



# How Safe is the use of Antiseptics and Disinfectants in Children?

ABDULLAH HOSSENI<sup>1</sup>, NIRMAL THAPA<sup>1</sup>, PRIYA T.<sup>2</sup>

A  
B  
S  
T  
R  
A  
C  
T

A wide range of antiseptic preparations and disinfectants have been used in varying concentrations and combinations in children but much research work regarding their safety and efficacy is not available. The aim of this review is to expand and broaden the pre-existing guidelines useful to the health care professionals so that antisepsis in the pediatric field can be performed appropriately, and at the same time, guarantee safety for children. Previously published studies were also assessed while writing this review. As per the data, there may be several local and systemic toxic effects related to the use of antiseptics and disinfectants in children. Properly designed large multicenter randomized clinical trials are required to direct the healthcare professionals regarding the most appropriate and safe antiseptic and disinfectant to use in pediatric patients.

**KEYWORDS:** Antiseptics, Disinfectants, Children

## INTRODUCTION

Antiseptics and disinfectants are used in children from birth, and their use is still poorly understood, because, as is the case with drugs, there is little literature available in this regard. Aside from infections in the uterus, newborns can come into contact with pathogens during childbirth, due to blood, feces, and microorganisms of the female genital tract, and in the post-partum phase, from contact with relatives, healthcare workers, contaminated objects and devices. In particular, in daily clinical work, the greatest critical issues arise for preterm infants, who may need invasive procedures, such as intubation or insertion of a central venous catheter, the use of complex devices, such as endoscopes, and frequent assistance maneuvers, such as venous sampling or endotracheal aspirations. The immune system of these newborns is often immature, as are many of their organs and systems which, under physiological conditions, act as a barrier for pathogens, such as the skin and the lungs. For this reason, infections can easily be acquired. This immaturity of cellular and antibody defenses in preterm infants with low weight, sometimes less than 1 kg, continues until and beyond the first year of age.<sup>1,2</sup>

Unfortunately, especially for neonatology, there are only a few medications that the therapists have at their disposal, and it is no news that the number of drugs authorized in the correct pediatric dosage is rather small. For this reason, many drugs and antibiotics are used outside the indications, in dosages or pharmaceutical forms other than those reported in the authorization, for which safety data are not available. Therefore, antisepsis and disinfection of the

environment and of all objects that come into contact with the pediatric patient have preventive importance. The skin antisepsis of preterm newborns presents particular aspects, related to the thin epidermis, with an insufficient stratum corneum, with the ongoing keratinization of the granular layer, and with the evolving mucosal and basal germinative cells.<sup>3</sup> The fewer anchoring fibrils in the dermoepidermal junction reduce the barrier effect and increase the risks of local and deep infection and general toxicity.<sup>1</sup> A good antiseptic must therefore combine maximum topical tolerability with the highest efficacy. Given the scarcity of guidelines and studies in pediatric literature, the aim of this work is to deepen and develop guidelines that will be of use to healthcare workers, so that they can perform the antisepsis in the neonatal pediatric context in an appropriate manner, while ensuring safety for young patients. One of the studies lists the characteristics of chlorine, which, may exhibit specific antiseptic properties of particular interest through its derivatives and is widely used in various pediatric and neonatal care settings.<sup>3</sup>

It should be noted that the widespread use of sodium hypochlorite as an antiseptic is especially due to its effectiveness on lipophilic and hydrophilic bacteria and viruses, as well as on spores, in low concentrations, and in a short time. Inexpensive and non-flammable, if concentrated it may be corrosive to steel and other metals. It is applied to damaged and undamaged skin, and to mucous membrane, in pediatric and neonatal age, at least half minute before carrying out the planned activities, taking care, for preterm infants, to rinse with



© Abdullah Hosseini et al. This is an open access article distributed under the terms of the Creative Commons Attribution License CC-BY-NC 4.0, which permits unrestricted use, distribution and reproduction in any medium, provided the use is not commercial and the original author(s) and source are cited.

sterile water after half minute, in order to avoid any type of skin irritation. French Society for Hospital Hygiene recommends the use of sodium hypochlorite also on the ocular mucous membrane, in concentrations equal to 0.06% in newborns and preterm infants. Alcohols are antiseptics tolerated on adult skin but cannot be used on mucous membranes and near the eyes. Volatile disinfectants for small surfaces have no persistent effect and are flammable. They can be dangerous in neonates and therefore the risk of percutaneous intoxication must be assessed, due to the surface/volume ratio, with particular attention to high concentration solutions. Cases of hemorrhagic necrosis of the skin have been reported in preterm infants, resulting from the use of products containing 70% ethyl alcohol.

A 0.5% chlorhexidine in 70% alcohol is also contraindicated in preterm infants and in newborns less than one month of age. Two of the studies analyzed highlighted the risk of ulceration associated with the use of both alcohol-based and aqueous solutions in children under two months of age.<sup>4,5</sup> One of these evaluated the use of chlorhexidine for the sterilization of the umbilical cord in underweight infants, highlighting the occurrence of two cases of skin burns localized in the treated area.<sup>4</sup> Instead, it is recommended to use simple soap and water, or sodium hypochlorite, for the care of the umbilical cord. For preterm infants and newborns up to one month of age, the antiseptic solutions to be preferred are the solutions based on 0.25% chlorhexidine in 4% alcohol which have a lower dermatological toxicity and fewer contraindications than the more concentrated solutions used for other age groups.

Unfortunately, concentrations of less than 0.5% chlorhexidine alone in water are easily contaminated, therefore they should be avoided. The cationic biguanide surfactant acts mainly on vegetative microorganisms, destroying the cell membrane, and partially coagulating its contents. A 2% chlorhexidine diluted in water, of rapid and persistent efficacy, is more active than povidone-iodine, and even in newborns, a 0.5% chlorhexidine diluted in 70% isopropyl alcohol is more active than povidone-iodine.<sup>6,7</sup> Chlorhexidine is also widely used in obstetrics and gynecology, it does not pose problems of general toxicity, but it may cause anaphylactic reactions and, in concentrations just over 0.02%, it may cause damage to the eye, middle ear, conjunctival tissue, and brain tissue, and may be toxic if used on the oral mucous membranes in the newborn. It should be used with caution in newborns, especially those born prematurely, as it can cause severe chemical

burns.<sup>4,5</sup> A larger number of studies have been analyzed to evaluate the most recommended antiseptics for skin disinfection before, during and after the implantation of a central venous catheter in pediatric patients. As regards venous access in adult patients, there is no doubt that the skin antiseptic of first choice is a 2% chlorhexidine gluconate in a 70% isopropyl alcohol solution. Similarly, above two months of age, a 2% chlorhexidine in a 70% isopropyl alcohol solution is considered the first choice for skin disinfection in children with CVC.<sup>8,9</sup> On the other hand, for patients with allergy or sensitivity to chlorhexidine, the use of 10% povidone-iodine as a second-choice antiseptic should be considered, as more than one study demonstrated lower efficacy than chlorhexidine. Curry S. et al., in an Arkansas hospital, used alcohol-based chlorhexidine on newborns weighing over 2 kg, to reduce CLABSI to 1/3. Due to the absence of side effects, he also adopted this antiseptic for preterm infants weighing 1-2 kg, and for those weighing less than 1 kg.<sup>10</sup>

In a prospective randomized controlled study, conducted in a pediatric cardiac surgery unit, the use of sponges impregnated with 2% chlorhexidine, for both, CVC disinfection, that for bathing the patient, in order to avoid the danger of the so-called healthcare-associated infections was found to be safe and effective, significantly reducing CVC colonization rates, compared to polyurethane dressings.<sup>11</sup> Other antiseptics, such as iodophors are effective biocides, and although less irritating, they are contraindicated under 6 months of age. In particular, povidone-iodine is contraindicated as it can lead to reversible changes in thyroid function, especially in children with congenital hypothyroidism. A single application cannot cause such complications, but the use of iodophors should not be applied long-term.

Mothers should also limit the use of these antiseptics in the last months of pregnancy and during breastfeeding. For the cleaning and disinfection of damaged skin, a mixture of Benzalkonium chloride and 96% ethyl alcohol can be used, with a limitation for children under two years of age with a predisposition to laryngospasm and convulsions. Triclosan, on the other hand, a chlorophenolic compound, is an effective antiseptic, and the literature emphasizes the preventive effect with regard to topical infections on damaged skin. Data relating to the use of disinfectants in pediatrics are even more scarce than those relating to antiseptics. All reusable objects and surfaces are classified into critical, semi-critical and non-critical items, which correspond to an equal degree of sterilization, or high-level or low-

level disinfection. There are few clinical cases of children who have shown toxic effects following the use of disinfectants precisely because, unlike it is the case with antiseptics, direct contact of chemical agents with tissues and organs is rather limited. As regards chlorhexidine, Agolini et al. report cases of cyanosis and bradycardia in infants who would have been breastfed from a mother's breast treated with products containing chlorhexidine, and cases of burns to the mouth and pulmonary edema in artificially fed infants who had used bottles and teats disinfected with chlorhexidine solutions and poorly rinsed.<sup>3</sup>

When used at very high concentrations, polyphenols can cause neonatal hyperbilirubinemia. Therefore, the concentrations suggested for environmental and surgical instruments disinfection range from 0.5% to 1%. Chlorine derivatives, in particular sodium hypochlorite, are undoubtedly the most used disinfectants, although at high concentrations they may cause eye damage. One study lists the characteristics that make them widely used disinfectants for water and the environment.<sup>12</sup> In fact, sodium hypochlorite is active on bacteria, lipophilic and hydrophilic viruses, as well as on spores and the much-feared *Clostridium Difficile*, in concentrations that are not too high and for not too long periods of time. It is an inexpensive non-flammable agent, but incompatible with some metals because it is corrosive and can be deactivated in the presence of organic compounds. A good alternative to sodium hypochlorite is sodium dichloroisocyanurate which, in the form of water-soluble tablets, is easier to handle and less corrosive. It should be emphasized that chlorine derivatives have a good disinfectant action if a good preventive cleaning of the objects and surfaces to be treated is carried out, contrary to other disinfectants, such as polyphenols, which are active even without an effective pre-washing.<sup>12</sup> Chlorine derivatives are used in hospitals to disinfect baby bottles and teats, toys, heat cradles, and normal cradles. Social games used in pediatric wards, considered by the Center for Disease Control and Prevention as vehicles for the transmission of pathogens, also include procedures that recommend sanitization, disinfection with 1,000 ppm chlorine for at least 10 minutes, and rinsing. The procedures for daily cleaning of cradles, on the other hand, involve the use of detergent/disinfectant solutions or ready-to-use wipes that do not require rinsing.

In case of contamination of the cradles by infected microorganisms, and in case of the use of heat, it is recommended to use a 0.1% sodium hypochlorite or a

0.5% chlorhexidine solution, in combination with Cetrimide. Obviously, it is important to take into consideration the information provided by the various cradle manufacturers regarding the procedures and compatibility with the different disinfectants. Hydrogen peroxide has been used for years as a disinfectant but has the limit of presenting stability problems. Considering that no significant literature on disinfection dedicated to the pediatric age is available, it was deemed appropriate to conduct a review of the available literature. The review has shown that there may be various toxic effects associated with the use of antiseptics and disinfectants in children and infants, especially in preterm babies, not only on the skin and mucous membranes, but also on a systemic level.

## CONCLUSION

The field of disinfection and antisepsis in pediatric age can be considered, in fact, an orphan field in all respects, but although the available data are limited, the suggested chemical agents guarantee the combination of maximum efficacy and maximum safety, obviously adopting all necessary precautions. The creation and use of best practices, in order to prevent infections at home or in the hospital environment, given the delicacy and physiological immaturity of young patients, is a safer strategy to adopt than the long-term disability that could result from improper use of the aforementioned chemical agents. In fact, attention should be focused on the culture of safety, using teamwork, with the creation of a multidisciplinary team dedicated to the management of infection prevention in pediatric hospital wards, and all pediatricians and pharmacists should be updated. Simple rules, such as rinsing the antiseptic or disinfectant, the correct dilution, the use of applicators, which allow for the use of known doses of antiseptic so as to avoid the build-up effect, use of wipes or disinfectant sprays that do not require rinsing, all improve the administration of therapeutic aids, essential for the fight against infections. In addition, use of galenic formulations in clinical practice may play an important role in the case of pediatric patients and, should there be the need to customize compositions of antiseptic solutions in the absence of readymade products available on the market, they can be used as a tool for responding to otherwise unsolvable clinical problems.

## REFRENCES

1. Agolini G, Tansini G, De Vonderweid U. Infezioni Neonatali. Testo D. 2006; 30-9.

2. Baldan R, Cavallerio P, Parlato C, Rocchetti A, Lomolino G et al. Meticillin-resistant *Staphylococcus aureus* SCCmec type IV: nosocomial transmission and colonisation of healthcare workers in a neonatal intensive care unit. *J Hosp Infect.* 2008;69(3):304-6. <https://doi.org/10.1016/j.jhin.2008.04.002>.
3. Agolini G, Faldella G, Janes E, Raitano A, Spinelli M et al. Problemi di antisepsi nei neonati prematuri [Skin antiseptics in premature infants]. *Pediatr Med Chir.* 2011 Jul-Aug;33(4):169-77. Italian. Erratum in: *Pediatr Med Chir.* 2012;34(3):154.
4. Kutsch J, Ottinger D. Neonatal skin and chlorhexidine: a burning experience. *Neonatal Netw.* 2014 Jan-Feb;33(1):19-23. <https://doi.org/10.1891/0730-0832.33.1.19>.
5. Lashkari HP, Chow P, Godambe S. Aqueous 2% chlorhexidine-induced chemical burns in an extremely premature infant. *Arch Dis Child Fetal Neonatal Ed.* 2012;97(1):F64. <https://doi.org/10.1136/adc.2011.215145>. Epub 2011 Jul 11. PMID: 21746795.
6. Borghesi A, Stronati M. Strategies for the prevention of hospital-acquired infections in the neonatal intensive care unit. *J Hosp Infect.* 2008;68(4):293-300. <https://doi.org/10.1016/j.jhin.2008.01.011>.
7. Blaney M, Shen V, Kerner JA, Jacobs BR, Gray S et al. Alteplase for the treatment of central venous catheter occlusion in children: results of a prospective, open-label, single-arm study (The Cathflo Activase Pediatric Study). *J Vasc Interv Radiol.* 2006;17:1745-51. <https://doi.org/10.1097/01.RVI.0000241542.71063.83>.
8. Marschall J, Mermel LA, Fakih M, Hadaway L, Kallen A et al. Strategies to prevent central line-associated bloodstream infections in acute care hospitals: 2014 update. *Infect Control Hosp Epidemiol.* 2014;35(7):753-71. <https://doi.org/10.1086/676533>.
9. O'Grady NP, Alexander M, Burns LA, Dellinger EP, Garland J et al. Guidelines for the prevention of intravascular catheter-related infections. *Clin Infect Dis.* 2011 May;52(9):e162-93. <https://doi.org/10.1093/cid/cir257>.
10. Curry S, Honeycutt M, Goins G, Gilliam C. Catheter-associated bloodstream infections in the NICU: getting to zero. *Neonatal Netw.* 2009;28(3):151-5. <https://doi.org/10.1891/0730-0832.28.3.151>.
11. Levy I, Katz J, Solter E, Samra Z, Vidne B, Birk E, Ashkenazi S, Dagan O. Chlorhexidine-impregnated dressing for prevention of colonization of central venous catheters in infants and children: a randomized controlled study. *Pediatr Infect Dis J.* 2005;24(8):676-9. <https://doi.org/10.1097/01.inf.0000172934.98865.14>.
12. Williams GJ, Denyer SP, Hosein IK, Hill DW, Maillard JY. Use of sodium dichloroisocyanurate for floor disinfection. *J Hosp Infect.* 2009;72(3):279-81. <https://doi.org/10.1016/j.jhin.2009.02.017>.

**Source of support:** Nil, **Conflict of interest:** None declared

**Cite this article as:**

Hosseni A, Thapa N, Priya T. How Safe is the use of Antiseptics and Disinfectants in Children?. *Int Healthc Res J.* 2021;5(3):RV6-RV9. <https://doi.org/10.26440/IHRJ/0503.06429>

**AUTHOR AFFILIATIONS:** (\*Corresponding Author)

1. Pediatric Specialists and Consultant Private Pediatricians, Kathmandu, Nepal
2. M. Sc. (Nursing) and Nursing Consultant, Anuradhapura, Sri Lanka

Author's email id held at request. Contact editor.ihhr[at]gmail[dot]com for any queries