5. Schiøtz HA. Antiseptic catheter gel and urinary tract infection after short-term postoperative catheterization in women. *Arch Gynecol Obstet* 1996; **258:** 97–100.
6. Webster J, *et al*. Water or antiseptic for periurethral cleaning before urinary catheterization: a randomized controlled trial. *Am J Infect Control* 2001; **29:** 389–94.
7. Koskeroglu N, *et al*. The role of meatal disinfection in preventing catheter-related bacteriuria in an intensive care unit: a pilot study in Turkey. *J Hosp Infect* 2004; **56:** 236–8.

Preparations

BP 2008: Chlorhexidine Irrigation Solution; Chlorhexidine Mouthwash; Lidocaine and Chlorhexidine Gel;
USP 31: Chlorhexidine Gluconate Oral Rinse.

Proprietary Preparations (details are given in Part 3)
Arg.: Antiminth; Biguanex; Bucogel; Elugel; Finaplac; Hexidin; Hexil; Hexil-P; Hibiscrub; Hiboquad†; Laclorhex; Periodil; Pervinox Clorhexidina; Pervinox Incoloro; Plac Out; Strictus†; ***Austral.:*** Anti-Plaque Chewing Gum†; Bactigras; Bush Formula†; Catheter Preparation; Clorhexitulle†; Hexol†; Microshield 2, 4, and 5; Periogard Chlorohex†; Plaqacide†; Savacol Mouth and Throat Rinse; ***Austria:*** Chlorhexamed; Plak Out; ***Belg.:*** Astrexine; Baxil; Cedium Chlorhexidine; Corsodyl; Golaseptine; Hansamedic; Hibidil; Hibiguard; Hibiscrub; Hibitane; Medisepta; Mefren; Nolargin; Pixidin; Sterilon; Uro-Tainer†; ***Braz.:*** Asseptic; Glucohex†; Hibitane; Marclorhex; Merthiolate†; Noplak; ***Canad.:*** Bactigras; Baxedin; Hibidil; Hibitane; Peridex†; Spectro Gram; Stanhexidine; ***Chile:*** AB; Agermin†; Bucoseptil; Freshmel; Garonsept; Graneodin; Hibicrick†; Hibiscrub†; Oralgene; Ortoxine; Peridentt†; Perio-Aid; Periokin; Perioxidin†; ***Cz.:*** Corsodyl; Hibiscrub†; Septofort; ***Denm.:*** Hibitane; Periochip; ***Fin.:*** Corsodyl; Klorhexol; Travahex; ***Fr.:*** Biorgasept; Collunovar; Corsodyl; Dermachrome; Diaseptyl; Dosiseptine; Elgydium; Eluge; Euraxsepti; Exoseptoplix†; Hibidil; Hibiscrub; Hibisprint; Hibitane; Paroex; Plurexid; Prexidine; Septeal; Septiapaisyl; Septivon; ***Ger.:*** Bactigras†; Cathejell S; Chlorhexamed; CHX Dental Gel; Cidegol C; Dentosmin P; Frubilurgyl†; Gurgellosung Chauvin†; Hansamed Spray†; Lemocin CX; Nur 1 Tropfen Chlorhexidin; Periogard Chlorohex†; Trachisan N†; ***Gr.:*** Hibitane; Periochip; ***Hong Kong:*** Bactigras†; Corsodyl; Hexol†; Hibiscrub†; Hibitane†; Hydrex; Qualikin; Scanlin; ***Hung.:*** Septofort; ***India:*** Orinse; ***Indon.:*** Mediscrub; ***Irl.:*** Corsodyl; Hibiscrub; Hibitane; ***Israel:*** Alcoxidine; Bactoscrub; Bactosept; Cleardent; Corsodyl; Medident; Periochip; Pharma-Dentix; Septadine Scrub; Septal; Septalone; Septol; Tarodent; Uniscrub†; Unisept†; ***Ital.:*** Benodent; Benodent CLX; Broxodin; Clarifex; Clomirex; Clorosan; Corsodyl; Dempol; Dentosan Clorexidina; Dentosan Parodontale; Eburos; Ekuba; Esoform Mani; Golasan; Iodosan Clorexidina; Lenil; Master-Aid; Neo Perginol†; Neo-Destomygen; Neomercurocromo; Neoxene; Neoxinal; Parodontax; Periogard Chlorohex; Plak Out; Sicura 3; Triseptil; ***Malaysia:*** Antibex†; Antisol†; Baby Shield Plus; Bactigras; Hibiscrub†; Hibisol†; Hibitane†; Oradex†; Sepsol†; ***Mex.:*** Hibiscrub†; Perioxidin; ***Neth.:*** Chlorhexamed; Corsodyl; Hibiscrub; Hibitane; Hydrex; Irrisol; Lifo-Scrub; Periochip; Sterilon; Urogliss-S; ***Norw.:*** Corsodyl; Hibiscrub; Hibitane; Periochip; ***NZ:*** DP Hand Rub; Hibitane; Riotane; ***Philipp.:*** Bactigras; Orahex; ***Pol.:*** Septofervex; ***Port.:*** Bexident; Cloraldin; Corsodyl; Dialens; Handscrub; Hibitane; Lifo-Scrub; Periochip; Plak Out†; ***Rus.:*** Elgydium (Эльгидиум); Elugel (Элюгель); Hexicon (Гексикон); Intim (Интим)†; ***S.Afr.:*** Bactigras; Corsodyl; D-Germ; Hexidin; Hibidil†; Hibiscrub; Hibitane; Orosept; ***Singapore:*** Acnederm Wash; Baby Shield Plus; Chlorohex; Elgydium; Elugel; Hexodane Mouthwash; Hexoscrub; Pfizer Obstetric Lotion†; ***Spain:*** Clorxil†; Cristalcrom; Cristalmina; Curafil; Cuvefilm; Deratin; Hibimax; Hibiscrub; Menalmina; Septisan; ***Swed.:*** Cervitec†; Corsodyl; Descutan; Hexident; Hibiscrub; Hibitane; Periochip; ***Switz.:*** Chlorhexamed; Chlorohex†; Corsodyl; Dentohexine; Hibidil; Hibiscrub; Hibitane; Lifo-Scrub; Periochip; Plak Out; ***Thai.:*** Bacard Antiseptic; Bactigras; C-20; Chlorhex; Desmanol G†; Hexene; Hexide; Hexol†; Hibiscrub†; Hibitane†; Hidine†; Hydrex; Q-Bac; ***Turk.:*** Cloder; Disinfecting; Klorheksol; Klorhex; Mediscrub; Oroheks; ***UAE:*** Zordyl; ***UK:*** Acriflex; Bactigras; Cepton; Chlorohex; Corsodyl; Curasept; CX Powder; Elgydium; Hibiscrub; Hibitane; Hydrex; Savlon Antiseptic Wound Wash; Serotulle; Spotoway; Steripod Chlorhexidine Gluconate; Unisept; Uriflex C; ***USA:*** Betasept; Dyna-Hex; Exidine; Hibiclens; Hibistat; Peridex; Periochip; Periogard; ***Venez.:*** Peridont.

Multi-ingredient: ***Arg.:*** Antiseptic Plus; Buclorhex; Consil; Dexatopic†; Drill; Elgydium; Elgydium Dientes Sensibles; Elgyfluor†; Eludril; Fluorexidina†; Hexil Antiseptico; Instillagel; Merthiolate NF; Odontobiotic†; Parodium; Periobacter; Periobacter Prof Avio; Periodent; Periodil; ***Austral.:*** Acnederm Foaming Wash; Curacleanse†; Difflam-C; Hamilton Body Lotion†; Hamilton Cleansing Lotion†; Hemocane; Medi Creme; Medi Pulv; Microshield Antiseptic; Microshield Handrub; Microshield Tincture; Mycil Healthy Feet; Nasalate; Oralife Peppermint; Paraderm Plus; Pro-PS†; Savlon Antiseptic; Seda-Gel†; Silvazine; Soov Cream; Xylocaine Jelly with Chlorhexidine; ***Austria:*** Bepanthen Plus; Cathejell; Cathejell mit Lidocain; Dermaspray; Endosgel; Instillagel; Skinsept mucosa; Uromont; Vitawund; ***Belg.:*** Angiocine; Cathejell; Cetavlex; Dermaspray†; Eludril; HAC; Hacdil-S; Hibitane; Instillagel; Medica; Neo-Cutigenol; Neo-Golaseptine; Nestosyl; Sabenyl; Vita-Mefren†; ***Braz.:*** Effaclar; ***Canad.:*** Avagard CHG; Baxedin 2% - 70%; Flamazine C†; Savlodil; Spectro Tar†; ***Chile:*** AB Antitusivo; Cariax; Endogel Esteril; Freshmel Tos; Graneodin N†; Graneodin-Tos; Halita; Medisept†; Oralgene; Orthokin; Perio-Aid c Cloruro de Cetilpiridinio; ***Cz.:*** Bepanthen Plus; Cyteal; Drill; Hexoral; Hexoraletten N; Hibicet Hospital Concentrate†; Instillagel; N-Septonex†; Skinsept mucosa†; ***Denm.:*** Hexokain; Instillagel; ***Fin.:*** Duocort; Sibicort; Toncils; ***Fr.:*** Alco-Aloe; Aphtoral; Biseptine; Cantalene; Chlorispray†; Collu-Blache†; Collustan†; Cyteal; Dacryne; Dermaspraid Antiseptique; Dermobacter; Drill; Elgydium Dents Sensibiles; Elgyfluor†; Eludril; Instillagel; Mercryl; Mercrylsoins; Nostril; Parodium; Parogencyl sensibilite gencives; Paroplak; Posine†; Spitaderm†; Thiovalone; ***Ger.:*** Bepanthen Antiseptische; Cathejell mit Lidocain; Desmanol†; Endosgel; Hermalind†; Hexoraletten N; Instillagel; Nystalocal; Skinsept F; Skinsept mucosa; Trachisan†; Uro-Stilloson†; ***Gr.:*** Hibicet; Instillagel; Octrene; Trachisan; ***Hong Kong:*** Acnederm Wash; Dermobacter; Difflam-C; Hibicet Hospital Concentrate†; Hibisol†; Instillagel; Medicreme; Medipulv†; Mycil; Oragesic; Pilelife; Soov Cream; Trachisan†; ***Hung.:*** Alkcema; Alksebor; Bepanthen Plus; Drill; Instillagel; Vita-Merfen†; ***India:*** Argisept†; Burnheal†; Iteol-3; Silverex; ***Indon.:*** Dexatopic; Neo Resiguard; Pravlon; Spitaderm; ***Irl.:*** Alltracel S†; Hibicet; Hibisol; Instillagel; Mycil; Naseptin; Nystaform-HC†; Nystaform†; Savlon; ***Israel:*** Alcosept; Bepanthen Plus; Cathejell; Cetrin; Instillagel†; Merfen; Neocutan Silver; Savior; Septacare†; Septadine; Sterets H; Tisept; Travasept; V-Tabur; Vita-Merfen NF; ***Ital.:*** Bactigras; Baxidin; Benodent; Benodent Gel Gengivale†; Biopatch; Cetrexidin; Cetrisan; Citroclorex; Citromed; Citromed 80 and 85; Citromed Chirurgico; Citromedics Pronto; Citrosteril Pronto; Clorexan; Clorexan Ferri; Clotramid†; Cuprosodio Plus; Decon Lavanda; Dentaton; Dentosan Azione Intensiva; Dentosan Mese; Dentosan Placca & Carie; Disinfene; Eso Ferri Plus; Eso S 80; Esosan Pronto; Farvicett; Handexin; Hibizene; Neo-Stomygen; Neogyn; Ninfagin; Panseptil; Parogencyl Gengive Delicate; Rexichlor; Sicura3 Medical; Simp; Simpottantacinque; Spitaderm; Steridol†; Videorelax†; ***Malaysia:*** Acnederm Foaming Wash; Cathejell with Lidocaine; Difflam-C; Elan-Forte; Hibicet†; Horf; Oral-Aid; Trachisan†; ***Mex.:*** Instillagel†; Perioxidin; ***Neth.:*** Dexatopic†; Endosgel; Hibicet concentraat; Hibicet verdunning; Hibisol; Instillagel; Spitaderm; Urogliss; ***Norw.:*** Bacimycin; ***NZ:*** Acnederm Foaming Wash; Acnederm Wash†; Conditioning Solution†; Difflam-C; Egomycol†; Medicreme; Medipulv; Oralife Peppermint; Paraderm Plus; Savlon; Silvazine; Soov Cream; Xylocaine with Chlorhexidine†; ***Philipp.:*** Cathejell; ***Pol.:*** Bepanthen Plus; Sebidin; ***Port.:*** Alkagin; Alphacedre; Bepanthene; Bepanthene Plus; Biofluor Plus†; Biofluor Prevencao†; Cathejell; Cyteal; Drill; Eludril; Hibitane Menta†; Hibitane†; Instillagel; Lactigriet; Lubrificante Anestesico; ***Rus.:*** Bepanthen Plus (Бепантен Плюс); Cathejell with Lidocaine (Катеджель С Лидокаином)†; Cyteal (Цитеал); Drill (Дрилл); Elgyfluor (Эльгифлуор); Eludril (Элюдрил); Lysoplac (Лизоплак); Metrogyl Denta (Метрогил Дента); Parodium (Пародиум); Sebidin (Себидин); ***S.Afr.:*** Andolex-C; Cathejell with Lidocaine; Germolene; Hibicet†; Naseptin; Orochlor; ***Singapore:*** Cyteal; Difflam-C; Elgyfluor; Eludril; Hexodane Handrub; Oral-Aid; Savlon†; Silvazine; Silvin; Soov Cream; Trachisan; ***Spain:*** Angileptol; Bucodrin; Bucometasana; Bucospray; Drill; Eludril; Faringesic; Gargaril; Garydol; Hibitane; Mastiol; Menalcol; Mercryl Plus; ***Swed.:*** Instillagel; ***Switz.:*** Antebor N; Bepanthene Plus; Collu-Blache; Collunosol-N; Eludril; Eubucal†; Galamila; Gleitmittel†; Hibital; Hibitane Teinture; Lidohex†; Merfen; Nystacortone†; Nystalocal; Trachisan†; Vita-Hexin; Vita-Merfen; ***Thai.:*** Bacard; Cathejell with Lidocaine; Chlorhex-C; Dekka; Frebac; Hibicet†; Inhibac; Sepdine†; Septone†; ***Turk.:*** Bepanthene Plus; Dervanol; Gleitgelen; Hemoralgine; Kloroben; Pantenol Plus; Savlex; Savonol; Savrolin; Setilin; ***UK:*** Cathejell with Lidocaine; ChloraPrep; Clearasil Pore Cleansing Lotion; Covonia Throat Spray; Cyteal; Dermol; Eludril; Germolene; Germoloids†; Hibicet†; Hibisol; Instillagel; Medi-Swab H; Medi-Wipe; Mycil; Naseptin; Nystaform; Nystaform-HC; Quinoderm Antibacterial Face Wash; Savlon Antiseptic Cream; Savlon Antiseptic Liquid; Sterets H; Steripod Chlorhexidine Gluconate with Cetrimide†; Tisept; Torbetol; Travasept; ***USA:*** BactoShield; Fresh-N-Free.

Chlorinated Lime

Bleaching Powder; Cal clorada; Calcaria Chlorata; Calcii Hypochloris; Calcium Hypochlorite; Calcium Hypochlorosum; Calx Chlorata; Calx Chlorinata; Chloride of Lime; Chlorkalk; Chlorure de Chaux; Cloruro de Cal; Desmanche.
CAS — 7778-54-3.

Pharmacopoeias. In *Br.* and *Jpn*.
BP 2008 (Chlorinated Lime). A dull white powder with a characteristic odour, containing not less than 30.0% w/w of 'available chlorine'. It becomes moist and gradually decomposes on exposure to air, carbon dioxide being absorbed and chlorine evolved. Partly soluble in water and in alcohol.

Adverse Effects, Treatment, and Precautions
As for Sodium Hypochlorite, p.1661.

Uses and Administration
Chlorinated lime is a disinfectant and antiseptic with the general properties of chlorine (p.1638).

Its action is rapid but brief, the 'available chlorine' soon being exhausted by combination with organic material. It is used to disinfect faeces, urine, and other organic material, and as a cleansing agent for lavatories, drains, and effluents.

Chlorinated lime is used in the preparation of Surgical Chlorinated Soda Solution (BPC 1973) (Dakin's Solution) which has been employed as a wound disinfectant, and Chlorinated Lime and Boric Acid Solution (BP 1993), (Eusol), which has been used as a disinfectant lotion and wet dressing, sometimes with equal parts of liquid paraffin. However, such solutions are irritant when applied undiluted, and are no longer recommended for use in this way. In addition, there is some evidence that such chlorine-releasing solutions may delay wound healing (see Disinfection, Wounds under Uses and Administration of Sodium Hypochlorite, p.1662).

Preparations
BPC 1973: Surgical Chlorinated Soda Solution.

Chlorine

925; Chlor; Chlore; Chlorium; Cloro; Klor.
Хлор
Cl_2 = 70.906.
CAS — 7782-50-5.

Description. Chlorine is a greenish-yellow gas with a suffocating odour; commonly available as a pressurised liquid.

Adverse Effects and Treatment
Chlorine gas is irritant and corrosive producing inflammation, burns, and necrosis. Inhalation may result in coughing, choking, headache, dyspnoea, dizziness, expectoration of frothy white sputum (which may be blood stained), a burning chest pain, and nausea. Bronchospasm, laryngeal oedema, acute pulmonary oedema with cyanosis, and hypoxia may occur. There may be vomiting and development of acidosis. Death may result from hypoxia.

Some of the toxicity of chlorine may be due to its dissolution in tissue water to produce hydrochloric acid and hypochlorite. After exposure to chlorine, conjunctivitis may require a topical anaesthetic and frequent irrigations of water or saline. Respiratory distress should be treated with inhalations of humidified oxygen and bronchodilators; mechanical ventilation may be required. Corticosteroids have been given in an attempt to minimise pulmonary damage but their benefit is unproven. Acidosis may require the intravenous use of sodium bicarbonate or other suitable alkalising agent.

◊ Experience gained from 186 cases of acute chlorine exposure indicated that medical support was required for only a short time even when exposure was repeated;[1] late sequelae were not seen, even in patients with abnormal respiratory function tests or blood gases on admission. Thirteen children who were accidentally exposed to chlorine products and gas at a community swimming pool complained of eye and throat irritation, chest pain and tightness, shortness of breath, wheezing, and anxiety and 5 children with hypoxia required hospital admission. These children received humidified oxygen, salbutamol, and, in 4 patients, methylprednisolone, and all were discharged 1 to 2 days later.[2] Another report on 76 children with chlorine poisoning revealed that the longest period of hospitalisation was 12 hours after treatment with oxygen and corticosteroids.[3] A 14-year-old boy with a history of asthma exposed to chlorine gas developed acute respiratory distress syndrome and required intubation, ventilatory support, salbutamol, and corticosteroids. He was extubated after 19 days and recovered well.[4] There have been reports of deliberate inhalation of chlorine,[5,6] in one instance for pleasure,[5] leading to severe adverse effects. Some individuals may be unduly insensitive to chlorine-induced irritation and workers should be warned that concentrations of chlorine which can be tolerated for short periods without undue discomfort can still cause serious injury which may not be immediately apparent.[6]

Guidelines[7,8] have been issued for the management of chlorine exposure.

1. Barret L, Faure J. Chlorine poisoning. *Lancet* 1984; **i:** 561–2.
2. Sexton JD, Pronchik DJ. Chlorine inhalation: the big picture. *Clin Toxicol* 1998; **36:** 87–93.
3. Fleta J, *et al*. Intoxication of 76 children by chlorine gas. *Hum Toxicol* 1986; **5:** 99–100.
4. Traub SJ, *et al*. Case report and literature review of chlorine gas toxicity. *Vet Hum Toxicol* 2002; **44:** 235–9.
5. Rafferty P. Voluntary chlorine inhalation: a new form of self-abuse? *BMJ* 1980; **281:** 1178–9.
6. Dewhurst F. Voluntary chlorine inhalation. *BMJ* 1981; **282:** 565–6.
7. Department of Health. Chlorine: guidelines for action in the event of a deliberate release (issued February 2004). Available at: http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1194947362398 (accessed 27/08/08)
8. Agency for Toxic Substances and Disease Registry. Medical management guidelines (MMGs) for chlorine (Cl). Available at: http://www.atsdr.cdc.gov/MHMI/mmg172.html (accessed 15/03/06)

Effects on the eyes. Eye examinations of 50 subjects immediately before and after swimming in a chlorinated pool (chlorine range 1.0 to 1.5 ppm) showed that 68% had symptoms of corneal oedema and 94% had corneal epithelial erosions. No subject had a measurable decrease in visual acuity.[1]

1. Haag JR, Gieser RG. Effects of swimming pool water on the cornea. *JAMA* 1983; **249:** 2507–8.

Precautions
The antimicrobial activity of chlorine disinfectants is reduced by the presence of organic material and by increasing pH. Hypochlorite solutions may delay wound healing (see Disinfection: Wounds under Uses and Administration of Sodium Hypochlorite, p.1662).

Uses and Administration
Chlorine is a disinfectant with a rapid potent brief bactericidal action. It is capable of killing most bacteria, and some fungi, yeasts, algae, viruses, and protozoa. It is slowly active against spores.

It is used for the treatment of water (p.1623), but for most other purposes it is used in the form of hypochlorites, organic and inorganic chloramines, chlorinated hydantoins, chlorinated isocyanurates, and similar oxidising compounds capable of releasing chlorine. In the presence of water these compounds produce hypochlorous acid (HOCl) and hypochlorite ion (OCl^-) and it is generally considered that the lethal action on micro-organisms is due to chlorination of cell protein or enzyme systems by nonionised hypochlorous acid, although the hypochlorite ion may also contribute.

The activity of most of the compounds decreases with increase of pH, the activity of solutions of pH 4 to 7 being greater than those of higher pH values. However, stability is usually greater at an alkaline pH.

The potency of chlorine disinfectants is expressed in terms of **available chlorine**. This is based on the concept of chlorine gas (Cl_2) as the reference substance. Two atoms of chlorine (2 × Cl) yield in water only one

molecule of hypochlorous acid (on which activity is based), while hypochlorites and chloramines yield one molecule of hypochlorous acid for each atom of chlorine as shown in the following equations:

$$Cl_2 + H_2O \leftrightarrow HOCl + H^+ + Cl^-$$

$$NaOCl + H_2O \leftrightarrow HOCl + NaOH$$

Thus the assayed chlorine in such compounds has to be multiplied by 2 to produce 'available chlorine'. The term 'active chlorine' has been used confusingly for either 'available chlorine' (Cl_2) or 'combined chlorine' (Cl).

Because they have relatively low residual toxicity, chlorine compounds are useful for the disinfection of relatively clean impervious surfaces, such as babies' feeding bottles, baths, and food and dairy equipment. A concentration of 100 to 300 ppm of 'available chlorine' is used; a detergent may be added to ensure wetting of the surface. Solutions containing 1000 ppm 'available chlorine' are recommended for minor surface contamination and as part of general good hygiene practice. Solutions containing 10 000 ppm 'available chlorine' are used to disinfect surfaces contaminated with spilled blood or body fluids; this strength is effective against viruses including human immunodeficiency virus (HIV) and hepatitis B virus (p.1623). A concentration providing 20 000 ppm 'available chlorine' is used for material from patients with Creutzfeldt-Jakob disease (p.1622).

On a large scale, chlorine gas is used to disinfect public water supplies. On a smaller scale, the use of chlorine compounds is more convenient and sodium hypochlorite, tosylchloramide sodium, chlorinated lime, chlorine dioxide, or halazone are used. After satisfying the chlorine demand (the amount of chlorine needed to react with organic matter and other substances), a free-residual content of 0.2 to 0.4 ppm 'available chlorine' should be maintained, though more is required for alkaline waters with a pH of 9 or more. For the disinfection of potentially contaminated water a concentration of 1 ppm is recommended. Excessive residual chlorine may be removed by adding a little citric acid or sodium thiosulfate.

For use in small swimming pools, sodium or calcium hypochlorite may be added daily to maintain a free-residual 'available chlorine' concentration of 1 to 3 ppm. Tosylchloramide sodium, chlorinated lime, and the isocyanurates (see Troclosene, p.1665) may also be used. To minimise irritation of the eyes, maintain disinfectant activity, prevent precipitation of salts, and prevent metal corrosion, a pH of 7.2 to 7.8 should be maintained.

Solutions of chlorine-releasing compounds are also used in wound desloughing and disinfection (but see Disinfection: Wounds, under Sodium Hypochlorite, p.1662).

Chlorine Dioxide

926; Cloro, dióxido de.

ClO_2 = 67.45.

CAS — 10049-04-4.

Profile

Chlorine dioxide is a strong oxidising agent with the general properties of chlorine (p.1638). It is rapidly active against vegetative bacteria, including mycobacteria, and viruses and is also sporicidal. It is used for disinfection of medical equipment either in gaseous form or in a solution that requires activation before use and yields 700 to 1100 ppm 'available chlorine' (see p.1638) . Chlorine dioxide is irritant to the skin, eyes, and respiratory tract and should be stored in sealed containers. It is potentially corrosive to many materials and solutions may contain corrosion inhibitors.

Chlorine dioxide is also used for treatment and disinfection of water supplies.

◊ General references.

1. WHO. Chlorine dioxide (gas). *Concise International Chemical Assessment Document 37* Geneva: WHO, 2002. Available at: http://www.who.int/ipcs/publications/cicad/en/cicad37.pdf (accessed 14/03/06)

Disinfection of endoscopes. Chlorine dioxide solutions are used as an alternative to glutaral for the disinfection of endoscopes (p.1623).

Halitosis. Chlorine dioxide has been used in mouthwashes for the control of halitosis.[1]

1. Frascella J, *et al.* Odor reduction potential of a chlorine dioxide mouthrinse. *J Clin Dent* 1998; **9:** 39–42.

Preparations

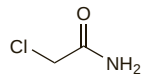
Proprietary Preparations (details are given in Part 3)
Belg.: Retardex; ***Philipp.:*** Oracare; ***UK:*** Retardex.

Chloroacetamide

Chloracetamide; Cloroacetamida. 2-Chloroacetamide.

C_2H_4ClNO = 93.51.

CAS — 79-07-2.



Profile

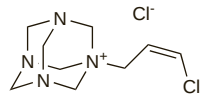
Chloroacetamide is a preservative that has been used in topical pharmaceutical preparations and cosmetics.

N-(3-Chloroallyl)hexaminium Chloride

N-(3-Cloroalil)hexaminio, cloruro de; Quaternium-15. 1-(3-Chloroallyl)-3,5,7-triaza-1-azoniaadamantane chloride.

$C_9H_{16}Cl_2N_4$ = 251.2.

CAS — 4080-31-3.



Profile

N-(3-Chloroallyl)hexaminium chloride is an antimicrobial preservative used in pharmaceutical preparations and cosmetics. Skin reactions have been reported.

Chlorobutanol *(BAN, rINN)*

Acetone-Chloroforme; Alcohol Trichlorisobutylicus; Chlorbutanol; Chlorbutanolum; Chlorbutol; Chloretone; Chlorobutanolis; Chlorobutanolum; Clorobutanol; Klooributanoli; Klorbutanol; Klorobutanol; Trichlorbutanolum. 1,1,1-Trichloro-2-methylpropan-2-ol.

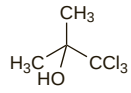
Хлоробутанол

$C_4H_7Cl_3O$ = 177.5.

CAS — 57-15-8 (anhydrous chlorobutanol); 6001-64-5 (chlorobutanol hemihydrate).

ATC — A04AD04.

ATC Vet — QA04AD04.



Pharmacopoeias. *Eur.* (see p.vii), *Int.*, and *USNF* allow either the anhydrous form or the hemihydrate; *Eur.* includes them as separate monographs. *Chin.* specifies the hemihydrate. *Jpn* permits up to 6% of water.

Ph. Eur. 6.2 (Chlorobutanol Hemihydrate; Chlorobutanol BP 2008). A white or almost white, crystalline powder or colourless crystals. It sublimes readily. M.p. about 78°. Slightly soluble in water; very soluble in alcohol; soluble in glycerol (85%). Store in airtight containers.

Ph. Eur. 6.2 (Chlorobutanol, Anhydrous). A white or almost white, crystalline powder or colourless crystals. It sublimes readily. M.p. about 95°. Slightly soluble in water; very soluble in alcohol; soluble in glycerol (85%). Store in airtight containers.

USNF 26 (Chlorobutanol). It is anhydrous or contains not more than one-half molecule of water of hydration. Colourless or white crystals with a characteristic, somewhat camphoraceous odour. M.p. about 76° for the hemihydrate and about 95° for the anhydrous form. Soluble 1 in 125 of water, 1 in 1 of alcohol, and 1 in 10 of glycerol; freely soluble in chloroform, in ether, and in volatile oils. Store in airtight containers.

Incompatibility and stability. The activity of chlorobutanol can be adversely affected by the presence of other compounds as well as by the packaging material. There may be sorption onto substances like magnesium trisilicate, bentonite, carmellose,[1] polyethylene,[2,3] or polyhydroxy-ethylmethacrylate that has been used in soft contact lenses.[4] Increasing heat[2,3] or pH[5,6] can reduce stability and activity.

1. Yousef RT, *et al.* Effect of some pharmaceutical materials on the bactericidal activities of preservatives. *Can J Pharm Sci* 1973; **8:** 54–6.
2. Friesen WT, Plein EM. The antibacterial stability of chlorobutanol stored in polyethylene bottles. *Am J Hosp Pharm* 1971; **28:** 507–12.
3. Holdsworth DG, *et al.* Fate of chlorbutol during storage in polyethylene dropper containers and simulated patient use. *J Clin Hosp Pharm* 1984; **9:** 29–39.
4. Richardson NE, *et al.* The interaction of preservatives with polyhydroxy-ethylmethacrylate (polyHEMA). *J Pharm Pharmacol* 1978; **30:** 469–75.
5. Nair AD, Lach JL. The kinetics of degradation of chlorobutanol. *J Am Pharm Assoc (Sci)* 1959; **48:** 390–5.
6. Patwa NV, Huyck CL. Stability of chlorobutanol. *J Am Pharm Assoc* 1966; **NS6:** 372–3.

Adverse Effects

Acute poisoning with chlorobutanol may produce CNS depression with weakness, loss of consciousness, and depressed respiration. Delayed (type IV) hypersensitivity reactions have been reported rarely.

◊ References.

1. Nordt SP. Chlorobutanol toxicity. *Ann Pharmacother* 1996; **30:** 1179–80.

Effects on the cardiovascular system. Rapid falls in arterial blood pressure were observed after injections of heparin containing chlorobutanol in patients undergoing coronary bypass.[1] No fall in blood pressure was seen in patients who received preservative-free heparin injection.

1. Bowler GMR, *et al.* Sharp fall in blood pressure after injection of heparin containing chlorbutol. *Lancet* 1986; **i:** 848–9.

Effects on mental function. The sedative effects of chlorobutanol have been reported to be a problem in a patient dependent on large doses (0.9 to 1.5 g daily with salicylamide 1.8 to 3.0 g daily)[1] and in another patient given high doses of morphine in an infusion preserved with chlorobutanol.[2]

1. Borody T, *et al.* Chlorbutol toxicity and dependence. *Med J Aust* 1979; **i:** 288.
2. DeChristoforo R, *et al.* High-dose morphine infusion complicated by chlorobutanol-induced somnolence. *Ann Intern Med* 1983; **98:** 335–6.

Hypersensitivity. A delayed, cellular type of hypersensitivity reaction to chlorobutanol used to preserve heparin injection after subcutaneous injection has been reported.[1] Pruritus from intranasal desmopressin has been attributed to the chlorobutanol preservative.[2]

1. Dux S, *et al.* Hypersensitivity reaction to chlorbutanol-preserved heparin. *Lancet* 1981; **i:** 149.
2. Itabashi A, *et al.* Hypersensitivity to chlorobutanol in DDAVP solution. *Lancet* 1982; **i:** 108.

Uses and Administration

Chlorobutanol has antibacterial and antifungal properties and it is used at a concentration of 0.5% as a preservative in injections and in eye drops as well as cosmetics.

Chlorobutanol has been used as a mild sedative and local analgesic but other compounds are preferred. It has been used in preparations for inflammatory and painful conditions of the ear and oropharynx.

Preparations

Proprietary Preparations (details are given in Part 3)
Fr.: Optrex; ***Port.:*** Vizoptal†.

Multi-ingredient: ***Arg.:*** Eludril; Otocalmia; ***Austral.:*** Cerumol; ***Austria:*** Aleot; ***Belg.:*** Eludril; Givalex; Prurisedine; ***Braz.:*** Auritricin; Lavolho†; ***Canad.:*** Cerumol; ***Fr.:*** Alodont; Balsamorhinol; Eludril; Givalex; ***Ger.:*** Givalex†; ***Hong Kong:*** Fungifax†; ***India:*** Andre; Clearwax; Waxolve; ***Irl.:*** Cerumol; Karvol; ***Israel:*** Cepadont; Cerumol; Dentin; Karvol; Pitrisan; ***Ital.:*** Fialetta Odontalgica Dr Knapp; Odontalgiche (Dentali)†; ***Malaysia:*** Cerumol; ***NZ:*** Frador; ***Port.:*** Eludril; Otoceril; ***Rus.:*** Eludril (Элюдрил); ***S.Afr.:*** Aurone Forte; Cerumol; Chamberlains Traditional Colic Remedy; Karvol; ***Singapore:*** Cerumol; Eludril; Karvol; ***Spain:*** Eludril; Otocerum; ***Switz.:*** Alodont†; Cerumenol; Eludril; ***Thai.:*** Opplin†; Optal; Optic; ***Turk.:*** Disinol; ***UK:*** Cerumol; Cetanorm; DDD; Dermidex; Eludril; Frador; Karvol; Monphytol†; ***USA:*** Outgro.

Chlorocarvacrol

5-Chlorocarvacrol; Clorcarvacrol; Clorcarvacrolum; Kloorikarvakroli; Klorkarvakrol; Monochloroisothymol. 4-Chloro-5-isopropyl-2-methylphenol.

$C_{10}H_{13}ClO$ = 184.7.

CAS — 5665-94-1.

Profile

Chlorocarvacrol is a phenolic antiseptic that is used as an ingredient of preparations for anorectal disorders.

Preparations

Proprietary Preparations (details are given in Part 3)

Multi-ingredient: ***Austria:*** Delta-Hadensa; Hadensa; Haemanal; ***Chile:*** Vatanal; ***Fin.:*** Hadensa; ***Ger.:*** Alcos-Anal†; ***Neth.:*** Epianal; ***Norw.:*** Alcos-Anal; ***Spain:*** Hadensa; ***Turk.:*** Hedensa.