Safety guideline: skin antisepsis for central neuraxial block

The Association of Anaesthetists of Great Britain and Ireland
The Obstetric Anaesthetists' Association
Regional Anaesthesia UK
Association of Paediatric Anaesthetists of Great Britain and Ireland

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This is a consensus document produced by expert members of a Working Party established by
the Association of Anaesthetists of Great Britain and Ireland, with representatives from the
Obstetric Anaesthetists’ Association, Regional Anaesthesia UK and the Association of
Paediatric Anaesthetists of Great Britain and Ireland. It has been seen and approved by the
elected Boards/Committees of all four organisations.
Summary
Concise guidelines are presented that recommend the agent to use for skin antisepsis prior to central neuraxial block. The Working Party specifically considered the concentration of antiseptic agent to use and its method of application. The advice presented is based on previously published guidelines, laboratory and clinical studies, case reports, and on the known properties of antiseptic agents.
• **What other guideline statements are available on this topic?**

The Royal College of Anaesthetists [1], the American Society of Anesthesiologists [2] and the American Society of Regional Anesthesia [3] have all published guidance on prevention of infectious complications associated with neuraxial techniques.

• **Why was this guideline developed?**

Although the current published guidelines comprehensively cover aseptic technique when performing central neuraxial blockade (CNB), they are lengthy and discursive documents which are impractical for use in the acute care setting. The remit of this Working Party was to produce a concise document that specifically considered which agent (including the concentration) to use for skin antisepsis prior to CNB, and the method of application.

• **How does this statement differ from existing guidelines?**

This statement specifically considers which agent to use for skin antisepsis prior to CNB, and is therefore more concise than currently available guidelines. Unlike existing guidance, this statement includes a recommendation on which concentration of antiseptic agent to use.

• **Why does this statement differ from existing guidelines?**

This statement was written in order to provide useful and concise guidance for anaesthetists in the clinical setting.
Recommendations:

1. A 0.5% concentration of chlorhexidine in alcohol should be used for skin antisepsis prior to performing a CNB.

2. The anaesthetist must be meticulous in taking measures to prevent chlorhexidine from reaching the CSF:
   
a. Chlorhexidine should be kept well away from the drugs and equipment to be used for CNB. Antiseptic solutions should not be poured into containers on or near the same surface as the equipment for CNB. Equipment should be covered or protected while the antiseptic is applied.

   b. The solution must be allowed to dry before the skin is palpated or punctured.

   c. The operator should check his/her gloves for contamination with chlorhexidine. If there is any doubt, they should be changed before continuing the procedure.

3. In children under two months of age, the volume of chlorhexidine used should be the minimum necessary whilst still ensuring antisepsis.

4. Optimum aseptic technique for CNB requires the use of barrier precautions. These include thorough hand washing with surgical scrub solution, the wearing of a cap, mask, sterile gown and gloves, and the use of a large sterile drape.
Introduction

The most appropriate and safe antiseptic solution to use on the skin before CNB remains controversial. A survey of consultant obstetric anaesthetists in 2009 revealed a wide range of practice across the United Kingdom both in terms of the antiseptic used and its method of application [4].

The ideal antiseptic agent should be effective against a wide range of micro-organisms, have immediate onset of action, exert a long-term effect, not be inactivated by organic material (e.g. blood) and should have minimal toxic effects on the skin [3]. Commonly-used antiseptic agents for CNB include chlorhexidine gluconate and povidone iodine. Both of these antiseptics are available as aqueous and alcoholic solutions.

Chlorhexidine vs povidone iodine

Chlorhexidine gluconate is a potent, broad-spectrum antiseptic that is effective against nearly all bacteria and yeasts. It has a faster onset and longer duration of action than povidone iodine, and it retains its efficacy in the presence of blood. It also has a lower incidence of skin reactions than povidone iodine [3].

Several investigators have compared the antiseptic efficacy of chlorhexidine and povidone iodine under a variety of experimental conditions [5-12]. In all but one investigation [7], chlorhexidine resulted in a more rapid and superior bactericidal effect that lasted several hours beyond its initial application. In one of these studies, Kinirons and colleagues [5] compared colonisation of epidural catheters following skin preparation using 0.5% chlorhexidine in alcohol with skin preparation using an aqueous solution of 10% povidone iodine. Catheters inserted following the use of chlorhexidine were six times less likely to be colonised than when povidone iodine had been used.

Chlorhexidine: aqueous vs alcoholic

Sakuragi and colleagues [10] investigated the effect of chlorhexidine and povidone iodine on the growth of MRSA and MSSA (the pathogens most commonly associated with epidural space infections) in vitro. They found that both pathogens grew colonies after exposure for 60 seconds to aqueous 10% povidone iodine or aqueous 0.5% chlorhexidine. In contrast, no bacteria grew after 15 seconds of exposure to 0.5% chlorhexidine in 80% alcohol.
The choice of concentration in the UK and Ireland is between 0.5% chlorhexidine in 70% alcohol (e.g. Hydrex® solution, Ecolab Ltd, Leeds, UK) and 2% chlorhexidine in 70% alcohol (e.g. ChloraPrep®, CareFusion UK Ltd, Reigate, UK).

Adams et al. [13] compared the efficacy of 2% chlorhexidine in alcohol with several other antiseptics including 0.5% chlorhexidine in alcohol against growth of *Staphylococcus epidermidis* in vitro. The authors found that after 30 seconds of exposure to antiseptic, 2% chlorhexidine in alcohol achieved a significantly greater log_{10} reduction factor in colony forming units/ml compared to the 0.5% solution.

The ‘Epic 2: National Evidence-Based Guidelines for Preventing Healthcare-Associated Infections in NHS Hospitals in England’ [14] recommend that prior to insertion of a central venous access device, the skin should be decontaminated using 2% chlorhexidine in 70% alcohol. However, no such guidance exists for CNB, possibly because of concerns about neurotoxicity associated with chlorhexidine.

**Chlorhexidine, alcohol and neurotoxicity**

Recently, the issue of which antiseptic, and the concentration, to use before CNB has become contentious. This follows several cases of permanent neurological injury in obstetric patients in which chlorhexidine was alleged to have been responsible. In one of these cases [15] a whole syringe of 0.5% chlorhexidine in alcohol was mistakenly injected into the epidural space; in another case it was suggested that a syringe of bupivacaine injected spinally had become contaminated with ‘a measurable quantity’ (defined as 0.1 ml or more) of 0.5% chlorhexidine in alcohol [16]. All patients developed a chronic adhesive arachnoiditis with a similar clinical course of progressive neurological deterioration leading to paraplegia [15-18].

Limited information is available on the risk of neurotoxicity with chlorhexidine. In 1955, Weston-Hurst reported that the neurotoxic concentration of aqueous chlorhexidine when injected into the cerebrospinal fluid (CSF) of monkeys appeared to be in the region of 0.05% [19]. In 1984, Henschen and Olsen showed that injection of just 5 µl of 0.05% aqueous chlorhexidine into the anterior chamber of the eye produced adrenergic nerve degeneration in rats, and the authors postulated that the thin unmyelinated nerves of the central nervous system might be equally affected [20]. There are no experimental data on the risk of neurotoxicity when using needles contaminated with chlorhexidine in either animals or humans.
It has been suggested that alcohol, which constitutes the main component of chlorhexidine solutions, might be the causative neurotoxic agent [21]. Alcohol-induced neurolysis is well established and is used therapeutically in a number of procedures [22]. Accidental injection of a syringe of alcohol (with or without chlorhexidine) into the epidural space may therefore be expected to result in neurological injury, although the effect of the tiny quantities that may contaminate a spinal needle has been questioned [23].

In a recent editorial on skin antisepsis for CNB [24], the author concluded that chlorhexidine in alcohol should still be used since the potential for neurotoxicity was outweighed by the superiority in reducing surgical site infection. Other bodies have drawn the same conclusion: the Royal College of Anaesthetists (in the NAP 3 report*) [1], the American Society of Anesthesiologists [2] and the American Society of Regional Anesthesia [3] all recommend chlorhexidine in alcohol as the skin disinfectant of choice for CNB. None of these guidelines specifies the concentration of chlorhexidine to use, although the authors of the NAP 3 report have stated that in their opinion, based on the limited evidence available, 0.5% chlorhexidine in alcohol is the optimum skin preparation for CNB [25].

*NAP 3 report: national audit of major complications of central neuraxial block in the United Kingdom

Method of application
Since it is possible that cases of arachnoiditis have been caused by accidental contamination of needles, syringes and catheters used for CNB with antiseptic, a method of skin application that minimises the risk of contamination of equipment should be used.

Traditionally, antiseptic solutions were poured into a gallipot on the anaesthetist’s sterile field. However, if there is another open container for a fluid intended for neuraxial injection (e.g. saline), the potential for a crossover error is created (the aetiology in one of the cases of arachnoiditis [15]). Moreover, Evans et al. [26] showed that pouring chlorhexidine into a gallipot generates splash that spreads up to 40 cm. The authors recommended that antiseptic solutions should not be poured into containers located on the same tray as equipment for CNB, and suggested the equipment be covered until the back has been prepared with antiseptic.

Presoaked antiseptic sponge applicators (‘swabsticks’) are now commonly used for skin preparation before central venipuncture and other procedures. Because the antiseptic solution is contained within the hollow of the handle, fluid spillage should be minimised. However, it has been observed that leakage of antiseptic solution over the operator’s gloves may occur via a
hole at the end of the handle when the device is held upside down (hole below the level of the antiseptic reservoir) to clean a patient’s back [18]. Currently, the ‘swabstick’ applicators available in the UK and Ireland contain a 2% solution of chlorhexidine in alcohol. A 0.5% version is not currently available, and is unlikely to come onto the market in the near future.

Skin antisepsis prior to CNB using 0.5% chlorhexidine in 70% alcohol (Hydrex® solution, Ecolab Ltd, Leeds, UK) from a multi-use spray bottle is widely practised in the UK. Advocates of this technique argue that contamination is minimised: the fluid is kept in a closed container and it can be applied at a distance from the sterile field. However, others have suggested that spraying may result in aerosol contamination of equipment with chlorhexidine and may compromise sterility by missing an area of skin [27]. Malhotra et al. [28] showed that a single spray application of 0.5% chlorhexidine in alcohol sterilised the skin over the lumbar spine in healthy volunteers. The authors concluded that repeated application was unnecessary, and might increase the risk of contamination of the CSF if the antiseptic was not allowed to dry completely. Robins et al. [29] compared application of chlorhexidine using a spray with application from a sachet in patients undergoing combined spinal-epidural anaesthesia (CSE). Both techniques were effective in reducing skin colonisation, but the time to achieve skin preparation was significantly shorter in the spray group.

Use of chlorhexidine in children
Chlorhexidine has been used for vaginal lavage, whole body cleansing and umbilical cord care in large well-designed clinical trials on tens of thousands of neonates without significant adverse events [30,31]. Despite its proven efficacy, there are concerns about the risk of skin reactions and percutaneous absorption into the bloodstream with chlorhexidine, particularly in preterm and low birth weight infants. Transient contact dermatitis has been reported in preterm, very low birth weight infants after long-term placement of chlorhexidine-impregnated dressings for central venous catheters. [32] However, it has been suggested that the effect may have been caused by external pressure from the dressing rather the chlorhexidine itself [33]. Alcohol-based chlorhexidine preparations have been reported to cause burns in infants of 24 – 26 weeks’ gestational age [34,35]. There are few data addressing the potential for chlorhexidine absorption following topical application. Cowan et al. [36] took blood samples from 24 infants after whole body bathing with 4% aqueous chlorhexidine and found that five had detectable chlorhexidine levels. All were less than 36 weeks’ gestational age and the authors suggested that their immature skin was likely to have increased the permeability of the epidermis. The clinical significance of traces of chlorhexidine in the blood is unknown. There are no
established values for a safe concentration of chlorhexidine in the blood, and there are no reports of adverse consequences as a result of absorption of chlorhexidine in neonates [37]. Because of the limited safety data in neonates, the Society for Healthcare Epidemiology of America states ‘chlorhexidine products are not approved by the US Food and Drug Administration for children younger than two months of age’ [38]. Despite this recommendation, chlorhexidine is commonly used in neonatal intensive care units in the United States, mostly for central venous access device skin preparation and maintenance [39].

Other infection control precautions for CNB
Application of antiseptic to the skin is only one component of aseptic technique prior to CNB. Both the AAGBI and OAA have issued guidance on the other precautions that should be employed [40,41]. These include thorough hand washing with surgical scrub solution, the wearing of a cap, mask, sterile gown and gloves, and the use of a large sterile drape [3]. The Working Party is aware that some anaesthetists do not employ this level of asepsis for spinals or ‘one-shot’ epidurals but believes that full aseptic precautions are required whenever CNBs are performed. The NAP 3 report stated that aseptic technique had been suboptimal in a number of the reported cases of epidural abscess [1].

Skin antisepsis for peripheral nerve blocks
These guidelines address only CNBs. However, as the nerves targeted by some peripheral nerve blocks (PNBs) lie a shorter distance beneath the skin than the neuraxis, and the evidence of the neurotoxicity of chlorhexidine is not restricted to the neuraxis, it seems reasonable to extend the guidance that 0.5% chlorhexidine in alcohol be used for CNBs to PNBs as well.

Suggestions for further research
1. The duration of antiseptic action required for different types of CNB may vary. A single intrathecal injection may only require antisepsis for a few minutes whereas insertion of an epidural catheter requires antisepsis to be maintained throughout the time the catheter remains in situ. Isopropyl alcohol causes a rapid reduction in the number of skin microorganisms but does not have any residual activity. In comparison, chlorhexidine exerts an antiseptic effect for up to 24 hours [42]. Hibbard et al. [43] compared the effect of 70% isopropyl alcohol with 2% chlorhexidine in alcohol on abdominal sites. The authors found that both maintained antimicrobial activity for at least six hours, but the chlorhexidine solution was more effective at 24 hours. It may be that isopropyl alcohol alone could
provide adequate antisepsis for a single injection CNB, obviating the need for chlorhexidine and avoiding exposure of the neuraxis to a neurotoxic substance. A CNB involving an indwelling catheter, on the other hand, probably requires the more prolonged action of a chlorhexidine solution. Research is needed comparing the duration of antimicrobial activity of 0.5% chlorhexidine in alcohol with 70% isopropyl alcohol when used for CNB.

2. Costerton has shown that *Staphylococcus epidermidis* exists at depths of up to five cell layers in the skin [44]. Dead skin cells are constantly being shed along with the colonising bacteria. These, together with sebum, sweat and environmental material, form an oily layer covering the skin. It is possible that a single application of antiseptic to the skin removes bacteria from this oily layer covering the surface, but is ineffective at removing bacteria at depth. It might be more effective first to apply an antiseptic that will dissolve this oily surface layer and remove its bacteria. This could then be wiped away before applying antiseptic again to remove bacteria living within the epithelium. This ‘apply-wipe-apply’ technique requires *in vitro* and *in vivo* investigation.

3. Several cases of severe neurological damage have been attributed to contamination of equipment for CNB with chlorhexidine in alcohol, caused by splashes, aerosols, or insertion through solution that has not dried on the skin, or through chlorhexidine crystals that have dried on the skin [16-18]. However, there are no experimental data to support these allegations. Animal studies are needed to address the risk of 0.5% and 2% chlorhexidine in 70% alcohol, and 70% alcohol alone, in causing neurological damage from such sources of contamination.

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All AAGBI guidelines are reviewed to ensure relevance/accuracy and are updated or archived when necessary. Date of review: 2019.