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Umbilical Cord Care in the Newborn Infant

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Postpartum infections remain a leading cause of neonatal morbidity and mortality worldwide. A high percentage of these infections may stem from bacterial colonization of the umbilicus, because cord care practices vary in reflection of cultural traditions within communities and disparities in health care practices globally. After birth, the devitalized umbilical cord often proves to be an ideal substrate for bacterial growth and also provides direct access to the bloodstream of the neonate. Bacterial colonization of the cord not infrequently leads to omphalitis and associated thrombophlebitis, cellulitis, or necrotizing fasciitis. Various topical substances continue to be used for cord care around the world to mitigate the risk of serious infection. More recently, particularly in high-resource countries, the treatment paradigm has shifted toward dry umbilical cord care. This clinical report reviews the evidence underlying recommendations for care of the umbilical cord in different clinical settings.

INTRODUCTION

Despite significant global progress in recent decades,[1] bacterial infections (sepsis, meningitis, and pneumonia) continue to account for approximately 700 000 neonatal deaths each year, or nearly one-quarter of the 3 million neonatal deaths that occur worldwide.[1,2] Although the magnitude of its contribution to these deaths remains uncertain, the umbilical cord may be a common portal of entry for invasive pathogenic bacteria,[3] with or without clinical signs of omphalitis. Neonatal mortality associated with bacterial contamination of the umbilical stump may therefore rank among the greatest public health opportunities of the 21st century.

Common risk factors for the development of neonatal omphalitis include unplanned home birth or septic delivery, low birth weight, prolonged rupture of membranes, umbilical catheterization, and chorioamnionitis.[4,5] In countries with limited resources, the risk of omphalitis may be 6 times greater for infants delivered at home than for hospital births.[6] Multiple studies have delineated the susceptibility of the umbilical

abstract

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cord to bacterial colonization. The method of caring for the umbilical cord after birth affects both bacterial colonization and time to cord separation.[7–10] The devitalized umbilical cord provides an ideal medium for bacterial growth. Sources of potentially pathogenic bacteria that colonize the umbilical cord include the mother's birth canal and various local bacterial sources at the site of delivery, most prominently the nonsterile hands of any person assisting with the delivery.[11] *Staphylococcus aureus* remains the most frequently reported organism.[5–7,12] Other common pathogens include group A and group B *Streptococci* and Gram-negative bacilli including *Escherichia coli*, *Klebsiella* species, and *Pseudomonas* species. Rarely, anaerobic and polymicrobial infections also may occur. In addition to omphalitis, tetanus in neonates can result from umbilical cord colonization, particularly in countries with limited resources. This infection results from contamination of the umbilical separation site by *Clostridium tetani* acquired from a nonsterile device used to separate the umbilical cord during the peripartum period or from application of unhygienic substances to the cord stump.

Multiple complications can occur from bacterial colonization and infection of the umbilical cord because of its direct access to the bloodstream. These complications include the development of intraabdominal abscesses, periumbilical cellulitis, thrombophlebitis in the portal and/or umbilical veins, peritonitis, and bowel ischemia.[13–16] Neonatal omphalitis may present at 4 grades of severity: (1) funisitis/umbilical discharge (an unhealthy-appearing cord with purulent, malodorous discharge), (2) omphalitis with abdominal wall cellulitis (periumbilical erythema and tenderness in addition to an unhealthy-appearing cord with discharge), (3) omphalitis with systemic signs of infection, and (4) omphalitis with necrotizing fasciitis (umbilical necrosis with periumbilical ecchymosis, crepitus, bullae, and evidence of involvement of superficial and deep fascia; frequently associated with signs and symptoms of overwhelming sepsis and shock).[6]

The incidence of omphalitis reported in different communities varies greatly, depending on prenatal and perinatal practices, cultural variations in cord care, and delivery venue (home versus hospital). Reliable current data on rates in untreated infants are surprisingly scant. In high-resource countries, neonatal omphalitis now is rare, with an estimated incidence of approximately 1 per 1000 infants managed with dry cord care (eg, a total of 3 cases among 3518 infants described in 2 reports from Canada[17,18]). In low-income communities, omphalitis occurs in up to 8% of infants born in hospitals and in as many as 22% of infants born at home, in whom omphalitis is moderate to severe in 17% and associated with sepsis in 2%.[19] Depending on how omphalitis is defined, case-fatality rates as high as 13% have been reported.[4] The development of necrotizing fasciitis, with predictable complications from septic shock, is associated with much higher case-mortality rates.[5] These disparate observations in different settings have resulted in divergent recommendations for cord care by the World Health Organization (WHO), which advocates dry cord care for infants born in a hospital or in settings of low neonatal mortality and application of chlorhexidine solution or gel for infants born at home or in settings of high neonatal mortality.[20]

EVIDENCE-BASED PRACTICE

Best practices for antisepsis of the umbilical cord continue to remain somewhat controversial and variable, even in high-resource countries with relatively aseptic conditions at the time of delivery. In resource-limited countries, in accordance with cultural traditions, unhygienic substances continue to be applied to the umbilicus, creating a milieu ideal for the development neonatal omphalitis. To achieve the goal of preventing omphalitis worldwide, deliveries must be clean and umbilical cord care must be hygienic. The cord should be cut with a sterile blade or scissors, preferably using sterile gloves, to prevent bacterial contamination leading to omphalitis or neonatal tetanus. As discussed later, dry cord care without the application of topical substances is preferable under most circumstances in high-resource countries and for in-hospital births elsewhere; the application of topical chlorhexidine is recommended for infants born outside the hospital setting in communities with high neonatal mortality rates.[20]

Methods of umbilical cord care have been the subject of 4 recent meta-analyses,[21–24] including 2 Cochrane reviews.[23,24] Although the scope and methodologies of these reviews differed, all 4 stratified results according to the study setting, distinguishing results reported from communities with high proportions of births at home and high neonatal mortality rates from those obtained in hospitals and settings with low neonatal mortality rates. These analyses concluded that 3 studies (including >44 000 subjects) in community settings in South Asia with a high neonatal mortality rate[3,25,26] support the effectiveness of application of 4% chlorhexidine solution or gel to the umbilical cord stump within 24 hours after birth, which results in a significant reduction in both omphalitis (relative risk [RR]: 0.48; 95% confidence interval [CI]: 0.40–0.57) and neonatal mortality

(RR: 0.81; 95% CI: 0.71–0.92) compared with dry cord care.[24] No other cord-management strategies have been evaluated systematically in such settings, but the application of traditional materials (eg, ash, herbal or other vegetal poultices, and human milk) may provide a source of contamination with pathogenic bacteria, including *C tetani*.[27] In contrast, the meta-analyses found little evidence of benefit from topical treatments for infants born in hospitals.[22–24] The meta-analyses used different criteria for inclusion of trials and compared a variety of treatments versus dry cord care or versus one another. Only a single trial[28] reported mortality data, which did not differ between topical chlorhexidine and dry care (RR: 0.11; 95% CI: 0.01–2.04). However, the low mortality rate and the small contribution made by bacterial infection[29] in these settings provide only a small opportunity for a reduction in mortality rates. In 5 such trials[30–33] analyzed by Karumbi et al,[22] no treatment was found to significantly reduce omphalitis and sepsis when compared against one another, although the sample sizes were small and the evidence was deemed of low quality.[22] The Cochrane review by Imdad et al,[23] which compared a variety of pairs of topical agents, reached similar conclusions. The most recent meta-analysis, by Sinha et al,[24] considered 2 studies[28,34] comparing chlorhexidine with dry cord care. In the first of these, 140 infants admitted to the NICU at a hospital in north India were randomly assigned to receive cord treatment with chlorhexidine solution or dry cord care.[28] Enrollment criteria included gestational age >32 weeks and birth weight >1500 g, but the provided demographic data suggest that the infants were predominantly late-preterm, and they experienced high rates of complications of prematurity (including asphyxia, respiratory distress, mechanical ventilation, and necrotizing enterocolitis). No cases of umbilical sepsis were reported in either group, but culture-proven sepsis was more common in the dry cord care group than in the chlorhexidine group (15 of 70 vs 2 of 70; $P = .002$). These observations cannot be generalized to all healthy infants born in a hospital. The second enrolled 669 subjects, who were randomly assigned to receive treatment with chlorhexidine powder or dry cord care.[34] Cord-related adverse events (erosion, irritation, lesion, omphalitis, erythema, umbilical granuloma, purulence, bleeding, discharge, or weeping of the navel) were more common in the dry cord care group (29% vs 16%; $P = .001$), but there were no differences in serious adverse events (2.1% in both groups) or in the incidence of omphalitis (2.1% vs 0.6%; $P = .1$). Although the meta-analysis reported a significant difference in the pooled risk of omphalitis (RR: 0.48; 95% CI: 0.28–0.84), combining culture-proven sepsis cases[28] with omphalitis cases[34] is not appropriate. This analysis provides only very weak, or perhaps no, evidence for a benefit of chlorhexidine treatment.

Since 1998, the WHO has advocated the use of dry umbilical cord care in high-resource settings.[35] Dry cord care includes keeping the cord clean and leaving it exposed to air or loosely covered by a clean cloth. If it becomes soiled, the remnant of the cord is cleaned with soap and sterile water. In situations in which hygienic conditions are poor and/or infection rates are high, the WHO recommends chlorhexidine.[16]

There is some uncertainty as to the effect of chlorhexidine on mortality when applied to the umbilical cords of newborn infants in the hospital setting, but there is moderate evidence for its effects on infection prevention.[24] Although the application of chlorhexidine is regarded as safe,[35] trace levels of the compound have been detected in the blood of infants after umbilical cord cleaning.[36,37] In addition, contact dermatitis has been reported in up to 15% of very low birth weight infants after placement of a 0.5% chlorhexidine impregnated dressing over a central venous catheter.[38] The data on the safety of chlorhexidine application are incomplete, and the amount of exposure to chlorhexidine that can be considered safe is not known.[24] In addition to the incremental increase in the cost of using chlorhexidine, the practice of reducing bacterial colonization may have the unintended consequences of selecting more virulent bacterial strains without demonstrable benefits.[24] Because the incidence of omphalitis is very low in high-resource countries and the severity is mild, the preponderance of evidence favors dry cord care.

PROMOTING NONPATHOGENIC COLONIZATION OF THE UMBILICAL CORD

Promoting colonization of the umbilical cord by nonpathogenic bacteria may prevent the development of neonatal omphalitis. By allowing neonates to "room-in" with their mothers, one can create an environment conducive for colonization from less pathogenic bacteria acquired from the mother's flora.[39] This type of colonization helps to reduce colonization and infection from potentially pathogenic organisms that are ubiquitous in the hospital environment. Over time, attempts to decrease bacterial colonization with topical antimicrobial agents may actually select for resistant and more pathogenic organisms[35] (level of evidence: III).

IMPLICATIONS FOR CLINICAL PRACTICE

1. Application of select antimicrobial agents to the umbilical cord may be beneficial for infants born at home in resource-limited

countries where the risks of omphalitis and associated sequelae are high.

2. Application of select antimicrobial agents to the umbilical cord does not provide clear benefit in the hospital setting or in high-resource countries, where reducing bacterial colonization may have the unintended consequence of selecting more virulent bacterial strains. In high-resource countries, there has been a shift away from the use of topical antimicrobial agents in umbilical cord care for this reason.
3. For deliveries outside of birthing centers or hospital settings and in resource-limited populations (eg, Native American communities), the application of prophylactic topical antimicrobial agents to the umbilical cord remains appropriate.
4. At the time of discharge, parental education regarding the signs and symptoms of omphalitis might decrease significant morbidities and even associated mortalities.
5. Of paramount importance is the need for all primary care providers to be diligent in reporting infections associated with umbilical cord care. The development of a local reporting system regarding the occurrence of omphalitis and/or its morbidities to the health care providers at the site of delivery will create more robust data, allowing for improvement in treatment paradigms in the future.

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ABBREVIATIONS

CI: confidence interval
RR: relative risk
WHO: World Health Organization

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