*** AND JOSEPH D. TOBIAS****

Background: Anesthesia providers frequently rely upon in-situ peripheral intravenous catheters (IVs) during the perioperative care of pediatric patients. IV dysfunction can result in complications including inability to administer medications for resuscitation, extravasation of tissue-toxic medications, and incomplete induction of anesthesia. This study was performed to prospectively assess the frequency of IV dysfunction in children presenting for anesthesia care.

Methods: A survey of IV patency and integrity was completed in patients less than 18 years of age arriving at the preoperative holding area for anesthesia evaluation. Prior to the induction of anesthesia, an anesthesiologist examined the IV for patency and evidence of infiltration. Demographic information, catheter site and size, condition of skin, elapsed time since insertion, and hospital site of catheter insertion were recorded.

Results: Over a 14-month period, 108 IVs were evaluated in 106 patients. One or more problems were identified with 35% of the IVs. Problems included erythema or pain to palpation at insertion site (29%), difficulty with injection of saline (45%), pain on injection of saline (50%), infiltrate at insertion site (13%), no flow or poor flow to gravity (42%), and kinked catheter (11%). The frequency of IV dysfunction was higher in infants (50%), with 24 gauge catheters (59%), with lower extremity IVs (50%), and with IVs in place for more than 3 days (75%).

Conclusions: Approximately one-third of pre-existing IVs were dysfunctional in children presenting for anesthesia and surgery. Inspection for the integrity of the IV should occur prior to and during use, and a plan should be in place for readily replacing the IV in cases of dysfunction or for using an alternative route for the induction of anesthesia.

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Introduction

Anesthesiologists may rely upon a pre-existing peripheral intravenous catheter (IVs) in the perioperative period. Dysfunction of these catheters can result in complications including pain on injection, the inability to administer medications for resuscitation, incomplete induction of anesthesia, and extravasation of medications and fluids leading to tissue injury. Along with compromising patient safety, complications relating to IVs have an economic impact. In the United States, IV dysfunction which is not promptly rectified may be considered a hospital acquired condition and cause for Medicare nonpayment under future Department of Health and Human Services directives.

Pediatric patients may be particularly vulnerable to IV dysfunction due to the fragility of their vasculature, smaller veins, smaller size of the IV catheters, and increased subcutaneous tissue. Although there are no data on the frequency of IV-related dysfunction in infants and children in the perioperative setting, other clinical settings have been examined. In a large population of children receiving intravenous infusions, Brown et al. reported an 11% incidence of extravasation and a 0.25% incidence of significant skin and tissue damage with sloughing. In a pediatric intensive care unit (PICU), the frequency of phlebitis was 13% and extravasation was 28%. The incidence has been noted to be particularly high in younger patients especially neonates with an incidence of IV complications, including infiltrates, as high as 80%. Devastating complications have occurred, particularly in neonates, resulting in compartment syndrome, full thickness injury requiring skin grafting, and associated mortality. Numerous medications that may be administered in the perioperative setting are associated with extravasation morbidities, including vasoactive medications (epinephrine, vasopressin), hyperosmolar infusions (calcium chloride, sodium bicarbonate, total peripheral nutrition, mannitol), and medications containing propylene glycol (etomidate, diazepam). Additional studies have demonstrated that the frequency of IV complications is increased in infants and patients with long in-situ catheter times.

The current study prospectively evaluated the incidence of IV catheter dysfunction and occlusion in pediatric patients presenting for anesthesia and attempted to determine risk factors for such problems.

Methods

After institutional review board approval, a survey of IV patency and integrity was completed in patients less than 18 years of age arriving in the preoperative holding area for anesthesia evaluation prior to their surgical procedure. The inclusion criterion was that a patient had one or more IV catheters in place. Data collected included patient demographics, as well as IV function, site condition, and problems related to its use during anesthesia. Patient demographic information included age, weight, and gender. Description of the IV included catheter gauge, anatomic location of the insertion site, presence or absence of kinking, hospital site of catheter placement, and elapsed time since insertion. An anesthesiologist evaluated the IV function by examining the flow of an intravenous solution delivered by gravity and by flushing the IV with 0.1 mL/kg of normal saline (NS). Flow was recorded as good versus poor/absent. Injection was recorded as easy versus impossible/difficult, and the patient’s response to injection was recorded as pain/response versus no pain/no response. The skin was evaluated for presence or absence of erythema, edema, and pain to palpation. Finally, the anesthesiologist noted whether there were problems related to the use of the IV during anesthesia. The evaluation and flushing of the IV was performed by the anesthesiologist assigned to the case. All of the data was collected and recorded by a research associated not involved with the care of the patient. Data were analyzed and descriptive statistics generated using the program, Statistical Package for the Social Sciences (SPSS, Chicago, IL).

Results

The study cohort included 108 IVs that were evaluated in 106 patients over a 14-month period. The distribution of the patients’ ages, location of the catheters, size (gauge of the catheters, the hospital location where they were placed, and their duration of use are listed in Table 1. One or more problems were identified with 38 of the IVs (35% of total IVs). In
these 38 IVs, problems included erythema or pain to palpation at insertion site (11), difficulty with injection of NS (17), pain with injection of NS (19), infiltrate at insertion site (5), poor flow or no flow to gravity (16), and kinked catheter (4).

The frequency of IV dysfunction, which was considered to be present when one or more of the problems was identified, was evaluated against several variables. Findings included a frequency of dysfunction that was 50% (9/18) in infants, 59% (13/22) in 24 gauge catheters, 50% (5/10) in lower extremity IVs, and 75% (9/12) in IVs greater than three days old. The anesthesiologist used 68 of the 70 IVs scored as having no problems and 19 of the 38 IVs scored as dysfunctional. In the group in which the IV catheter was judged as dysfunctional, in some patients, the problems were able to be resolved by taking down the dressing, reapplying tape or flushing the IV catheter. No complications occurred with use in either group.

Discussion

Hospitalized children requiring surgery frequently present to the preoperative holding area with one or more IVs in place. Anesthesiologists often rely upon these IVs for the induction of anesthesia and the administration of fluids intraoperatively. In this study, approximately one-third of in-situ IVs were found to be dysfunctional, with evidence of inflammation at the insertion site, obstruction to flow, or both.

IV failure can lead to serious consequences. Incomplete induction of anesthesia in a patient with a “full-stomach” may lead to gastric insufflation, delays in tracheal intubation, and aspiration of gastric contents. Infiltration of the IV site can lead to tissue injury resulting from direct chemical effects of medications (e.g. vasoactive substances and concentrated electrolytes) or by increased local pressure. The extent of damage may be more severe in infants who have decreased peripheral circulation, lower mean arterial pressure, a small body mass, and may not be able to communicate discomfort effectively. Extravasation that occurs in the perioperative period may be undetected as the extremities are under surgical drapes and may have devastating consequences, including skin necrosis requiring surgical debridement and skin grafting. Finally, the inability to administer medications for resuscitation can result in critical delays in correcting hemodynamic instability and restoring perfusion to vital organs.

Despite these significant potential complications of a dysfunctional IV, placement of a new IV prior to the induction of anesthesia in an awake child can be difficult for a variety of reasons. Children are afraid of needles and will not cooperate with insertion. Their lack of cooperation may disrupt the preoperative holding area environment, causing anxiety in other children waiting for surgery. Insertion of the IV may be technically difficult, especially in infants or children with chronic illnesses with prolonged hospital stays. Repeated attempts may make the post-induction insertion of an IV more difficult due to elimination of many potential sites. Such factors often compel an anesthesiologist to utilize an in-situ IV unless it is entirely non-functional. In our study, 50% of the IVs scored as dysfunctional were utilized by the anesthesiologist without complication, but only after

<table>
<thead>
<tr>
<th>Variable</th>
<th>Frequency (total cohort = 108)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient age (years)</td>
<td>Infants (0-1) 18 (9) Preschoolers (1-5) 31 (7) School age (5-12) 34 (13) Teenagers (more than 12) 25 (9)</td>
</tr>
<tr>
<td>Location of IV catheters</td>
<td>Hand 45 (17) Forearm 24 (7) Antecubital fossa 29 (9) Lower extremity 10 (5)</td>
</tr>
<tr>
<td>Catheter size</td>
<td>24 gauge 22 (13) 22 gauge 54 (13) 20 gauge 24 (10) Undetermined 8</td>
</tr>
<tr>
<td>Location placed</td>
<td>Inpatient ward 59 (22) ICU 4 (2) ED 20 (6) Outside hospital/other 25 (8)</td>
</tr>
<tr>
<td>Catheter age</td>
<td>Less than 1 day 64 (19) 1-2 days 20 (6) 2-3 days 12 (4) More than 3 days 12 (9)</td>
</tr>
</tbody>
</table>

The total number of IVs is listed followed by the number that were judged as dysfunctional in parenthesis.

ED = emergency department; ICU = intensive care unit

Table 1

Patient demographics and catheter information

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correcting the obstruction to flow or ascertaining that fluid and medications were properly reaching the circulation. When necessary, a new IV was then placed after the induction of general anesthesia.

This study identified factors that were associated with a higher frequency of IV dysfunction in children presenting for anesthesia and surgery. The frequency of dysfunction was ≥ 50% in younger patients (less than 1 year of age), with smaller catheters (24 gauge), when the IV was in the lower extremity, and when the IV was in place for more than 3 days. The potential for a high incidence of a dysfunctional IV in younger children and infants is particularly worrisome as this population may be challenging when it comes to vascular access.

Anesthesiologists should be aware that pre-existing IVs in hospitalized children presenting for surgery are frequently dysfunctional. As noted in our study, it may be feasible to resolve problems of a dysfunctional IV catheter with simple maneuvers such as removing the dressing, eliminating a kink in the IV catheter or simply administering a normal saline flush. However, if such maneuvers fail, the IV catheter should not be used for anesthetic care. The frequency of dysfunction may be particularly high in infants, who are also more susceptible to injury with infiltration and extravasation of medications. The correct functioning of the IV should be established prior to its use. Inadequate free flowing of the IV or problems with flushing the IV with saline may be addressed and the IV used for anesthetic care once function has been restored. However, dysfunctional IVs should be used with caution or not at all and the site monitored throughout the case.

References

2. NIEZGODA J: An ounce of prevention is worth a pound of cure... as well as a pound of cash. Anesth Analg; 2012, 115:743-4.
BRIDION—for **optimal neuromuscular blockade management** and improved recovery

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- 97% of BRIDION patients recovered to a TOF\(^+\) ratio of 0.9 from 1 to 2 PTCs\(^1\) within 5 minutes\(^3\)

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- BRIDION rapidly reversed patients from reappearance of T\(_2\)\(^+\) in 1.4 minutes\(^2\)
- BRIDION rapidly reversed patients from 1 to 2 PTCs\(^1\) in 2.7 minutes\(^3\)

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BRIDION has not been investigated in patients receiving rocuronium or vecuronium in the Intensive Care Unit (ICU) setting. If neuromuscular blockade is required within 24 hours of BRIDION administration, a nonstriatal neuromuscular blocking agent should be used instead of rocuronium or vecuronium. The most commonly reported adverse reactions were dysgeusia (metal or bitter taste) and anesthetic complications (movement, coughing, grimacing, or sucking on the endotracheal tube). In patients treated with BRIDION, a few cases of awareness were reported. The relation to BRIDION was uncertain. In a few individuals, allergic-like reactions (i.e., flushing, erythematous rash) following BRIDION were reported. Clinicians should be prepared for the possibility of allergic reactions and take the necessary precautions. In a trial of patients with a history of pulmonary complications, bronchospasm was reported in 2 patients and a causal relationship could not be fully excluded.

Volunteer studies have demonstrated a slight (12%-22%) and transient (<30 minutes) prolongation of the prothrombin time/activated partial thromboplastin time (PT/aPTT) with BRIDION; however, clinical studies have demonstrated no clinically relevant effect on peri- or postoperative bleeding complications with BRIDION alone or in combination with anticoagulants. As BRIDION has demonstrated an in vitro pharmacodynamic interaction with anticoagulants, caution should be exercised in patients on anticoagulation for a pre-existing or concomitant condition. This pharmacodynamic interaction is not clinically relevant for patients receiving routine postoperative prophylactic anticoagulation. Although formal interaction studies have not been conducted, no drug interactions were observed in clinical trials. Preclinical data suggest that clinically significant drug interactions are unlikely with the possible exceptions of toremifene, fusidic acid, and hormonal contraceptives.

\(^{1}\) Train-of-four
\(^{2}\) Post tetanic count
\(^{3}\) Second twitch

**REFERENCES**

1. BRIDION Summary of Product Characteristics (SPC).

Please see summary of product characteristics for full prescribing information.
**TAP Block And InfiltraLong**
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**Sono Cannulas**
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**SonoSystem And SonoLong Curl**
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