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**Is Chlorhexidine an Effective Antiseptic to Prevent CLABSI for
PICC Line Maintenance in the Neonatal Population?**

An Honors Thesis submitted in partial fulfillment of the requirements for Honors in Nursing

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ABSTRACT

Central venous catheters (CVCs) are inserted in order to administer fluids and medications. A peripherally inserted central catheter (PICC) is a type of CVC. While beneficial, central line associated bloodstream infection (CLABSI) is a risk for patients having a CVC inserted. Antiseptics are used for skin preparation when inserting a central line to prevent infection and during maintenance of the central line. Currently, the Center for Disease Control recommends the use of chlorhexidine for central venous catheter insertion in patients two months of age or older. Studies have found reduced CLABSI rates with the use of chlorhexidine for CVC insertion and maintenance in neonates. Research has also found chlorhexidine to have a more substantial and longer lasting effect than povidone- iodine as an antiseptic. However, studies have also noted concerns related to skin irritation and burns in low weight neonates with the use of chlorhexidine. Additional research is needed to determine the efficacy of chlorhexidine in preventing CLABSI infections in the neonatal population.

This study compared the CLABSI rate in a Northwest Arkansas neonatal intensive care unit (NICU) with the use of povidone-iodine versus chlorhexidine as the antiseptic for PICC line maintenance. The study examined all neonates in the NICU who had a PICC line. The data was analyzed using a descriptive statistics examining CLABSI with the use of povidone-iodine versus chlorhexidine as the antiseptic. One CLABSI occurred during the povidone-iodine protocol. No infection occurred during the chlorhexidine protocol. Because of the small infection rate during the timeframe of this study, it was concluded that both antiseptics were effective at preventing CLABSI in neonates with PICCs. This study was limited in scope and timeframe therefore more extensive research could be conducted to further examine if the new

chlorhexidine protocol is more effective at preventing CLABSI in the neonatal population with PICCs.

Is chlorhexidine an effective antiseptic to prevent CLABSI for PICC line maintenance in the neonatal population?

INTRODUCTION

Central venous catheters (CVCs) are inserted when necessary to administer medications and intravenous fluid. The insertion of a CVC while beneficial, places the patient at risk of complications of a central line associated bloodstream infection (CLABSI) (Curry, Honneycutt, Goins, & Gilliam, 2009). According to the National Healthcare Safety Network, CLABSI occurs at a rate of 3.1-6.4 per 1,000 CVC days in the neonatal intensive care unit (NICU) (Edwards, et al, 2007).

Antiseptics are used for skin preparation prior to CVC insertion and during maintenance to reduce the incidence of infection. Povidone-iodine is currently used for CVC skin preparation in neonatal patients. However, CLABSIs are still a major concern in the NICU. Chlorhexidine is a topical antiseptic solution that has clinically been shown to be a safe and effective antiseptic in adults and children for hand washing and preoperative skin preparation (Milstone, Passaretti & Peri, 2008). Currently, the CDC recommends the use of 0.5% chlorhexidine gluconate with alcohol for skin preparation before CVC and peripheral arterial catheter insertion and during dressing changes in adults and children older than two months of age. The Center for Disease Control (CDC) makes no recommendation for the use of chlorhexidine in infants under two months old (CDC, 2011). The efficacy of chlorhexidine in the reduction of CLABSIs in the neonatal population is in need of further research.

Although the CDC has not approved chlorhexidine for use in children less than 2 months of age, a national survey found that 61% of US NICUs are using chlorhexidine for CVC line insertion and maintenance. Fifty one percent of these NICUs restrict the use of chlorhexidine by birth weight, gestational age, or chronological age. Forty two percent restricted chlorhexidine use by gestational age of 28 weeks or less, 40% restricted by birth weight, 1000g or less, and 26% restricted by chronological age, of less than two weeks. The other 49% used chlorhexidine without restriction (Tamma, Aucott & Milstone, 2010).

Chlorhexidine has been shown to be an effective antiseptic in low birth weight infants. One time skin cleansing with 0.25% chlorhexidine reduced colonization by 62% compared to no cleansing (Sankar et al., 2009).

Research compared the efficacy of povidone-iodine and chlorhexidine. A study comparing the effectiveness of chlorhexidine to povidone iodine and sodium hypochlorite found all antiseptics were comparable for short procedures but found chlorhexidine to be the only antiseptic with a substantive effect, indicating that the antiseptic is effective against the introduction of new organisms over time. Chlorhexidine is recommended for longer procedures such as indwelling catheter insertion and surgery (Macias et al., 2013). However, in a pilot trial conducted in 2009 comparing the use of povidone-iodine (10%) to chlorhexidine gluconate (2%) for the insertion of CVC in neonates seven days of age or older and weighing over 1500 g, no statistically significant difference in infection rates between the two antiseptics was found (Garland et al., 2009). A study published in 2001 found the use of chlorhexidine-impregnated dressing and 70% alcohol scrub to be as effective as 10% povidone iodine in preventing CRBSI (catheter related bloodstream infection) and BSI (bloodstream infection) in neonates (Garland et al., 2001).

Chlorhexidine is not currently recommended for use in neonates less than 2 months of age due to concerns related to skin integrity. A study in a NICU found severe contact dermatitis in very low birth weight infants with the use of chlorhexidine gluconate impregnated patches. The trial continued excluding infants less than 800g or less than 7 days old and found only three reactions of the remaining 75 participants (Garland, Alex, Mueller & Cisler-Kahill, 1996). Garland and coworker's study (2001) found contact dermatitis only in neonates under 1000g with use of Chlorhexidine impregnated dressings. A more recent study comparing provodine-Iodine to chlorhexidine gluconate did not find any contact dermatitis with the use of chlorhexidine gluconate in neonates over 1500g. The study did result in a case of contact dermatitis with the use of povidone iodine (Garland et al., 2009). One time skin cleansing with 0.25% chlorhexidine did not cause adverse skin effect or induce hypothermia in neonates 1001-2000g (Sankar et al., 2009). In a national survey of NICUs, 17 of the participating NICUs reported burns from using chlorhexidine in which 13 of the cases were in neonates less than 1500g (Tamma, Aucott & Milstone, 2010).

Another concern related to the use of chlorhexidine in neonates is absorption of the antiseptic into the bloodstream. A study comparing provodine-iodine to chlorhexidine gluconate found that chlorhexidine gluconate was absorbed into the bloodstream of the neonates. However, no significant side effects were reported in the trial (Garland et al., 2009).

Studies have found implementation of central line bundles in the NICU, including the use of chlorhexidine as an antiseptic; have shown a statistically significant decrease in the number of CLABSI infections (Schulman et al., 2011; Miller et al., 2011). Bundles are evidence-based practices implemented as a group, at the same time, in a clinical setting (Butler-O'Hara, D'Angio, Hoey & Stevens, 2012). These bundles provide protocol for central line insertion and

site maintenance. A New York statewide implementation of a bundle including chlorhexidine resulted in a 67% CLABSI rate decrease statewide (Schulman et al., 2011). Another study implemented the use of chlorhexidine in all CVC catheter types in the NICU, which resulted in a decrease in CLABSI infection rates among all catheter types and birth weight neonates (Sannoh, Clones, Munoz, Montecalvo & Parvez, 2010).

A study completed by Arkansas Children's hospital examined the impact of the implementation of a CVC site bundle consisting of best practice measures to reduce CLABSI. The bundle included the use of chlorhexidine and alcohol as a skin antiseptic, and a chlorhexidine impregnated patch around the catheter insertion site. This study included infants greater than 2000g or who were greater than two weeks old. A substantial reduction in infection rates from 4.9 infections per 1000 catheter days in 2005 to 2.1 infections per 1000 catheter days in 2007 occurred despite an overall 40% increase in total line days (Curry, Honeycutt, Goins, & Gillam, 2009). A similar three year study of 29 pediatric intensive care units (PICUs) demonstrated a 56% decrease in the rate of CLABSI infections after bundle implementation (Miller et al., 2011).

Further research is needed to determine the efficacy of chlorhexidine as an antiseptic in neonates. Although concerns exist related to skin integrity, more recent studies have not resulted in skin integrity issues. Bloodstream absorption of chlorhexidine is also a concern, but negative side effects related to absorption have not been documented. Chlorhexidine has been shown to be an effective antiseptic in both adults and children and implementation of bundles including the use of chlorhexidine in the NICU have been successful in the reduction of CLABSIs.

AIMS

The aim of this study will be to compare CLABSI rates in a Northwest Arkansas NICU with use of povidone-iodine as an antiseptic to the rates of CLABSI following implementation of a standard protocol using chlorhexidine for PICC line site maintenance.

Variables. The independent variables are the antiseptics used to maintain PICC lines, povidone and chlorhexidine, and the dependent variable is the CLABSI rate.

METHODS

Design. A quasi-experimental study design using a pre- post design with two comparison treatments was used in this study. This study used a retrospective chart review to evaluate the variables.

Purposive sampling was used in this study. The sample included neonates receiving a PICC line placement during the determined study period. The first group in the study consisted of neonates admitted to the NICU between August-November 2012 who had a PICC line inserted for greater than 24 hours and received the povidone-iodine protocol. The second group consisted of neonates admitted to the NICU between August-November 2013 who had a PICC line inserted for greater than 24 hours who received the chlorhexidine protocol.

Procedure. Prior to data collection, approval was obtained from the University of Arkansas Institutional Review Board (IRB) and the Quality Improvement Department of study hospital. Data was then collected from comparable time periods before the new protocol was implemented and after implementation. Retroactive chart audits of all infants meeting the study criteria were reviewed for CLABSI. Additional data including gestational age, birth weight, age at time of PICC insertion, weight at time of PICC insertion, age at time of PICC removal, weight at time of PICC removal, and length of time PICC was in use was collected. All data was de-identified.

RESULTS

Table 1

PICC inserted in the NICU during the 2012 Povidone-Iodine Protocol

<u>Patient Number</u>	<u>Gestational Age</u>	<u>Birth weight</u>	<u>Age at PICC insertion</u>	<u>Weight at PICC insertion</u>	<u>Age at PICC removal</u>	<u>Weight at PICC removal</u>	<u>Duration of PICC</u>	<u>CLABSI</u>
1	28 4/7 weeks	1090g	9 days	1220g	30 days	1800g	21 days	Positive
2	27 weeks	1080g	7 days	950g	31 days	1481g	24 days	Negative
3	34 1/7 weeks	2195g	2 days	2105g	8 days	2085g	6 days	Negative
4	32 weeks	1210g	8 days	1197g	22 days	1610g	14 days	Negative
5	34 1/7 weeks	2204g	1 day	2215g	8 days	2080g	7 days	Negative
6	35 6/7 weeks	3090g	5 days	2900g	9 days	3150g	4 days	Negative
7	32 6/7 weeks	2226g	2 days	2063g	25 days	2788g	23 days	Negative

Table 2

PICC inserted in the NICU during the 2013 Chlorhexidine Protocol

<u>Patient Number</u>	<u>Gestational Age</u>	<u>Birth weight</u>	<u>Age at PICC insertion</u>	<u>Weight at PICC insertion</u>	<u>Age at PICC removal</u>	<u>Weight at PICC removal</u>	<u>Duration of PICC</u>	<u>CLABSI</u>
1	35 1/7 weeks	2537g	2 days	2565	7 days	2548 g	5 days	Negative
2	33 weeks	1840g	2 days	1690g	9 days	1810g	7 days	Negative
3	33 weeks	2015g	10 days	2000g	24 days	2561g	14 days	Negative
4	37 4/7 weeks	2460g	6 days	2490g	N/A	N/A	N/A	N/A
5	31 5/7 weeks	1735g	4 days	1648g	12 days	2079g	8 days	Negative
6	31 5/7 weeks	1570g	2 days	1518g	18 days	1739g	16 days	Negative
7	32 1/7 weeks	1625g	0 days	1625g	8 days	1613g	8 days	Negative
8	29 weeks	1245g	7 days	1170g	14 days	2178g	7 days	Negative
9	33 weeks	2010g	1 day	1940g	7 days	2045g	6 days	Negative
10	34 1/7 weeks	1510g	4 days	1438g	14 days	1668g	10 days	Negative
11	38 weeks	2983g	3 days	2880g	7 days	2835g	4 days	Negative

Data was analyzed using descriptive analysis. The data from the povidone-iodine protocol was compared to that under the chlorhexidine protocol regarding CLABSI rates, gestational age, birth weight, age at time of PICC insertion, weight at time of PICC insertion, age at time of PICC removal, weight at time of PICC removal, and length of time PICC was in use.

Under the povidone-iodine protocol between August and October 2012 seven PICC lines were inserted (Table 1). The gestational ages of the infants with PICC lines ranged from 27 to 35 6/7 weeks with an average gestational age of 32.07 weeks (Table 1). The birth weight of the infants ranged from 1080g to 3090g with an average of 1870g (Table 1). The age at time of insertion of the PICC line ranged from 1 to 9 days with an average of 4.85 days (Table 1). The infant weight at time of insertion of the PICC ranged from 950g to 2900g with an average of 1807.1g (Table 1). The age ranges on removal of the PICC was 8 to 31 days with an average time of 19 days (Table 1). The weight at time of PICC removal ranged from 1481g to 3150g with an average of 2142g (Table 1). The range PICC line duration was 4 to 24 days with an average of 14.1 days (Table 1). Under the chlorhexidine protocol between August and October 2013 eleven PICC lines were inserted (Table 2). The gestational ages of the infants with PICC lines ranged from 31 5/7 to 38 weeks with an average gestational age of 33.5 weeks (Table 2). The birth weight of the infants ranged from 1510g to 2983g with an average of 1957.3g (Table 2). The age at time of insertion of the PICC line ranged from 0 to 10 with an average of 3.7 days (Table 2). The infant weight at time of insertion of the PICC ranged from 1170g to 2880g with an average of 1905.8g (Table 2). The age ranges on removal of the PICC was 7 to 24 days with an average of 12 days (Table 2). The weight at time of PICC removal ranged from 1613g to 2835g with an average of 2107.6g (Table 2). The range PICC line duration was 4 to 16 days with an average time of 8.5 days (Table 2).

Of the data collected one CLABSI infection occurred. This infection occurred under the previous povidone-iodine protocol in October 2012. The infection occurred in an infant born in October 2012 who was 28 weeks gestation with a birth weight of 1090 grams. The infant was 9 days old upon insertion of the PICC line and weighed 1220g. The line blood cultures tested positive for staphylococcus epidermis 19 and 21 days later. The PICC line was removed on day 21 when the infant was 30 days old and weighed 1800g.

DISCUSSION

In comparing the CLABSI rate under the previous Povidone-Iodine protocol and the new chlorhexidine protocol minimal infection occurred. Only one CLABSI occurred under the Povidone-Iodine protocol. While the infection rate was not significant at this facility, any infection should be treated as a critical incident. That being said from the data collected, a definite conclusion cannot be drawn as to if chlorhexidine is a more effective antiseptic than povidone-iodine, however the data shows both antiseptics to be effective at preventing CLABSI based on the low infection rates under both protocols.

The study was limited because the new chlorhexidine protocol was not fully implemented to include chlorhexidine use on the skin during PICC line insertion. This study was also limited in the scope and timeframe of data that could be included in the study. For neonate 4 under the chlorhexidine protocol only part of the information could be obtained because the neonate was transferred to a different hospital for care.

CONCLUSION

Based on the data collected this facility's former and current protocols were both effective at preventing CLABSI in neonates with PICCs. This study was limited in its scope of data and timeframe that could be included. A larger more extensive study could be conducted to

determine if both antiseptics prove to be equally effective at preventing CLABSI in neonates with PICCs.

Research could also be conducted at this facility to determine employee compliance with the new protocol to define what factors were most effective at preventing infection. Employee compliance with documentation of PICC insertion, maintenance, and removal could also be examined for improved standardization of documentation.

Further research should also be done at this facility after the new chlorhexidine protocol is expanded to include skin contact with Chlorhexidine. During this study chlorhexidine use on the skin was not implemented as part of the protocol. Research including the use of chlorhexidine on the skin is needed to examine concerns related to the use of chlorhexidine in neonates and skin integrity. Additional and more extensive research studies are needed to develop standard restrictions based on age and weight for chlorhexidine skin contact with neonates due to previous research conveying concerns related to skin integrity.

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