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Intravenous Infiltration Risk by Catheter Dwell Time Among Hospitalized Children

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Purpose This study was aimed to examine the cumulative risk for infiltration over IV catheter dwell time by general or catheterization-specific characteristics of pediatric patients with IV therapy.
Design and methods: This secondary data analysis was done with the data of 1596 children who received peripheral IV therapy at least once during their hospital stay between August 1st and October 30th, 2011 and in June, 2013 in an academic medical center, Yangsan, Republic of Korea. The survival functions of infiltration were determined by using the Kaplan–Meier analysis.
Result: The cumulative risk for infiltration had rapidly increased from 1.5% after 24 hours of catheter dwell time to 17.3% after 96 hours. The survival functions were significantly different in the medical than in the surgical department ($p = .005$), lower extremities than upper ones ($p = .001$), and use of 10% dextrose ($p = .001$), ampicillin/sulbactam ($p < .001$), vancomycin ($p = .024$), high-concentration electrolytes ($p = .001$), and phenytoin ($p < .001$).
Conclusion: When catheter dwell times are similar, the cumulative risk for infiltration was higher in cases wherein the patient had a risk factor. The cumulative risk for infiltration has rapidly increased after 24 hours in patients who have 10% dextrose, high-concentration electrolytes, and phenytoin.
Practice implications: The results suggest that nurses are required to assess the IV site every hour after 24 hours of catheter dwell time for the infusion of irritants for a safer practice of IV therapy. However, this monitoring time may be modified by the age of child, previous IV complications, and/or hemodynamic issues which may impact IV integrity.

Intravenous (IV) catheter insertion is one of the most common and important nursing practices performed for patients admitted to the hospital. It is estimated that 60–90% of hospitalized patients have used IV catheters and about 300 million IV catheters are yearly consumed in the United States (Hadaway, 2010; Helm, Klausner, Klemperer, Flint, & Huang, 2015). Various complications may result from IV catheterization.

Infiltration, one of the most common complications, may cause discomfort, pain, reinsertion of the IV catheter (Fang, Fang, & Chung, 2011; Kim, Lee, & Kim, 2012), or more serious negative consequences, such as tissue ulceration or necrosis, which may require a surgical intervention (Park

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et al., 2015; Talbot & Rogers, 2011). Such complications have not only increased the length of hospital stay and care costs for additional treatments (Woody & Davis, 2013), but also resulted in permanent damage and limitations of physical functions in pediatric patients (Park et al., 2015).

Considering such negative consequences of infiltration, the healthcare providers need to know the various measures that help to prevent or promptly recognize infiltration in order to reduce the risk of the complications (Doellman et al., 2009; Hadaway, 2007). Well-known strategies include appropriate site selection, use of the smallest-gauge catheter, stabilization and security of an IV needle, confirmation of blood return, and assessment of the IV site (Infusion Nurses Society, 2011; Sauerland, Engelking, Wickham, & Corbi, 2006).

According to clinical guidelines, an IV site requires frequent assessment for redness, tenderness, swelling, numbness, or tingling on the regular basis. It is recommended that care providers assess the IV site at least every hour for neonates and pediatric patients on continuous infusion and every 5 to 10 minutes for those who receive infusions of vesicants or vasoconstrictive agents (Gorski et al., 2012). For intermittent infusion of nonirritant or non-vesicants, every six hour assessment is recommended for children (The Royal Children's Hospital Melbourne, 2014). In particular, if there is tenderness in the IV site, the care provider needs to replace the dressing with a transparent dressing to be able to assess the site clearly.

In our research setting, nurses assess the IV site every hour with a structured IV site assessment checklist in the neonatal intensive care unit (NICU); however, it is not as feasible to assess IV sites every hour in the general ward because nurses typically care for more number of patients than NICU. In order to deal with this limitation, nurses advocate for central venous access administration of vesicants or vesicant potential of non-antineoplastic agents (Gorski et al., 2012). In practice, nurses assess the IV site at least per every shift. In addition to that, they instruct the patient and his/her caregiver about the infiltration risk by providing educational materials and encourage them to notify nurses if the patient shows any infiltration sign or symptoms such as pain, burning or change in sensation at the IV site, or fluid leaking on the skin by frequently observing the site of IV insertion (Park et al., 2016). In this context, nurses need empirical findings to figure out when infiltration is at high risk so that they can assess the status of the IV site efficiently even with an increased number of patients.

Therefore, the purpose of this study was to examine the cumulative risk for infiltration over IV catheter dwell time by general or catheterization-specific characteristics of pediatric patients with IV therapy.

Methods

Study Subjects

We conducted secondary data analysis on the data retrieved from a database developed by Park (2014) for his research project whose purpose was to identify risk factors for infiltration and to build a prediction model of infiltration risk in pediatric patients who were admitted to a children's hospital in an academic medical center in Yangsan city, South Korea. The database contains data from the pediatric patients admitted to one of the three units (i.e., hemato-oncology, internal medicine, and surgery units). The data were collected and inputted into the database for the following periods of time: 1) from August 1 to October 30, 2011 for risk model construction, and 2) from June 1 to June 30, 2013 for the model validation. The total number of subjects was 1598.

The data collection in the parent study was done through a retrospective chart review by one investigator during two phases; the 1st phase was to collect data for identifying risk factors of infiltration and build an infiltration risk prediction model, and the 2nd phase was directed to collect data for testing the validity of the risk prediction model. This parent study was approved by the institutional review board of the hospital. In this study, subjects were pediatric patients with complete records of IV catheter insertion and removal and their data were available for analysis. Data were de-identified. The study protocol was reviewed and approved by the Institutional Review Board of Pusan National University for this study.

Variables of Interest

Our data set includes the following variables: gender, age, height, weight, type of clinical department, peripheral catheter dwell time, catheter gauge, IV insertion site, the name of the fluid continuously administered, types of IV medications, and occurrence of infiltration. The fluids continuously administered were 5% dextrose, 10% dextrose, 1:4 dextrose solution, normal saline, total parenteral nutrition, amino acids, and lipids. Intravenous medications were antibiotics, antiviral agents, 15% mannitol, blood vessel modulating agents, high-concentration electrolytes, anticancer drugs, anticonvulsant reagents, antitussive compounds, steroids, etc. High-concentration electrolytes included calcium gluconate, sodium bicarbonate, potassium chloride, and magnesium sulfate. Steroids include dexamethasone, hydrocortisone, and methylprednisolon.

These data elements were categorized into three groups: 1) general characteristics, 2) catheterization-specific characteristics, and 3) catheter dwell time and occurrence of infiltration. General characteristics included gender, age, and clinical department. Catheterization-specific characteristics were catheter gauge, insertion site, and types of fluid or IV medications administered (e.g., 10% dextrose, ampicillin/sulbactam combinations, vancomycin, high-concentration electrolytes, steroids, and pheytoin). Catheter dwell time was defined as the time period between the insertion and the removal of the catheter for any reason, e.g., occurrence of infiltration, discharge, or completion of treatment.