The impact of chlorhexidine gluconate bathing on skin bacterial burden of neonates admitted to the Neonatal Intensive Care Unit

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Abstract

Background: Chlorhexidine gluconate (CHG) is a broad-spectrum topical antiseptic frequently used to prevent hospital-acquired infections (HAIs) and is increasingly used in the NICU. Limited information is available to help guide dosing and frequency of administration in neonates.

Methods: From March 2015 until October 2016, a prospective observational pilot study was conducted in the Johns Hopkins Children's Center NICU in Baltimore, Maryland, to assess the impact of CHG bathing on the skin bacterial burden of neonates receiving baths as part of clinical care. Bathing schedules varied by indication from twice weekly to two baths 48 hours apart. Arm and groin swabs were obtained in CHG-exposed neonates prior to their first bath, and at 1 hour, 24 hours, 48 hours, and 72 hours after bathing, and in non-exposed neonates at baseline. Bacterial growth was measured quantitatively, and residual CHG was assessed via colorimetric assay.

Results: A total of 40 neonates were enrolled, 18 of whom were CHG-exposed. Mean baseline Gram positive bacterial burden was 2.16 log CFU/ml (range 0-5.86) on the arm and 1.81 log CFU/ml (range 0-5.18) on the groin. Mean baseline Gram negative bacterial burden was 0.03 log CFU/ml (range 0-1.18) on the arm and 0.50 log CFU/ml (range 0-4.00) on the groin. In CHG-exposed neonates, bacterial burden decreased after the first CHG bath, but gradually increased toward baseline by 72 hours. Residual CHG concentration declined over time, with a corresponding increase in skin Gram positive bacterial burden.

Conclusions: CHG bathing reduces skin bacterial burden in hospitalized neonates, but bacterial burden increases back toward baseline 72 hours after CHG administration. CHG bathing may be needed more often than twice weekly to adequately suppress bacterial growth on the skin as part of infection prevention in hospitalized neonates.

Background

- Chlorhexidine gluconate (CHG) is a broad-spectrum topical antiseptic frequently used to prevent healthcare-acquired infections (HAIs).
- A 2015 survey of United States NICUs with fellowship training programs found that 86% of responding institutions used CHG (Johnson 2016).
- The Johns Hopkins Children's Center NICU uses presoaked 2% CHG cloths for CLABSI prevention and targeted MRSA/MSSA decolonization.
- Neonates with central venous catheters (CVCs) receive twice weekly CHG baths after 72 hours of life if ≥36 weeks gestation at birth or after 4 weeks of life if <36 weeks gestation at birth. After 2 months of life, all neonates with CVCs receive daily CHG bathing.
- MRSA/MSSA colonized neonates receive CHG baths twice 48 hours apart after 72 hours of life if ≥36 weeks gestation at birth or after 4 weeks of life if <36 weeks gestation at birth, or daily baths for 5 days after 2 months of age.
- Age-based restrictions exist due to concerns for potential adverse dermatologic effects, including skin irritation and burns, and for potential systemic absorption in preterm neonates with immature skin.
- A 2012 study assessed bacterial burden and residual CHG concentration in adults receiving baths every 24 hours; in this population, a residual CHG concentration of >18.75 µg/ml was associated with decreased Gram positive burden on the skin (Popovich 2012).

Methods

Study Design: We conducted a prospective observational pilot study from March 2015 until October 2016 in neonates admitted to NICU of the Johns Hopkins Bloomberg Children's Center. Admitted neonates were screened for eligibility by review of the medical record for gestational age, chronologic age, and indications for CHG use, including presence of CVC or colonization with MRSA/MSSA, prior to initiation of CHG baths. This study was approved by the Johns Hopkins Medicine Institutional Review Board. Consent for study participation was obtained from authorized caregivers.

Skin bacterial burden: Skin swabs were obtained prior to the first CHG bath to assess baseline bacterial growth on the skin; skin swabs were repeated at 1, 24, 48, and 72 hours after the first bath, until the time of the second CHG bath. Swabs were obtained at the upper arm and the groin. Swabs were inoculated onto blood agar and Columbia CNA agar to isolate Gram positive bacteria, and MacConkey agar to isolate Gram negative bacteria. Bacterial growth was measured quantitatively in log CFU/ml, and bacterial species were identified by Matrix-Assisted Laser Desorption/Ionization Time-of-Flight (MALDI-TOF) Mass Spectrometry.
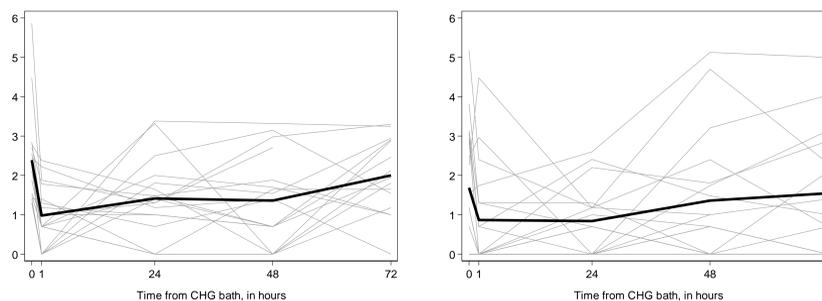
Residual CHG: Residual CHG concentration was measured at 1, 24, 48, and 72 hours after the first CHG bath at upper arm and groin sites. Swabs were obtained adjacent to sites swabbed for bacterial culture. CHG concentration was assessed via colorimetric assay for CHG detection previously utilized in studies (Popovich 2012). Swabs were placed into a solution of cetyltrimethylammonium bromide and sodium hypobromite and observed for color change, which was compared with standard swabs inoculated with known concentrations of CHG.

Statistics: Analysis was performed using Stata version 13.0 (Stata Corp., College Station, TX).

Results

- A total of 40 neonates were enrolled, 18 of whom were CHG-exposed.
- The mean gestational age was 34.1 weeks. There was no statistically significant difference in gestational age in CHG-exposed and non-exposed neonates (p=0.17).
- The mean birth weight was 2332.2 grams. There was no statistically significant difference in birth weight in CHG-exposed and non-exposed neonates (p=0.35).
- Mean baseline Gram positive bacterial burden was 2.16 log CFU/ml (range 0-5.86) on the arm and 1.81 log CFU/ml (range 0-5.18) on the groin.
- In CHG-exposed neonates, mean arm Gram positive bacterial burden decreased from 2.39 log CFU/ml (range 1.3-5.86) at baseline to 0.98 log CFU/ml (range 0-2.38) at 1 hour and 1.42 log CFU/ml (range 0-3.38) at 24 hours; at 48 hours, mean arm Gram positive bacterial burden was stable at 1.36 log CFU/ml (range 0-3.32). By 72 hours, mean arm Gram positive bacterial burden was close to baseline at 2.15 log CFU/ml (range 1.00-3.30).
- In CHG-exposed neonates, mean groin Gram positive bacterial burden decreased from 1.69 log CFU/ml (range 0-5.18) to 0.87 log CFU/ml (range 0-4.48) at 1 hour and 0.84 log CFU/ml (range 0-2.6) at 24 hours. Mean groin Gram positive bacterial burden increased to 1.37 log CFU/ml (range 0-5.13) at 48 hours and was close to baseline by 72 hours at 1.66 log CFU/ml (range 0-5.00).

Figure 1: Gram positive bacterial burden on the arm (left) and groin (right) as a function of time from CHG bath.

Figure 2: Gram negative bacterial burden on the arm (left) and groin (right) as a function of time from CHG bath.
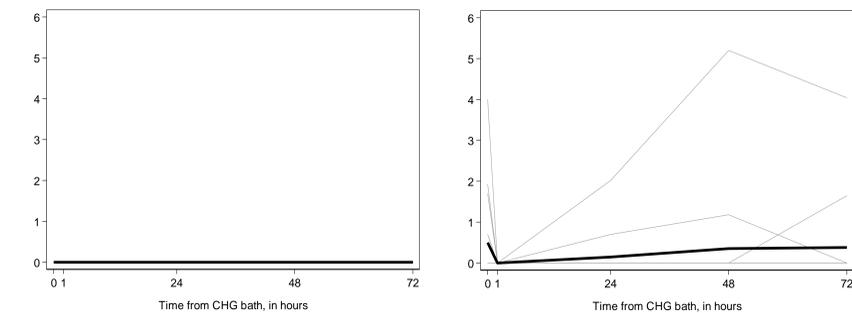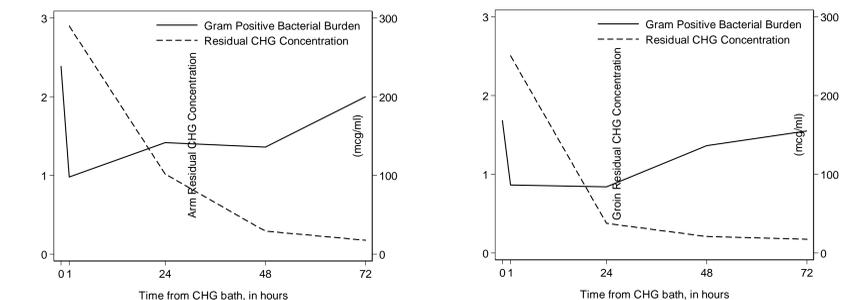

Figure 3: Mean Gram positive bacterial burden and residual CHG concentration as a function of time from CHG bath, separately at the arm (left) and groin (right)

- Mean baseline Gram negative bacterial burden was 0.03 log CFU/ml (range 0-1.18) on the arm and 0.50 log CFU/ml (range 0-4.00) on the groin. No Gram negative bacteria were isolated on the arm of any CHG-exposed neonates; 7 of 18 CHG-exposed neonates had Gram negative organisms isolated on the groin at least once.
- The most common Gram positive organisms isolated on the arm at baseline were S. epidermidis (35/40 = 87.5%) and E. faecalis (3/40 = 7.5%); on the groin, the most common Gram positive organisms were also S. epidermidis (22/40 = 55.0%) and E. faecalis (10/40 = 25.0%).

Conclusions

- Gram positive bacterial burden decreased after CHG bathing but gradually increased toward baseline within 72 hours.
- Overall Gram negative bacterial burden was low; groin Gram negative bacterial burden decreased after CHG bathing.
- In neonates admitted to the NICU and at high risk for infection including CLABSI, CHG bathing reduces skin bacterial burden, especially for the first 48 hours after bathing.

Acknowledgements

References
Johnson et al. Trends in chlorhexidine use in US Neonatal Intensive Care Units: Results from a follow-up national survey. *Infect Control Hosp Epidemiol* 2016.
Popovich et al. Relation of chlorhexidine gluconate skin concentration to microbial density on skin of critically ill patients bathed daily with chlorhexidine gluconate. *Infect Control Hosp Epidemiol* 2012.