National Collaborating Centre for Environmental Health

Centre de collaboration nationale en santé environnementale

Cleaning, Disinfection, and Sterilization at Personal Service Establishments

Daniel Fong and Prabjit Barn

Introduction

Health concerns regarding the transmission of infections at personal service establishments (PSEs) are often mitigated by public health inspectors (environmental health officers). Inspection of PSEs are carried out to ensure that premises have adequate cleaning, disinfection, and sterilization protocols to reduce the risk of transmitting pathogens such as human immunodeficiency virus (HIV), hepatitis B virus, hepatitis C virus, and herpes simplex virus, as well as fungal and bacterial infections of the skin.[1,2]

This document is intended for use by public health inspectors and clarifies the role of cleaning, disinfection, and sterilization in reducing the risk of injury and transmission of communicable diseases in PSEs. Concerns regarding disinfectants (health effects, dangers of mixing, effects on equipment) and unreliable methods of achieving sterilization are discussed. Furthermore, common equipment and instruments in PSEs are classified as critical, semi-critical, and non-critical items (using the Spaulding classification) and tabulated with their recommended levels of disinfection/sterilization. It is important to note that many critical items (e.g., piercing studs and disposable tattoo needles) are often pre-sterilized, single-use, and disposable.

Cleaning

Cleaning involves the removal of debris (organic and inorganic material) from a surface. This is accomplished by using mechanical methods (e.g., manual scrubbing, ultrasonic cleaning) in combination with detergents and water. Floors and furniture are routinely cleaned and, if necessary, may only require low level disinfection. Nonetheless, operators of PSEs are expected to have a regular cleaning schedule and documented procedures for cleaning, disinfection, and sterilization.

Cleaning is a critical step in the processes of disinfection and sterilization, as these latter treatments require a surface with minimal organic/inorganic load so the activity of the disinfectant or sterilant will be focused on destroying microorganisms.[3,4] Proper cleaning is especially important for items requiring high-level disinfection or chemical sterilization, including callus removal blades and piercing needles. Inadequate cleaning of instruments and surfaces increases the risk of disease transmission; proper cleaning is especially important in settings where procedures require pre-sterilized equipment (e.g., tattoo/piercing establishments).

Disinfection

Disinfection involves the destruction of pathogenic or potentially pathogenic microorganisms (bacteria, viruses, fungi, endospores) from an environmental surface or inanimate object.[5] The use of chemicals and wet-pasteurization (e.g., exposure to hot water for a sufficient period of time) are methods of disinfecting surfaces. Disinfectants are classified by Health Canada according to standards in the *Assessment of Efficacy of Antimicrobial Agents for Use on Environmental Surfaces and Medical Devices* (CAN/CGSB-2.161-97) from the Canadian General Standards Board.[5] Three general levels of disinfection (low, intermediate, high) exist and are based on the type of organisms they destroy and levels of disinfection for which they are intended (see Table 1).

Efficacy of disinfection

Several factors can impact the effectiveness of disinfectants, including:

- Bioburden (organic and inorganic load);
- Number and type of microorganisms present;
- Texture and composition of the item/surface being disinfected;
- Concentration and type of disinfectant;
- Contact time (period of time surface is exposed to treatment).

To maximize the effectiveness of disinfection[3]:

- Ensure there is substantial reduction in bioburden through adequate cleaning prior to disinfection.
- Consider the type of microorganisms that can potentially be present on the surface to be treated (e.g., Is the surface exposed to blood, skin, and other debris?).
- Consider the texture and composition of the item being treated (e.g., size, crevices, joints, many parts).
- Choose the appropriate type and concentration of chemical for the objective level of disinfection required (i.e., high, intermediate or low level).
- Ensure proper use of the disinfectant by following the manufacturer's instructions (e.g., allow for adequate contact time, many require air drying vs wiping to remove residual).

Level of disinfection for items at personal service establishments

Depending on the type of instruments used and procedures performed at a PSE, particular levels of disinfection are required to minimize health risks. Instruments can be categorized into critical, semi-critical, and non-critical items, depending on their required level of disinfection (summarized in Table 2). Although this classification system is intended for devices used at health-care settings, some provinces have adapted this system for PSEs.[1,6,7]

Instruments and equipment used directly for invasive procedures are often single-use, sterile, and disposable. This standard is used in many provincial guidelines for PSEs in order to reduce the risk of transmitting diseases through critical instruments or equipment that cannot be adequately disinfected or sterilized between uses. These pre-sterilized items (e.g., disposable tattoo needles) must be kept in their original sterile packaging, used promptly after opening, and appropriately disposed of after use. Disposable coverings (e.g., plastic wrap or bag) are used to

cover instruments or equipment that cannot be easily disinfected or sterilized between uses (e.g., tattoo machines, electrolysis control panels).

Drug Identification Number (DIN)

Disinfectants/sterilants are classified as drug products and must be approved by Health Canada before they can be sold in Canada.[5] Health Canada ensures that disinfectants and sterilants are in compliance with regulations governing labelling (including instructions for use), safety, and good manufacturing practices and also reviews manufacturers' claims about the product (e.g., whether it is a sporicide, virucide, bactericide).[5,8] Once approved, unique eight-digit Drug Identification Numbers (DINs) are assigned to products.

Consumers, including PSE operators and staff, should be aware that using drug products without a DIN may be unsafe or ineffective for their intended purposes (e.g., disinfection). A database for drug products including disinfectants, approved for sale in Canada, can be found at the Drug Product Database.[9]

Concerns with disinfection

Health effects associated with disinfectants

By definition, disinfectants are intended for use on inanimate objects and surfaces to destroy microorganisms; adverse effects may result if living tissue is exposed to disinfectants. Generally, acute dermal or inhalation exposure to chemical disinfectants may cause skin, eye, and respiratory tract irritation, burning sensations, blistering, and burns.[3,10,11]

Chronic inhalation exposure can occur in occupational settings where high-level disinfectants are used frequently without proper ventilation or use of personal protective equipment, including nitrile gloves and safety goggles. Chronic effects may persist even with the absence of exposure to disinfectants.

Although many disinfectants are respiratory and skin irritants, glutaraldehyde, a high level disinfectant, is especially known for its adverse health effects resulting from occupational exposure.[12] It is extremely toxic and use of the product requires adequate ventilation and protective equipment to minimize the level of exposure. Furthermore, inadequate rinsing of residual disinfectant can lead to adverse health effects in persons subsequently exposed to the equipment or instrument. For example colitis (inflammation of the colon) reportedly has been induced by glutaraldehyde disinfectant residual on endoscopes.[13]

Public health inspectors may work with operators to review the disinfection products at PSEs to ensure there is adequate equipment, storage area, and physical space to prevent health hazards from occurring when using or handling a product. Furthermore, these chemicals should be stored in areas only accessible to staff (e.g., away from non-employees or children). To protect themselves and their clients, personal service workers are encouraged to read and understand the manufacturer's recommended safety precautions and instructions before using any chemical products (e.g., product labels, material safety data sheets/MSDS).

Dangers of mixing different types of disinfectants

Different types of disinfectants should never be used simultaneously. Many disinfectants are oxidizers that readily react with other compounds to generate toxic by-products which may

result in adverse health effects. Bleach (chlorine-based disinfectant) is a readily available multi-purpose disinfectant which, if mixed with other disinfectants or cleaning products, can create hazardous conditions. Public health inspectors may review sanitation procedures with operators to ensure mixing of products does not occur.

Chlorine compounds and ammonia
Mixing chlorine-based disinfectants with ammonia-based products (e.g., QUATs) generates chloramines.[14] Chloramines have a characteristic odour commonly associated with chlorinated swimming pools. Besides neutralizing the disinfectant activity of the chlorine-based disinfectant, the formation of chloramines can cause skin, eye, and respiratory tract irritation and induce asthma in sensitive individuals.[15,16]

Chlorine compounds and acids
Chlorine gas can be released from reactions between chlorine-based disinfectants and acidic products (e.g., peroxyacetic acid, acetic acid). This gas reacts with moisture to form acids (hydrochloric and hypochlorous acid) which can irritate the skin, eyes, and respiratory tract. Exposure may lead to coughing, chest tightness, breathing difficulty, headache, and nausea.[17] Asthma-like symptoms may result and could lead to a build up of fluid in the lungs, as well as chest pain.[14,16] Unconsciousness or death can result from inhalation of high concentrations (1000 ppm) of chlorine gas.[18]

Chlorine compounds and peroxides
Oxygen gas may form when chlorine compounds and peroxide products mix (e.g., hydrogen peroxide, accelerated hydrogen peroxide).[14] Bubbling may cause spills if large volumes are mixed rapidly. This can lead to splashing of these corrosive disinfectants onto the skin or into the eyes, causing irritation or chemical burns.

Adverse effects on equipment
In general:

- Chlorine-based disinfectants may corrode metal and destroy adhesives.[3]
- Accelerated hydrogen peroxide (7%) and hydrogen peroxide (6%) are strong oxidants and can damage iron, brass, zinc, and copper.[19]
- Alcohol (60-95%) can damage rubber and plastic.[3]
- Iodophors may corrode metals as well as stain synthetic materials.[4]

Sterilization

Sterilization is a level of disinfection that involves the complete destruction of *all* microorganisms, including bacterial endospores.[3,5] This high level of decontamination requires specialized equipment and vigilant monitoring to maintain efficacy. Methods include the use of high temperature steam/dry air under pressure (autoclave), ethylene oxide gas, hydrogen peroxide gas plasma, or chemical sterilants. Autoclaves may be used as a method of sterilization in some PSEs, including tattoo parlours. Autoclaves should be tested on a regular basis, as specified by the health authority; records of their tests should be kept for inspection purposes (e.g., monthly spore testing).[20] Some high level disinfectants can also be used as chemical sterilants (i.e., they are sporicidal) but take a significantly longer processing/contact time (many hours) to achieve sterilization.

Health departments may require tests and/or records that show the efficacy of any method used for sterilization before they are approved for use. For example, this is usually the case if operators are using methods of treatment that claim to be effective for sterilization but have yet to become an established practice. Some examples are provided in the following section.

Unreliable methods for achieving sterilization

Misconceptions regarding sterilization have been exacerbated by the wide-spread availability of antimicrobial technologies, products, and methods. Many of these methods are inadequate to achieve an acceptable level or standard of treatment,[4,21] including: use of ultraviolet radiation, glass bead "sterilizers," pressure cookers, ultrasonic cleaners, microwave ovens, and pasteurization (hot/boiling water). When used in combination with approved sterilization methods or as methods of pre-cleaning or disinfection, some of these methods can maximize the effectiveness of sterilization methods such as autoclaving or chemical sterilization.

Public health inspectors may encounter some of the outlined methods during an inspection and will need to ensure that adequate sterilization methods are being applied or that only single-use, disposable equipment is used. Prospective operators may also inquire about the type of sterilization equipment that would be adequate for the types of services performed at their establishment.

Ultraviolet (UV) radiation

By exposing microorganisms to sufficient doses of UV radiation, they can be inactivated (i.e., cannot reproduce). However, the major disadvantage of this technology is that microorganisms are shielded from their antimicrobial effects by any debris between the microorganism and the source of UV radiation; therefore, the necessary disruption of nucleic acid for inactivation cannot be achieved. Debris on the instruments, as well as irregular shapes or crevices, can effectively prevent UV light from penetrating microorganisms. Additionally, not all pathogens can be inactivated; bacterial spores are resistant to UV radiation and require prolonged exposure to inactivate them, rendering this method impractical for sterilization.[22,23] UV radiation should only be used as a secondary form of treatment, following the use of an approved method of disinfection.

Glass bead sterilizers

This method relies on exposing small instruments to superheated glass beads (approx. 230°C) to inactivate microorganisms. The efficacy of this technology has been disputed because the temperature of the instrument being sterilized cannot be monitored or assured to reach sterilization conditions. Inconsistent heating, air gaps, and irregular shapes or crevices of instruments can impede sterilization and lead to unacceptable risks.[4,24]

Pressure cookers

The pressure generated by heating water in a sealed vessel can allow water to heat up to temperatures above 100°C without boiling. Although conventional pressure cookers may achieve temperatures and pressures similar to autoclaves, the reliability of pressure cookers to maintain sterilization conditions is questionable. Time, pressure, and temperature monitoring is inadequate and accuracy cannot be assured. Importantly, household pressure cookers are not required to meet the same quality standards (e.g., ANSI/AAMI ST55, EN 13060) or validation/regulatory requirements for the construction and operation of autoclaves, as the intended use of each device is drastically different. However, tabletop autoclaves are available and acceptable for sterilization purposes.

Microwave ovens
Studies have shown that the standard of sterilization cannot be reliably achieved through the use of conventional microwave ovens. This standard is based on the inactivation of the extremely heat resistant spores of *Bacillus stearothermophilus* bacteria (*B. stearothermophilus*).

Spores of *B. stearothermophilus* remain active even after extended irradiation using high powered microwave ovens (e.g., 1400W microwave oven for 20 minutes).[25,26] Furthermore, the effectiveness of microwave irradiation is dependent on water availability and type of material.[26-29] Uneven distribution of heat/microwaves may lead to *cold spots* and inconsistent results.[3,4,30] This issue is especially important for objects that have a complex internal structure.

Other issues include: fire and explosion hazards, risk of burns/injury, compromised integrity of objects (e.g., plastics melting), electrical arcs from metal objects, and mechanical malfunctions.

Ultrasonic cleaners
These devices, when used with a cleaning solution, are used for cleaning by means of mechanical action from the implosion of cavitation bubbles (small air bubbles) generated by ultra-high frequency sound waves. As these devices are very effective for cleaning, their use prior to autoclaving or chemical sterilization may be recommended or required by some health authorities. However, ultrasonic cleaning has no significant effect on inactivating microbes and is not acceptable as a replacement for either disinfection or sterilization.

Studies have noted that cleaning solution itself can harbour microbes and attach to surfaces of subsequently cleaned instruments.[31,32] The ultrasonic solution should be changed daily, as per manufacturer's instructions, or as required upon visual inspection.[1] A cover/lid must be used to prevent the escape of aerosols generated during the operation of ultrasonic cleaners, as they can carry pathogens through the air.

Pasteurization
Exposing instruments to hot (e.g., 70°C for 30 minutes) or even boiling water is inadequate for sterilization as the temperatures are insufficient to inactivate bacterial endospores.[3,21] Steam-based sterilizers are required in order to produce temperatures high enough to inactivate bacterial endospores (e.g., 121°C for 30 minutes).

Acknowledgements

We would like to thank Bonnie Henry, Thomas Fuller, Joanne Edwards, Melanie Cyrenne, and Sarah MacDougall for their valuable input and review of the draft document. Guidance for the development of this document was provided by Mona Shum and Karen Rideout. Library assistance was provided by Michele Wiens.

Table 1. Examples of high-, intermediate-, and low-level disinfectants

Level of disinfection [1,3,5]	Example disinfectant trade names
High-level disinfection (HLD): • Destruction of all microbial pathogens, including mycobacteria; levels of spores are reduced but high levels of spores are not completely eliminated at practical exposure times.	• Cidex®, MetriCide®, Omnicide®, Sonacide®, Wavicide® • Cidex OPA®, MetriCide® OPA Plus • ACCEL® CS 20, RAPICIDE PA®, STERIS 20 • 5.25-6.15% household bleach (1:10 diluted to achieve 5000 ppm)
Intermediate-level disinfection (ILD): • Destruction of all microbial pathogens; has mycobactericidal properties, but spores are not eliminated by this level of disinfection.	• BioMERS, BioSURF, BioTEXT, BM-6400™, Gamut Plus, Instrubex-E, SEPTeFX® 7D-TEXT, tb Minuteman, $T^3$6® Disinfex • 5.25-6.15% household bleach (1:50 diluted to achieve 1000 ppm)
Low-level disinfection (LLD): • Destruction of most microbial pathogens, but does not reliably kill mycobacteria, fungi, and non-lipid viruses; spores are not eliminated by this level of disinfection.	• Barbicide, Zepamine-A • Environ™ LpH™, Lysol • Virox 5, Carpe Diem • 5.25-6.15% household bleach (1:500 diluted to achieve 100 ppm)

Table 2. Common critical, semi-critical, and non-critical items found at personal service establishments[*1-3,5,6,33-35]

Item classification	Description	Risk of transmitting infection if contaminated	Minimum level of treatment to reduce risk	Items at personal service establishments[†]				
				Body Piercing	Tattooing/ Micropigmentation	Electrolysis	Hairdressing/ Barbering	Esthetics (waxing, makeup, manicure/pedicure, etc.)
Critical	Items that present a high risk of infection if they are not sterile (such as items that enter/penetrate into sterile tissues of the body[a])	Extremely high	Sterilization	• Piercing needles • Needle pushers • Needle receiver tubes • Insertion tapers • Clamps • Forceps • Containers that hold sterile instruments • Ring-opening or ring-closing pliers • Implants • Jewellery (rings, studs, barbells) inserted into a new piercing • Gauze for aftercare	• Tattooing needles[b] • Needle bar[b] • Metal tube[b] • Grip[b] • Gauze for aftercare	• Electrolysis needles • Hypodermic needles/ lancets • Forceps	• Fixed straight razors (single-use disposable recommended)	• Lancets • Tweezers (if used to break skin and remove ingrown hairs) • Extractor needle and loop (single-use disposable recommended)

*This table is meant to illustrate how some PSE tools are categorized with respect to required level of disinfection. Since these categorizations may differ slightly by jurisdiction, applicable provincial/territorial guidelines should be consulted to obtain information on levels of cleaning, disinfection, and/or sterilization required for specific tools.

†Note: Any reusable instrument or equipment that is suspected to have contact with blood or bodily fluids must be disinfected with a high level disinfectant, at minimum.

Semi-critical	Items that contact mucous membranes or non-intact skin, but do not normally penetrate sterile areas of the body	Moderate to high	High level disinfection	• Calipers • Swabs/gauze for cleaning	• Pigment/ink trays • Chuck/clamp[b]	• Scissors • Cords[c] • Needle holder pin device[c] • Needle holder tip[c] • Eye protection	• Electric clippers/blades • Razor handles/cradle (if used on skin) • Razors for hair • Crochet hooks	*Makeup/facial:* • Applicators contacting open lesions/infection • Comedone extractor loop *Manicure/pedicure:* • Recirculation systems (foot baths) • Callus removal blades • Cuticle pushers • Cuticle scissors • Drill bits
Non-critical	Items that only contact intact skin and not mucous membranes during routine use	Low	Intermediate- or low-level disinfection	• Ear piercing device • Service trays • Furniture • Floors	• Spray bottle • Clip cord[b] • Motor frame[b] • Service trays • Dirty-instrument container	• Swabs/ gauze for skin preparation • Control knobs/ buttons[c] • Service trays • Magnifying lamp/glass • Dirty-instrument container	• Combs/ brushes • Scissors • Service trays	*Makeup/facial:* • Brushes • Electrodes • Glass ventouse *Waxing:* • Eye protection • Spatula • Personal (roller) applicators *Manicure/Pedicure:* • Clippers/nippers • Nail files • Manicure/pedicure bowls

[a] includes items that carry/contact substances or objects which are destined to penetrate the body (e.g., containers or trays that contact sterile items or fluids)

[b] part of tattoo machine

[c] part of epilator (electrolysis machine)

References

1. Ontario Ministry of Health and Long-Term Care. Infection prevention and control best practices for personal services settings. Ottawa, ON: Ontario Public Health Division; 2008. Available from: http://www.health.gov.on.ca/english/providers/program/pubhealth/oph_standards/ophs/progstds/pdfs/pssp_2008.pdf.
2. Alberta Health and Wellness. Health standards and guidelines for barbering and hairstyling. Edmonton, AL: Government of Alberta; 2002. Available from: http://www.health.alberta.ca/documents/Standards-Barber-Hairstyling.pdf.
3. Rutala WA, Weber DJ, Healthcare Infection Control Practices Advisory Committee. Guideline for disinfection and sterilization in healthcare facilities. Atlanta, GA: Centers for Disease Control and Prevention; 2008. Available from: http://www.cdc.gov/hicpac/pdf/guidelines/Disinfection_Nov_2008.pdf.
4. Health Canada, Laboratory Centre for Disease Control. Hand washing, cleaning, disinfection and sterilization in health care. Infection control guidelines. Canada Communicable Disease Report. Vol. 24S8. Ottawa, ON: Health Canada; 1998. Available from: http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/98pdf/cdr24s8e.pdf.
5. Health Canada (Health Products and Food Branch). Guidance document: Disinfectant drugs. Ottawa, ON: Health Canada; 2007. Available from: http://www.hc-sc.gc.ca/dhp-mps/alt_formats/hpfb-dgpsa/pdf/prodpharma/disinf_desinf-eng.pdf.
6. Alberta Health and Wellness. Health standards and guidelines for tattooing. Edmonton, AL: Government of Alberta; 2002. Available from: http://www.health.alberta.ca/documents/Standards-Tattooing.pdf.
7. British Columbia Ministry of Health and Ministry Responsible for Seniors, Communicable Disease Control, Health Protection and Safety. Guidelines for personal service establishments (PSEs). Victoria, BC: Ministry of Health and Ministry Responsible for Seniors, Public & Preventive Health Division; 2000. Available from: http://www.health.gov.bc.ca/library/publications/year/2000/pse.pdf.
8. Health Canada. Drug Identification Number (DIN) (fact sheet). Ottawa, ON: Health Canada; 2009. Available from: http://www.hc-sc.gc.ca/dhp-mps/prodpharma/activit/fs-fi/dinfs_fd-eng.php.
9. Drug product database [database on the Internet]. Health Canada. 2010. Available from: http://www.hc-sc.gc.ca/dhp-mps/prodpharma/databasdon/index-eng.php.
10. National Institute for Occupational Safety and Health (NIOSH). Guidelines for protecting the safety and health of health care workers. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, NIOSH; 1988. Report No.: 88-119. Available from: http://www.cdc.gov/niosh/docs/88-119/chemical.html.
11. Health & Safey Executive (HSE). Controlling exposure to disinfectants used in the food and drink industries. Food information sheet no. 29. Merseyside, UK: UK Government, HSE; 2001. Available from: http://www.hse.gov.uk/pubns/fis29.pdf.
12. Rideout K, Teschke K, Dimich-Ward H, Kennedy SM. Considering risks to healthcare workers from glutaraldehyde alternatives in high-level disinfection. J Hosp Infect. 2005 January;59(1):4-11.
13. West AB, Kuan SF, Bennick M, Lagarde S. Glutaraldehyde colitis following endoscopy: clinical and pathological features and investigation of an outbreak. Gastroenterology. 1995 April;108(4):1250-5.

14. Sodium hypochlorite incompatibility chart. Arlington, VA: The Chlorine Institute, Inc.; 2009. Available from: http://www.chlorineinstitute.org/files/FileDownloads/SodiumHypoIncompatibilityChart-English%2020090324%20CSIT%20FINAL.pdf.
15. Mrvos R, Dean BS, Krenzelok EP. Home exposures to chlorine/chloramine gas: review of 216 cases. South Med J. 1993 Jun;86(6):654-7.
16. Pascuzzi TA, Storrow AB. Mass casualties from acute inhalation of chloramine gas. Mil Med. 1998 Feb;163(2):102-4.
17. Centers for Disease Control and Prevention. Epidemiologic notes and reports chlorine gas toxicity from mixture of bleach with other cleaning products -- California. MMWR Morb Mortal Wkly Rep. 1991 Sept 13;40(36):627-9.
18. Noltkamper D, O'Malley GF. CBRNE - lung-damaging agents, chlorine. eMedicine [serial on the Internet]. 2008; (Jul 3): Available from: http://emedicine.medscape.com/article/832336-overview.
19. National Institute for Occupational Safety and Health (NIOSH). Hydrogen peroxide. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, NIOSH; 2005. Report No.: 2005-149. Available from: http://www.cdc.gov/niosh/npg/npgd0335.html
20. Manitoba Health, Environmental Health Branch. Personal service facility guidelines. Winnipeg, MB: Government of Manitoba; 2009. Available from: http://www.gov.mb.ca/health/publichealth/environmentalhealth/protection/docs/psf_guideline.pdf.
21. British Columbia Ministry of Health, Patient Safety Branch. Best practice guidelines for the cleaning, disinfection and sterilization of medical devices in health authorities. Victoria, BC: Ministry of Health; 2007. Available from: http://www.health.gov.bc.ca/library/publications/year/2007/BPGuidelines_Cleaning_Disinfection_Sterilization_MedicalDevices.pdf.
22. Setlow P. Spores of Bacillus subtilis: their resistance to and killing by radiation, heat and chemicals. J Appl Microbiol. 2006;101(3):514-25.
23. Christofi N, Misakyan MA, Matafonova GG, Barkhudarov EM, Batoev VB, Kossyi IA, et al. UV treatment of microorganisms on artificially-contaminated surfaces using excimer and microwave UV lamps. Chemosphere. 2008;73(5):717-22.
24. Centres for Disease Control and Prevention. Bead sterilizer. Are bead sterilizers an effective means of sterilization? Atlanta, GA: U.S. Department of Health and Human Services; 2009. Available from: http://www.cdc.gov/OralHealth/InfectionControl/faq/bead.htm.
25. Dovigo LN, Pavarina AC, Ribeiro DG, de Oliveira JA, Vergani CE, Machado AL. Microwave disinfection of complete dentures contaminated in vitro with selected bacteria. J Prosthodont. 2009;18(7):611-7.
26. Najdovski L, Dragas AZ, Kotnik V. The killing activity of microwaves on some non-sporogenic and sporogenic medically important bacterial strains. J Hosp Infect. 1991 Dec;19(4):239-47.
27. Sasaki K, Mori Y, Honda W, Miyake Y. Selection of biological indicator for validating microwave heating sterilization. PDA J Pharm Sci Technol. 1998 Mar-Apr;52(2):60-5.
28. Vela GR, Wu JF. Mechanism of lethal action of 2,450-MHz radiation on microorganisms. Appl Environ Microbiol. 1979;37(3):550-3.
29. Wang J-C, Hu S-H, Lin C-Y. Lethal effect of microwaves on spores of Bacillus spp. J Food Prot. 2003;66(4):604-9.

30. Celandroni F, Longo I, Tosoratti N, Giannessi F, Ghelardi E, Salvetti S, et al. Effect of microwave radiation on Bacillus subtilis spores. J Appl Microbiol. 2004;97(6):1220-7.
31. Muqbil I, Burke FJ, Miller CH, Palenik CJ. Antimicrobial activity of ultrasonic cleaners. J Hosp Infect. 2004 July;60(3):249-55.
32. Miller CH, Riggen SD, Sheldrake MA, Neeb JM. Presence of microorganisms in used ultrasonic cleaning solutions. Am J Dent. 1993 Feb;6(1):27-31.
33. Alberta Health and Wellness. Health standards and guidelines for body and ear piercing. Edmonton, AL: Government of Alberta; 2002. Available from: http://www.health.alberta.ca/documents/Standards-Body-Ear-Piercing.pdf.
34. Alberta Health and Wellness. Health standards and guidelines for electrolysis. Edmonton, AL: Government of Alberta; 2002. Available from: http://www.health.alberta.ca/documents/Standards-Electrolysis.pdf.
35. Alberta Health and Wellness. Health standards and guidelines for ethestics. Edmonton, AL: Government of Alberta; 2002. Available from: http://www.health.alberta.ca/documents/Standards-Esthetics.pdf.

This document was produced by the National Collaborating Centre for Environmental Health at the British Columbia Centre for Disease Control, December 2012.

Production of this document has been made possible through a financial contribution from the Public Health Agency of Canada through the National Collaborating Centre for Environmental Health.

400 East Tower
555 W 12th Avenue
Vancouver, BC V5Z 3X7
Tel.: 604-707-2445
Fax: 604-707-2444
contact@ncceh.ca

www.ncceh.ca

National Collaborating Centre for Environmental Health

Centre de collaboration nationale en santé environnementale

To provide feedback on this document, please visit www.ncceh.ca/en/document_feedback