

Legionnaires' disease (p.176) is commonly transmitted via cooling water in **air conditioning** systems or **hot water** supplies. Hyperchlorination has been attempted to eradicate the organism from contaminated water sources but has been largely ineffective^{6,7} and is no longer recommended. Other disadvantages of using chlorine-based systems at these temperatures and concentrations are corrosion of the plumbing system⁷ and the production of potentially carcinogenic byproducts.⁸ Effective disinfection can be achieved by raising and maintaining the water temperature above 50°, ultraviolet light, and copper-silver ionisation.

Haemodialysis patients are exposed to large quantities of municipal drinking water as it is used for the production of **dialysis** fluids and may also be used for dialyser rinsing and reuse. Many of the chemical substances in the water, such as calcium, sodium, aluminium, chloramines, fluoride, copper, zinc, sulfates, and nitrates are potentially dangerous for dialysis patients, and can lead to acute or chronic poisoning. There is also a microbiological risk associated with the control of bacterial growth in the water treatment and distribution system. Contaminants are therefore removed by water purification systems. Water is pre-treated with activated carbon filters to remove chlorine and its derivatives and other suspended particles, and the hardness of the water is decreased with sodium exchange cationic resins, which remove calcium and magnesium. The final purification process then involves the removal of dissolved salts, bacteria, and endotoxins by reverse osmosis. Reverse osmosis membranes need to be regularly disinfected with chemical agents (such as hypochlorite and peracetic acid), heat, or ozone.⁹

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Hand hygiene

Hospital-acquired infections, including those due to multi-drug-resistant pathogens, such as methicillin-resistant *Staphylococcus aureus*, vancomycin-resistant *Staph. aureus*, and vancomycin-resistant enterococci, are a major problem in health care facilities.¹ Hand hygiene is one of the most important factors in preventing such infections, as it prevents transmission of pathogens by contact and the faecal-oral route. However, healthcare workers frequently do not wash their hands, and compliance rarely exceeds 40%.² A randomised study³ to compare the efficacy of an alcohol-based solution for hand rubbing with hand washing with a medicated soap in reducing bacterial hand contamination during routine patient care found that the alcohol-based solution was significantly more effective (83% reduction versus 58%). The authors considered that the difference in efficacy might have been due to the duration of hand washing. Participants rubbed or washed their hands for about 30 seconds, but the recommended duration for hand washing is 30 seconds to 1 minute, a time that was adhered to in less than 35% of instances.

Authorities recommend^{1,2} that alcohol-based hand rubs should replace hand washing as the standard for hand hygiene in all situations in which the hands are not visibly soiled. The basis for this is that hand rubbing requires less time, is microbiologically more effective, and is less irritating to skin than traditional hand washing with soap and water. The CDC in the USA advises⁴ hand washing with a non-antimicrobial or antimicrobial soap and water when hands are visibly dirty or contaminated with proteinaceous material, blood, or other body fluids and if exposure to *Bacillus anthracis* is suspected or proven. Alcohols, chlor-

hexidine, iodophores, and other antiseptic agents are not recommended for *B. anthracis* contamination as they have poor activity against the spores. If hands are not visibly soiled, an alcohol-based hand rub may be used. Decontamination of the hands with an antiseptic hand rub or hand wash should occur before direct contact with patients, and before putting on sterile gloves when inserting catheters or other invasive devices that do not require a surgical procedure. Decontamination of the hands should also occur after contact with a patient's intact or non-intact skin, body fluids, mucous membranes, and wound dressings if hands are not visibly soiled. Hands should be decontaminated if moving from a contaminated body site to a clean body site during patient care, after contact with inanimate objects (including medical equipment) in the immediate vicinity of the patient, and after removing gloves. When performing surgical procedures hand hygiene with either an antimicrobial soap or an alcohol-based hand rub with persistent activity is recommended before putting on sterile gloves.

The CDC⁴ considers that the best antimicrobial efficacy can be achieved with alcohol (ethanol), isopropyl alcohol, and propyl alcohol, as their activity is broad and they are fast acting. Ethanol at high concentrations is the most effective treatment against non-enveloped viruses, whereas propyl alcohol seems to be more effective against the resident bacterial flora. Combinations of alcohols may have a synergistic effect. The antimicrobial efficacy of chlorhexidine (2 to 4%) and triclosan (1 to 2%) is both lower and slower. Bacterial resistance may occur, although the risk is higher for chlorhexidine than triclosan. Even if used in conjunction with hand washing, they are still less effective than the alcohols. Plain soap and water has the lowest efficacy of all.

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Injection site and catheter care

The need to disinfect the skin before injection is controversial.¹ Routine skin preparation of the injection site by swabbing with antiseptic has been reported to be both ineffective and unnecessary.^{2,3} Central venous and arterial catheters, however, require the application of strict aseptic technique and injection site antiseptics to reduce the chance of infection.⁴ Disinfection of catheter insertion sites with aqueous chlorhexidine 2% has been reported to be associated with fewer local and systemic infections than site preparation with either 10% povidone-iodine solution or 70% isopropyl alcohol,⁵ although this has been challenged.⁶ A subsequent study reported lower rates of catheter colonisation and catheter-related infection with an alcoholic solution of chlorhexidine 0.25% and benzalkonium chloride 0.025% than with povidone-iodine 10%.⁷ In a study in preterm infants, technique had greater influence on bacterial counts at injection sites than the antiseptic used; chlorhexidine 0.5% in isopropyl alcohol and aqueous povidone-iodine 10% were equally effective, but cleansing with alcoholic chlorhexidine for 30 seconds or for two 10-second periods was more effective than cleansing for 5 or 10 seconds.⁸

The use of catheters impregnated with antiseptics or antibacterials has also been studied. Catheters impregnated with chlorhexidine and sulfadiazine silver on the external luminal surface, appear to be effective in reducing both catheter colonisation and related bloodstream infection in high-risk patients when used within 14 days.⁹ Central venous catheters impregnated with minocycline and rifampicin have been reported to be associated with a lower infection rate than standard silicone catheters¹⁰ and those impregnated with chlorhexidine and sulfadiazine silver.¹¹

Guidelines have been produced for the prevention of infection associated with both peripheral intravascular and central venous catheterisation.^{12–14}

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Pre-operative skin disinfection

Skin preparation with antiseptics before surgery is generally carried out in an attempt to reduce the risks of surgical infection (see p.195), but the evidence base for the practice is conflicting. The CDC recommends¹ pre-operative cleaning of skin at the incision site with either iodophores (e.g. povidone-iodine), alcohol-containing products, or chlorhexidine gluconate. While alcohol is considered to be the most effective and rapidly acting skin antiseptic, there are no appropriate studies to assess comparative efficacy. Furthermore, an analysis² of randomised studies comparing the use of pre-operative skin antiseptics with no antiseptics and studies comparing different skin antiseptics, found that there was insufficient evidence to conclude whether pre-operative skin antiseptics were effective in preventing postoperative surgical wound infection.

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Wound disinfection

Antiseptic preparations are widely used to treat or prevent superficial infections and wounds, but their usefulness on broken skin and wounds has been questioned.¹ For further information on wound care, see p.1585. Chlorine-releasing antiseptic solutions are generally regarded as irritant and although there is little direct evidence in patients there is concern that they may delay wound healing. Cetrinide,² tosylchloramide sodium,³ hydrogen peroxide 3%,⁴ iodophores,⁴ and sodium hypochlorite solutions² are all reported to be cytotoxic *in vitro* or in animal models. Long-term or repeated use of these antiseptics for wound cleaning should probably be avoided. Chlorhexidine is relatively non-toxic.^{2,3}

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Acridine Derivatives

Acridina, derivados.

Description. Acridine derivatives are a group of quinoline antimicrobial dyes structurally related to acridine.