6 Basic Principles and Introduction to Disinfectants and Antiseptics for Skin, Mucosa, and Wounds

Elisabeth Presterl, Magda Diab-El Schahawi, Luigi Segagni Lusignani, Helga Paula, and Jacqui S. Reilly

6.1 Antiseptic vs. Disinfectant

Definition Antiseptic
An antiseptic is a chemical used in medicine to prevent wound infection and, subsequently, sepsis.

Antimicrobial Agent (Disinfectant)
Antimicrobial agents are applied to the surface of nonliving objects to destroy microorganisms that are living on the objects.

Nonliving surfaces = disinfectants

Live tissue = antiseptics

Unlike antimicrobial therapeutics ("antibiotics"), systemic administration is not possible as systemic side effects would exceed the antimicrobial effect.

Requirements for antiseptics: Various pathogens must be killed with sufficient certainty without damaging the patient.

E. Presterl (✉) · M. Diab-El Schahawi (✉) · L. S. Lusignani · H. Paula
Department of Hygiene and Infection Control, Medical University of Vienna, Vienna, Austria
e-mail: elisabeth.presterl@meduniwien.ac.at; magda.diab-elschahawi@meduniwien.ac.at; luigi.segagnilusignani@meduniwien.ac.at; helga.paula@meduniwien.ac.at

J. S. Reilly
Glasgow Caledonian University, Glasgow, UK
e-mail: jacquelinereilly@nhs.net

E. Presterl et al. (eds.), *Basic Microbiology and Infection Control for Midwives*,
https://doi.org/10.1007/978-3-030-02026-2_6

Requirements for Skin Antiseptics/Hand Disinfectants

- Fast action, short exposure time
- Broad spectrum of action (complete removal of transient flora)
- Reduction of the resident flora as much as possible
- Low to no absorption
- Good tolerability and low risk of allergic reactions
- Moisturizing substances (only with hand disinfectant)
- Immediate effect or residual effect according to indication
- Lack of irritation and allergenic potential
- Indications for skin antisepsis

The indication for the application of skin antiseptics is when intact skin is damaged. The purpose is to prevent the introduction of microorganisms into primarily sterile tissue, e.g., injection, puncture, surgical procedures, and set of intravascular catheters.

An exception is the eradication of pathogens, e.g., MRSA eradication.

First-choice skin antiseptics are alcohols, since they have the highest organism reduction factor (n-propanol > isopropanol > ethanol).

Depending on the indication, other substances may also be used. If one wishes to achieve a residual effect, the use of chlorhexidine or a combination of alcohols with other active ingredients is possible.

6.2 Preoperative Skin Antisepsis

Because of the risk of fire and the fastest reduction potential, alcohol with a higher flash point should be used (iso-/n-propanol). Advantage of alcohol: Fast action, easy handling, cheap.

Concentration and exposure time of the manufacturer must be taken into account with all antiseptics, and the alcohol must be allowed to evaporate completely. The performance of a preoperative skin antiseptic is obligatory.

Based on various recommendations, the following reaction times for alcoholic antiseptics should be taken into account, depending on the risk classification (Table 6.1):

Summary skin antisepsis:

- Alcohols are 1st choice drugs for skin antisepsis.
- Order of potency: n-propanol > isopropanol > ethanol.
- Microorganism reduction is more potent with longer exposure time and higher concentrations of antiseptic.
- Alcohols have no residual effect; after evaporation they have no effect. By combination with residual effect (e.g., chlorhexidine), a quick- and long-term effect can be achieved (intravascular catheters!).

Table 6.1 Reaction time for alcoholic antiseptics according to risk classification

Risk classification	Application	Alcohol-based skin antiseptic
Low risk	Blood collection, s.c., insulin injection, blood collection from fingertip, acupuncture	Min. 30 s (one application)[a]
Medium risk	i.m. injection, insertion of a peripheral venous catheter, puncture (cerebrospinal fluid, ascites, pleural puncture)	Min. 1 min (two applications)
High risk	Insertion of CVC, iliac crest puncture, puncture in regions of or in patients at particular risk of infection	Min. 5 min (three to six applications)
Sebaceous skin	Lumbar puncture	Min. 10 min

[a]Observe manufacturer instructions for contact time!

- The necessary exposure time depends on the indication and the risk.
- The rule of thumb is 30 s—1 min—5 min.
- The safest recommendation is always follow the manufacturer's instructions !!!

6.3 Wound Antisepsis

A wound infection can throw back the previous healing process significantly and can also develop into a life-threatening situation.

The classic indications of wound antisepsis are:

Prevention of wound infection—if contamination or colonization of the wound must be assumed from the outset.

Therapeutic—if there is already a clinical infection and, in addition to the systemic antimicrobial therapy, a local fast and high pathogen, elimination may be necessary.

In wound antisepsis, the transitions between a prophylactic and a therapeutic goal are usually interchangeable. The decisive criterion for selecting the wound antiseptic is the ratio between the desired microbicide and undesired cytotoxic effect. Since every acute or chronic wound has at least one or often several causes, in addition to the actual wound therapy, treatment should be considered for accompanying comorbidities. The one-sided reliance on local or systemic treatment agents is probably the most common error encountered in practice.

In addition to wound cleansing and consistent debridement, the following measures may be indispensable: a consequent venous compression (chronic venous insufficiency), the reduction of circumscribed pressure (pressure ulcers), the optimal adjustment of the blood sugar level, elimination of malnutrition, and improvement of the arterial blood circulation.

6.3.1 Co-dependence of Surgical Wound Treatment and Antiseptic

Successful wound antisepsis is inextricably linked to proper surgical wound care, including wound aftercare with appropriate dressings.

Wound debridement: The prerequisite for rapid wound healing is the debridement of dead tissue. Otherwise, the risk of infection increases due to optimal bacterial colonization conditions. Furthermore, inflammatory processes can be maintained, resulting in delayed proliferation and repair. Surgical debridement is the most effective method of removing necrotic tissue and has the advantage that further wound management can commence immediately afterward.

6.4 Frequency of Wounds and Wound Infections

6.4.1 Acute Injuries

In primary care facilities, the medical attention of acute traumatic wounds accounts for approximately 25–30% of treatments. Lacerations most commonly occur as a result of blunt trauma, cuts, abrasions, and burns, with most of these injuries responding quickly to treatment and healing without complications. Wound infections, with an incidence of approximately 3.5% in Europe and North America, are among the major complications of acute wound injury.

6.4.2 Chronic Wounds

It is estimated that approximately 5% of inpatients in hospitals and rehabilitation facilities account for chronic wound prevalence. Common infectious chronic wounds are ulcus cruris, ulcer decubitus, diabetic foot, and secondarily healing traumatic wounds (burn wounds).

6.5 Definitions

Wound Cleansing
The aim of wound cleansing is to remove possible contaminants (e.g., dirt, cell detritus from dried wound exudate, toxins, microorganisms) from the wound so as not to hinder wound healing.

Wound Decontamination
By wound decontamination, all measures are understood to mean a wound that has been contaminated with vital or avital particles. Decontamination of wounds is based solely on physical effects. Microorganisms are only removed from the wound

surface—a microbicide effect is not the primary intent. First choice agents are amphoteric surfactants.

Wound Antisepsis
Antiseptics are all antimicrobial measures on living tissue that are either prophylactic indication of an unwanted colonization or infection to prevent or treat it from a therapeutic point of view. The aim is to reduce the number of microorganisms by killing and/or inactivation or to stop their propagation definitively or at least for as long as possible. The microbiological minimum requirement for the term wound antiseptics is a reduction by 5 log levels (or 4 log levels for yeasts or under blood or exudate load ("protein error") by 3 log levels).

Disinfection
The objective of disinfection is the interruption of the infection chains by targeted or untargeted killing of pathogens on contaminated inanimate objects. See also chapter Surface, Instrument and Hand Disinfection (hand disinfection: hands—although animated tissue—are considered "instruments").

- Reliable microbicide effect (>5 log-steps reduction)
- Rapid onset of action (1–5 min)
- Effective effect in the presence of organic stress (>3 log-steps reduction)
- Low absorption, no allergy
- No induction of resistance
- No interference with normal wound healing
- Low to no cytotoxicity

6.6 Recommended Wound Antiseptics

- Short-term antiseptics: PVP-iodine, octenidine
- Long-term antiseptics: Polyhexanide, taurolidine

The criterion for selecting the wound antiseptic is the ratio between the desired microbicide and undesirable cytotoxic effects. To compare the tolerability of wound antiseptics, the biocompatibility index (BI) is suitable. Taking into account the application concentration of the active substance, testing for microbicide and cytotoxicity is carried out under the same experimental conditions.

BI = quotient of IC50 and CRF > log 3

IC50 = concentration that kills 50% of cells (fibroblasts)

CRF > log 3 = concentration which is necessary to min. 3 log levels to achieve reduction of the test organisms.

The BI is thus a dimensionless number and allows a comparison of the compatibility. A value >1 describes a good compatibility and a value <1 a poor microbicide activity combined with a high cytotoxicity.

6.6.1 PVP-Iodine

Advantages
- Rapid onset of action (30 s)
- Low loss of activity in the presence of proteins (low protein error)
- Broad spectrum of activity (bacteria, fungi, most viruses, spores, protozoa)
- Acceptable cytotoxicity
- First choice for puncture/cut injuries (HIV, hepatitis B, hepatitis C): ethanol/2-propanol with PVP-iodine

Contraindications
- Patients with overt hyperthyroidism
- Dermatitis herpetiformis
- Iodine allergy
- Not before and after radioiodine therapies

6.6.2 Octenidine Dihydrochloride

Advantages
- Onset of action (30 s to 1 min).
- No loss of effect by proteins.
- Spectrum of activity does not cover spores, but all relevant pathogens.
- No absorption.

Contraindications
- Must not be administered in the abdominal cavity, bladder, ear canal
- Allergy to octenidine

Note: Octenidine must NEVER be used in conjunction with PVP-iodine, as octenidine releases iodine radicals and results in brown discoloration and irritation of the tissue!

6.6.3 Polyhexanide

Advantages

- Very good tissue compatibility ⋄ 1st choice for chronic, poorly healing/sensitive wounds.
- Concentration of 0.04% takes 5–20 min to onset of action.
- No effect against spores, partly reduced effect against viruses.

Disadvantage

- Cartilage toxicity.
- There is a contraindication for use in the first 4 months of pregnancy.