Disinfection, sterilization and disposables

Anthony J Wilson

Sandeep Nayak

Abstract

Medical devices are one way by which healthcare-associated infections can be transmitted. Medical equipment can be categorized based on its risk of spreading infection and these categories aid decisions about whether to decontaminate or dispose of a used medical device. Decontamination is the process by which a reusable device is rendered safe for further use through cleaning and either disinfection or sterilization. It is frequently an automated process which usually involves thermal or chemical techniques and is subject to extensive quality control. Most microorganisms are inactivated or destroyed by disinfection but sterilization is required to eliminate resistant organisms and bacterial spores. Single-use medical devices are now commonplace and avoid the need for decontamination altogether.

Keywords Decontamination; disinfection; disposables; healthcare-associated infection; single-use medical device; sterilization

Royal College of Anaesthetists CPD Matrix: 1E01

Learning objectives

After reading this article you should be able to:

- define the term 'healthcare-associated infection'
- categorize commonly used anaesthetic equipment based on its potential to transmit infection
- define 'decontamination' and classify the methods by which medical equipment can be decontaminated
- discuss the merits and limitations of single-use medical devices compared to reusable ones
- outline the main steps in the decontamination process for flexible endoscopes

Healthcare-associated infections (HCAIs) are infections that develop following a medical intervention or contact in a healthcare setting. The 2011 Health Protection Agency survey of HCAIs in England revealed an overall prevalence of 6.4%, with the highest rates of HCAIs in critical care (23.4%).[1] HCAIs are estimated to cost the NHS over £1 billion per year and healthcare organizations have a legal responsibility to try to reduce the impact of HCAIs.

Anaesthetic equipment is one route by which HCAIs can spread, and the Medicines and Healthcare products Regulatory Agency (MHRA) highlighted this in 2011 when they reported on the death of a patient who developed sepsis from a contaminated laryngoscope handle[2]. The Association of Anaesthetists of Great Britain & Ireland (AAGBI) addressed the safe use of anaesthetic equipment in their guideline: *Infection Control in Anaesthesia* which supports the increasing trend in the UK towards single-use items, but there is still a need for a reliable system of decontamination for items that are impractical or too expensive to be available in single-use form.

Anthony J Wilson *MSci MBBS MRCP FRCA FFICM is a Specialist Registrar in Anaesthesia and Intensive Care Medicine, North Western Deanery, UK. Conflicts of interest: none declared.*

Sandeep Nayak *MBBS MD FRCA is a Consultant Anaesthetist at the Pennine Acute Hospitals NHS Trust, UK. Conflicts of interest: none declared.*

Classifying the risk of infection

Medical devices vary in their propensity to transmit infection and this influences the choice between single-use or and the decision to use a particular decontamination strategy. The Spaulding classification system (developed in 1968) has proved reliable in identifying the risk that a contaminated device poses to patients. Equipment is divided into three categories on the basis of how invasive it is during normal use, as follows.

Non-critical items (low risk) – items in contact with normal, intact skin or the environment (e.g. blood pressure cuff, stethoscope). Cleaning or low-level disinfection is usually adequate.

Semi-critical items (intermediate risk) – items in close contact with mucous membranes or non-intact skin (e.g. flexible endoscopes). This category also includes low-risk items which may become contaminated with readily transmissible organisms. They require cleaning followed by high-level disinfection.

Critical items (high risk) – items that penetrate skin or mucous membranes and enter normally sterile tissue (e.g. regional anaesthesia needles, vascular catheters). They must be sterile at the time of use.

Decontamination

Decontamination is the process by which a reusable medical device is rendered safe for further use. It is a combination of either cleaning *and* disinfection or cleaning *and* sterilization. With the exception of low-risk items, it is recommended that all reusable medical items should be processed by a sterile services department (SSD). Figure 1 shows how effective decontamination is a chain of events which relies on adherence to agreed protocols and good communication between hospital departments.

Cleaning

Cleaning is the physical removal of foreign material from an item. It is an essential first step in decontamination because it reduces the *bioburden* (the population of viable infectious agents contaminating a device) and because the persistence of any organic debris (e.g. blood) on an item may prevent disinfectant reaching every surface. Where appropriate, items should be

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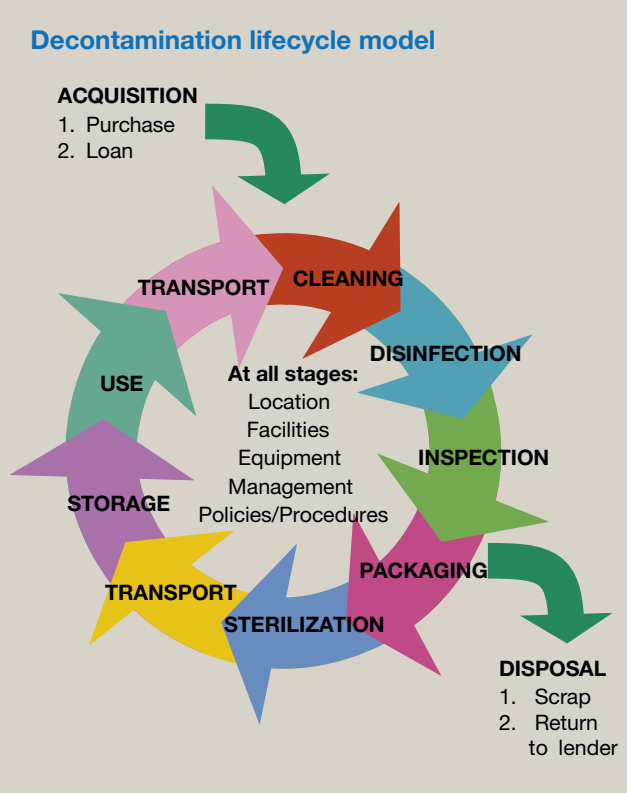

Figure 1

divided into their component parts (e.g. laryngoscope handle and blade) before cleaning to adequately expose all surfaces.

Cleaning can be manual or mechanical. Manual cleaning should only be used when automated cleaning is unavailable as mechanical processes are more amenable to quality control and protect the operator from exposure to chemicals and biohazards. A warm detergent solution is used to manually clean items. The water temperature should be around 35°C as higher temperatures may cause protein deposits to denature thereby creating a protective coating for microorganisms. Common mechanical cleaning methods include hot water disinfectors (discussed below) and ultrasonic cleaners; these usually form part of an automated decontamination process.

Ultrasonic cleaners work at low temperatures and are effective for cleaning delicate instruments. An ultrasound transducer creates numerous microscopic bubbles (cavitations) in a detergent solution. These bubbles collapse with tremendous force and this removes surface contamination without damaging the item itself.

Disinfection

Disinfection is the process by which many or all pathogenic organisms on an item are inactivated. Bacterial spores (Box 1) are not destroyed and cryptosporidia, mycobacteria and some viruses may be resistant depending on the technique chosen. A variety of methods are available, as follows.

Thermal disinfection

Hot water disinfectors combine mechanical cleaning and heat disinfection. A cool rinse and warm detergent wash (<45°C) are followed by hot water disinfection. Water temperatures greater than 65°C are needed to achieve disinfection, so cycles range from 70°C for 100 minutes to 90°C for 1 minute. It is only suitable for devices that can withstand repeated exposure to wet heat.

Pasteurization uses saturated steam below atmospheric pressure at temperatures around 75°C for 10–30 minutes; it is unsuitable for oily/greasy items.

Chemical disinfection

Chemicals are an alternative way to disinfect heat-sensitive equipment but are potentially toxic, flammable or corrosive; they can be divided into *low-level* and *high-level disinfectants*.

Low-level disinfectants (70% alcohol, chlorhexidine, iodophor and sodium hypochlorite) destroy vegetative bacteria and enveloped viruses but non-enveloped viruses, protozoan cysts, mycobacteria and bacterial endospores are more resistant.

High-level disinfectants (aldehydes, hydrogen peroxide, super-oxidized water, chlorine dioxide and peracetic acid) destroy all vegetative bacteria, viruses and fungi. With prolonged exposure they can also destroy bacterial spores and can therefore be used for sterilization. Table 1 gives examples of disinfection and sterilization regimes for common high-level disinfectants.

Ultra-violet radiation

Ultra-violet light destroys airborne organisms and inactivates organisms on surfaces. It is sometimes used in endoscope storage cabinets to limit recontamination of decontaminated scopes.

Bacterial endospores

- ***Vegetative bacteria*** describes bacteria in their active, reproducing state
- ***Bacterial endospores*** (spores) are a method by which some bacteria (e.g. clostridia, bacilli) can survive extreme environmental conditions by forming a copy of their DNA protected by a thick protein coat

Box 1

Immersion in high-level disinfectants – examples of disinfection and sterilization regimes

Disinfectant	Approximate duration of exposure	
	High-level disinfection	Sterilization
>2% Glutaraldehyde[a]	20–90 minutes	10 hours
7.5% Hydrogen peroxide	30 minutes	6 hours
>0.2% Peracetic acid at 50–55°C	Not indicated	12 minutes
0.55% Orthophthaldehyde[a]	12 minutes	Not indicated
Super-oxidized water (650–675 ppm active free chlorine)	10 minutes	Not indicated

ppm, parts per million.
[a] No longer recommended for endoscope decontamination as they fix proteins onto surfaces.

Table 1

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