Efficacy in the Reduction of Central Line-Associated Bloodstream Infection in a Patient With Intestinal Failure: An Ethanol Lock Pediatric Case Study

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Abstract

Intestinal failure and the subsequent reliance on parentral nutrition through central venous catheters increases the likelihood of a central line-associated bloodstream infection. Antimicrobial lock solutions such as ethanol lock therapy are providing promising evidence of the ability to reduce central line-associated bloodstream infection. This case study reviews the use of ethanol lock therapy for a pediatric patient who experienced 0 central line-associated bloodstream infections during the 2-year time period covered by this report.

Keywords: *ethanol lock therapy, intestinal failure, central line-associated bloodstream infection*

Intestinal failure (IF) is defined as a dependence on parenteral nutrition >90 days and encompasses clinical manifestations wherein the "absorptive capacity of the intestine is inadequate to meet nutrition, hydration, electrolyte, and (in pediatrics) growth requirements of the patient."[1] IF is divided into 3 categories: traditional short bowel syndrome, malabsorption, and motility disorders.[1]

The medical management of IF in patients is complex and requires focused medical care on parenteral nutrition. The goal of nutrition is to allow for homeostasis, appropriate growth and development, and the minimization of liver damage.[1] Parenteral nutrition provides calories, nutrients, vitamins, and electrolytes administered through a central venous catheter (CVC).

A complication for patients with IF requiring parenteral nutrition through a CVC is central line-associated bloodstream infection (CLABSI). It is estimated that there are 250,000-500,000 cases of bloodstream infections annually in hospitals throughout the United States.[1-3] With each infection is a 12%-35% attributable mortality and an estimated cost of $55,000 per episode.[3-5] Patients who are dependent on parenteral nutrition are at high risk for developing CLABSI.[1,4,6] The catheter provides a prime pathway for exposure to infection. As a result of the vulnerability, prudent care and maintenance of CVCs must be provided; however, despite the best care of CVCs, infections still occur.

Understanding the goal of minimizing and eliminating the risk of infection, attention has been placed on the outcomes of patients receiving prophylactic antimicrobial lock solutions. The Centers for Disease Control and Prevention state, "Use prophylactic antimicrobial lock solution in patients with long term catheters who have a history of multiple catheter related blood stream infections despite optimal maximal adherence to aseptic technique."[2] This is a category II recommendation, meaning that it is "suggested for implementation and supported by suggestive clinical or epidemiologic studies or a theoretical rationale."[2]

An antimicrobial solution demonstrating promising outcomes for patients with IF requiring parenteral nutrition is the use of ethanol lock therapy. Clinical research studies demonstrate a reduction in CLABSI and line removal in

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patients receiving ethanol lock therapy.[3,4,6-11] Ethanol lock therapy is the instillation of medical-grade ethanol into a CVC that remains in the catheter to dwell for a prescribed time period.

Ethanol lock therapy has been more commonly administered into silicone catheters despite a lack of profound evidence or specific labeling by catheter manufacturers. In a catheter integrity study of polyurethane and silicone[5] the effects of 70% ethanol had negligible effects not likely to have clinical relevance. Researchers and manufacturers are interested in catheter integrity with exposure to ethanol lock therapy and more data are needed to identify safety and efficacy in all catheter types.

Ethanol denatures microorganisms, including fungi, and, unlike antibiotics, is not dependent on sensitivity.[12] A review of studies on ethanol lock therapy in pediatric patients[4] demonstrated a 73% reduction in CLABSI and a 77% reduction in catheter removal due to infection. The variation of ethanol concentration and dwell time varies in the literature; however, 70% ethanol for a dwell time of 2-4 hours is most commonly used.[4,5]

Case Report

At age 9 months, our patient became the sixth special needs child adopted into his family. He had trouble with feeds before adoption and with time it became apparent this was progressive. October 13, 2011, the decision was made to begin parentral nutrition and he received his first central line, a peripherally inserted central catheter (PICC). Following extensive bowel studies at various specialized institutions, it was determined that parenteral nutrition may be the means of nutrition for his lifetime.

Health History

Upon arrival at our hospital for admission, the patient was under the care of his adoptive family and presented with symptoms of fever, cough, and difficulty breathing. Apart from his respiratory issues, he was also extremely hypotonic. After extensive medical testing, he was ultimately diagnosed with merosin-deficient congenital muscular dystrophy, a rare form of muscular dystrophy.

The patient had a gastrostomy tube placed for nutrition. He had difficulty with feeds and with gastroesophageal reflux despite adequate medical treatment. A Nissen fundoplication (a surgical procedure to treat reflux where the stomach is wrapped around the esophagus) was then performed, which resulted in decreased emesis. He continued to have severe retching, so the gastrostomy tube was converted to a gastrojejunostomy tube. Despite these interventions, he continued to have retching, abdominal distension, and jejunal feeds draining from the gastrostomy port, suggesting retrograde intestinal propulsion. He had multiple hospital stays where he would receive total or partial parenteral nutrition. It became apparent that he could no longer tolerate any enteral nutrition because of severe gastroparesis.

The patient had multiple admissions, and each time the pediatric vascular access team was required to secure a peripheral intravenous (PIV) catheter. Multiple issues with his PIV catheter included numerous infiltrations and phlebitis. Ultrasound was often needed to gain PIV access. His PIV catheter insertion, care, and maintenance was complicated by severe hypotonia and diaphoresis.

Parenteral Nutrition

On October 13, 2011, after months of failed feeding trials and weight loss, it was determined that the patient would temporarily receive total parenteral nutrition. A PICC was inserted by the pediatric vascular access team.

Recognizing that parenteral nutrition was going to be needed long-term, on November 14, 2011, a Broviac (silicone, tunneled, cuffed central venous catheter; Bard Access, Salt Lake City, UT) was placed in the central right chest. The surgeon performing the placement procedure mentioned that the insertion was difficult and future central venous access would be challenging.

CLABSI

On December 4, 2011, the patient presented to the hospital with lethargy, body temperature 100.5°F, and white blood cell count of 8,000. The patient was admitted pending the result of peripheral and central catheter blood cultures. Cultures from the Broviac and the peripheral veins were positive for *Candida albicans*. The Broviac, which had been in place <1 month, was removed. He was in critical condition and admitted to the intensive care unit. During his stay in the intensive care unit, he had multiple PIV catheters inserted, physician-inserted CVCs (including a femoral catheter), and multiple attempts for PICC placement. His venous access continued to be a challenge. As he began to recover, a PICC was placed by the pediatric vascular access team. A month after admission, he was discharged home with parenteral nutrition once again infusing through the PICC.

On January 27, 2012, he presented with contact dermatitis at the PICC site. This condition made keeping a dressing on the PICC site difficult, along with site tenderness. Concerning to the team was the unknown cause for the irritation to the skin. There are many possible culprits, including the dressing, skin antiseptic solution (chlorhexidine gluconate alcohol solution), skin prep, and the PICC securement device. His skin integrity was so compromised that the clinical team agreed to remove the PICC. The team members agreed that another Broviac would be the best option.

Ethanol Lock Therapy

On February 7, 2012, a second Broviac was placed in central left chest (Figure 1). With the placement of this Broviac, the vascular access nurse, infectious disease physician, and the pediatric hospitalist researched and agreed upon an ethanol lock therapy that would aid in the prevention of line infections. After extensive literature review, on February 17, 2012, ethanol lock therapy was started. This also required the writing and implementation of a hospital protocol and skills validation for antimicrobial lock therapy.

Protocol Development

Medical grade 70% ethanol (0.3 mL) is instilled in the Broviac catheter 3 times per week. The ethanol dwells in the catheter while the patient is off parenteral nutrition (4 hour dwell time) and is then withdrawn out of the catheter. The catheter