

Chapter 4

Infection prevention and control

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STERILE
HAND WASHING
C. DIFFICILE
DECONTAMINATION
INFECTION
MICROBIOLOGY
CLEANLINESS
ISOLATION
E. COLI
VIRUS
PATHOGENS
HCAI
SCRUB

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Being an accountable professional

At the point of registration, the nurse will:

- 9.** Use evidence-based, best practice approaches for meeting needs for care and support with the prevention and management of infection, accurately assessing the person's capacity for independence and self-care and initiating appropriate interventions.

Future Nurse: Standards of Proficiency for Registered Nurses (NMC 2018)

Overview

This chapter begins with an explanation of the causes of infection and then focuses on healthcare-associated infections (HCAIs), specifically describing the steps to be taken to minimize the risk of individuals acquiring infections while receiving healthcare. The chapter gives an overview of key principles, terminology and definitions, and describes the standard precautions that must be taken with patients at all times regardless of their known infection status. It also covers additional precautions that may be required because the patient is colonized or infected with micro-organisms that may pose a particular risk to others, or because they are particularly vulnerable to infection themselves. The chapter additionally describes the specific precautions that must be taken during invasive procedures, in particular aseptic technique.

Infection prevention and control

Definitions

Infection prevention and control

'Infection prevention and control' has been defined as the clinical application of microbiology in practice (RCN 2017); it is a collective term for activities intended to protect people from infection. Such activities may form part of everyday life, such as washing hands after using the toilet or before preparing food. However, the term is most often used in relation to healthcare, with reference in particular to avoiding patients acquiring preventable infections.

Healthcare-associated infection

A healthcare-associated infection (HCAI) is any infection acquired as a result of healthcare contact. It has replaced the term 'hospital-acquired infection' to recognize that not all healthcare is given in a hospital. Such infections are also known as 'nosocomial' infections.

Anatomy and physiology

Pathogens are what cause infection. It is important to understand types of pathogen, how they spread and what kinds of environment are favourable for their growth so that effective infection prevention and control measures can be put in place.

Causes of infection

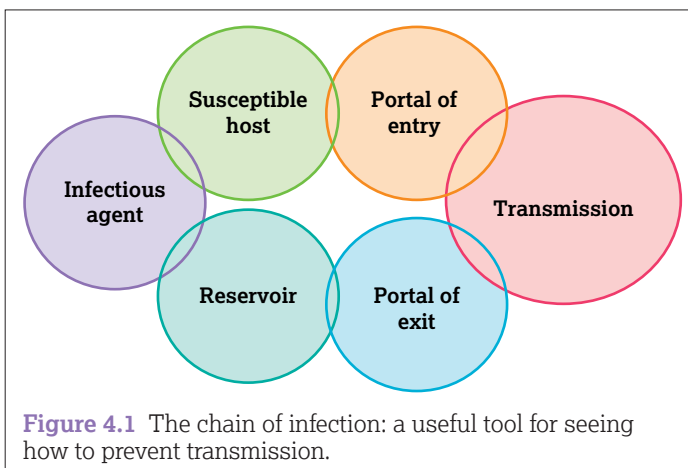
The term 'infectious agent' is often used to describe anything that may be transmitted from one person to another, or from the environment to a person, and subsequently cause an infection or parasitic infestation.

Distinct types of infectious agent act differently and have different impacts on the infected individual. For example, whether a particular infectious agent will cause an infection in any given circumstance is dependent on many factors, including how *easily* that agent can be transmitted, its *pathogenicity* (its ability to cause disease) and its *virulence* (the severity of the infection produced) (Gillespie and Bamford 2012). The *susceptibility* of the patient to infection is also a significant influence.

To practice effective infection prevention and control, it is helpful to understand the 'chain of infection' (Damani 2011). This is a helpful model to use when considering how infection can be prevented, as it shows how it is possible to break the 'links' in the chain. For an infection to exist, there must be an organism (pathogen) and it must be able to get into a susceptible host, multiply and exit. It may need a place to hide (reservoir) while waiting for the next susceptible host. Figure 4.1 illustrates the chain of infection and Table 4.1 lists the links with examples of how infection can be prevented at each link. The major groups of micro-organisms are described below.

Types and classification of micro-organisms

Historically, the classification of micro-organisms was based on physical characteristics such as their size, shape or ability to retain a particular stain to make them visible under the microscope.



Some of these distinctions are still useful, but classification is increasingly based on genetic characteristics, as increasingly sophisticated analysis techniques (such as genomic sequencing) reveal the actual relationships between organisms. This can lead to confusion as new discoveries lead to species being reclassified and renamed. For example, 'methicillin-resistant' *Staphylococcus aureus* is now 'meticillin-resistant' and *Clostridium difficile* is now termed *Clostridioides difficile*.

It should also be noted that there can be a wide variety of characteristics within each species, leading to significant variations in the severity of infection caused by different strains of the same organism. An example of this is Group A *Streptococcus pyogenes*, which is a common cause of sore throat but can also cause skin conditions such as erysipelas, scarlet fever, toxic shock syndrome and necrotizing fasciitis. Another is *Escherichia coli*, which is carried in the gut of all mammals with no ill effects but whose toxin-producing O157:H7 strain can cause serious illness.

In printed text, the names of bacteria are written in italics, with the name of the genus capitalized and the species in lower case, for example *Staphylococcus aureus*. The abbreviation 'spp.' is used to refer to all of the species of a genus, for example *Klebsiella* spp. This section gives an overview of the different types of organism that may be encountered in a healthcare environment as well as the differences between and within the types.

Bacteria

Bacteria are probably the most important group of micro-organisms in terms of infection prevention and control because they are responsible for the majority of opportunistic infections in healthcare. A healthy human being will typically be host to a quadrillion (1000 trillion or 10^{15}) bacteria – around ten times as many organisms as there are cells in the human body – and we need most of these to survive.

The so-called 'human microbiome' is increasingly being recognized as an essential part of human health (Bhalodi et al. 2019, Young 2017) and a variety of conditions – such as Crohn's disease, ulcerative colitis, irritable bowel syndrome, obesity, type 2 diabetes, Parkinson's disease, chronic fatigue syndrome, arthritis and even asthma – may all be related to disturbance of the balance of micro-organisms in the gut, although the question remains as to whether this is a cause or effect (Otter 2014, Tosh and McDonald 2012, Wang et al. 2017). See Table 4.2 for examples of how the human microbiome can be protective.

In normal circumstances, the relationship between bacteria and their host is symbiotic and the organisms are considered to be commensal (i.e. their presence does not cause the host any problems) and mutually beneficial; however, if the host has lowered resistance or a bacteria gains access to a different site, it can become an opportunistic pathogen. For example, *E. coli* from the gut may cause a urinary tract infection (with associated symptoms) if it enters the urethra and ascends the urinary tract.

Table 4.1 Links in the chain of infection

Link	Definition	Example	Examples of breaking the chain
Infectious agent	A potentially pathogenic micro-organism or other agent	<ul style="list-style-type: none"> • Smallpox • <i>Staphylococcus aureus</i> or any other bacteria 	<ul style="list-style-type: none"> • Vaccination – for example, we no longer need to worry about the virus that causes smallpox or how it is transmitted as it does not exist (except in some top-secret laboratories) • Removal of infectious agents through cleaning • Destruction of micro-organisms through sterilization of equipment • Using antibiotics to treat patients with bacterial infections
Reservoir	Any location where micro-organisms hide, exist or reproduce	<ul style="list-style-type: none"> • Humans • Dust in the healthcare environment • Sink drains 	<ul style="list-style-type: none"> • Cleaning/decontamination of equipment and the environment • Use of handwash basins for hand washing only • Flushing low-use taps and showers • Minimizing the number of people present in high-risk situations such as surgery
Portal of exit	The route by which the infectious agent leaves the reservoir	<ul style="list-style-type: none"> • Diarrhoea and vomit may carry norovirus • Droplets expelled during coughing or sneezing may contain flu 	<ul style="list-style-type: none"> • Asking a patient with active tuberculosis infection to wear a mask in communal areas of the hospital
Mode of transmission	The way the infectious agent is spread (see definitions section above)	<ul style="list-style-type: none"> • Contact • Enteric • Droplet • Airborne • Parenteral 	<ul style="list-style-type: none"> • Hands • Diarrhoea • Sneezing • Nebulizer or intubation • Needle stick injury
Portal of entry	The route by which the infectious agent enters a new host	<ul style="list-style-type: none"> • Organisms introduced into a normally sterile part of the body through use of an invasive device • Intravenous line into the bloodstream • Urinary catheter breaching the bladder • Inhalation of airborne pathogens into the lungs 	<ul style="list-style-type: none"> • Avoiding unnecessary invasive devices • Using strict aseptic technique • Staff members wearing masks when dealing with infectious agents that may be inhaled
Susceptible host	The person that the infectious agent enters has to be susceptible to infection	<ul style="list-style-type: none"> • The very old and very young are more susceptible • Underlying chronic illnesses 	<ul style="list-style-type: none"> • Ensuring adequate nutrition and personal hygiene • Vaccination – this will often completely prevent or significantly reduce the likelihood of an infection developing

Table 4.2 Examples of how the human microbiome can be protective

Bacteria	Comments
Gut flora including <i>Bacteroides</i> spp., <i>Bifidobacterium</i> spp., <i>Enterobacter</i> spp., <i>Klebsiella</i> spp., <i>Enterococcus</i> spp. and <i>Escherichia coli</i>	Disturbance through antibiotics, surgery or chemotherapy may have far-ranging effects on the human body, including obesity, inflammatory bowel diseases, antibiotic-associated diarrhoea and cancer.
Skin flora including <i>Staphylococcus epidermidis</i> , <i>Staphylococcus aureus</i> , diphtheroids and <i>Candida</i> spp.	A healthy, intact, normal resident skin flora means that pathogenic organisms are less likely to settle on the skin and cause infection.
Vaginal flora including <i>Lactobacillus</i> spp. and diphtheroids	Babies born per vagina are more likely to have their skin colonized with the 'right' organisms, which reduces problems with skin and allergies.

Despite the fact that we are surrounded by unquantifiable numbers of bacteria in our world, relatively few are pathogenic to us. There is an important balance to be struck in our home lives; we should not try to disinfect everything we come into contact with, and indeed many things around us are going to be contaminated (money, cash point buttons, our mobile phones and the handles on public transport, to name a few). If we are healthy and have good immunity and intact skin, this will often be of little consequence to us as long as we follow simple precautions such as practising hand hygiene, environmental hygiene (cleaning) and food hygiene.

For a patient receiving interventional healthcare, however, things can be very different and we need to do as much as possible to ensure items introduced into the care environment are free of pathogens. Our increasing understanding of the normal commensal micro-organisms in humans suggests that restoring and maintaining the microbiome may provide a key to preventing colonization and infection, including with multi-drug-resistant organisms (Otter 2014, Tosh and McDonald 2012), which can be 'selected out' when exposed to antibiotics. This means that bacteria that are sensitive to the antibiotics are killed but any resistant ones are left to replicate and become the dominant type. A developing form of treatment is the 'faecal microbiota transplant', or stool transplant, which involves replacing the stool in an affected

gut with stool from a healthy donor. This has been shown to be very effective for treatment of intractable *C. difficile* (van Nood et al. 2013) and may be helpful in other conditions.

Sometimes a patient will be ‘colonized’ with a species of bacteria, which means it is present but not causing them harm. However, if the bacteria are transferred to another patient and gain access to a portal of entry, that person may suffer harm, so there is a need for effective precautions. Whether or not any particular situation will result in an infection depends on a wide range of factors and these are not always predictable. What is certain is that bacterial infections cannot occur when bacteria are not present, hence the importance of measures designed to minimize the risk of transmission.

The presence of an organism in a specimen result does not on its own imply that an infection has occurred. Any laboratory results must always be interpreted in association with an assessment of the patient’s condition and symptoms, which will guide the need for treatment.

Morphology

Bacterial cells are much smaller and simpler than human cells; this small size means that bacteria do not have separate structures (such as a nucleus) within their cells. The structure of the cell wall determines another important distinction in medically significant bacteria: whether they are gram positive or gram negative. The ‘gram’ in these terms refers to Gram staining, named after its Dutch inventor, Hans Christian Gram (1853–1938), who devised the stain in 1884. The structure of the cell wall determines whether or not the bacteria are able to retain a particular stain in the presence of an organic solvent such as acetone. This structure also determines other characteristics of the bacteria, including their susceptibility to particular antibiotics, so knowing whether the cause of a bacterial infection is ‘gram positive’ or ‘gram negative’ can help to determine appropriate treatment (Goering et al. 2012). The structures of the two different types of cell wall are shown in Figure 4.2.

Other structures visible outside the cell wall may include pili, which are rigid tubes that help the bacteria attach to host cells (or, in some cases, other bacteria for the exchange of genetic material); flagellae, which are longer, mobile projections that can help bacteria to move around; and capsules, which can provide protection or help the bacteria to adhere to surfaces. These are illustrated in Figure 4.3. The presence or absence of different structures plays a part in determining an organism’s pathogenicity – that is, its ability to cause an infection and the severity of that infection (Goering et al. 2012).

A final bacterial structure to consider is the spore. Bacteria reproduce via a process called ‘binary fission’ – they create a copy of their genetic material and split themselves in two, with each ‘daughter’ cell being an almost exact copy of the ‘parent’ (there are mechanisms by which bacteria can transfer genetic material between cells and so acquire characteristics such as antibiotic resistance, but they are beyond the scope of this chapter). Some bacteria, notably the Clostridia, have the capacity, in adverse conditions, to surround a copy of their genetic material with a tough coat called a ‘spore’. Once the spore has been formed, the parent cell dies and disintegrates, leaving the spore to survive until conditions are suitable for it to germinate into a normal, ‘vegetative’

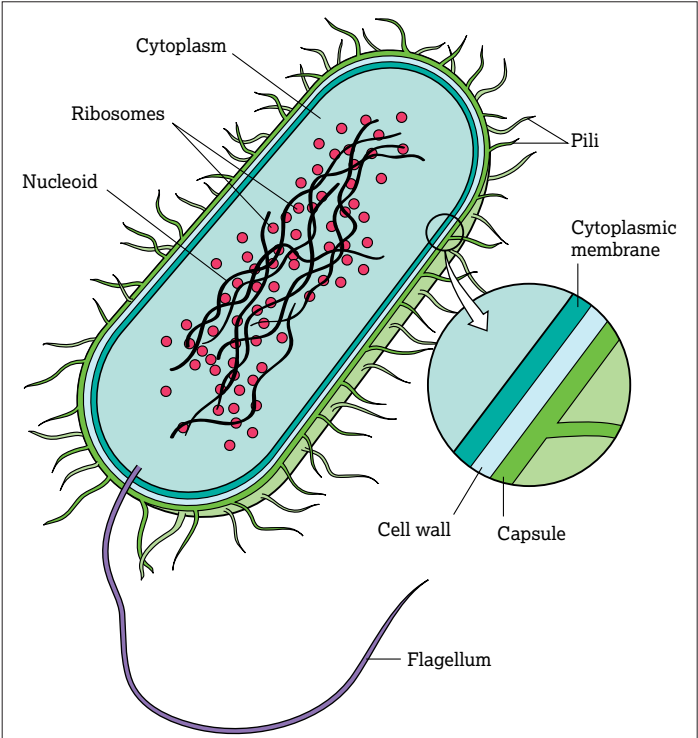


Figure 4.3 Bacterial structures.

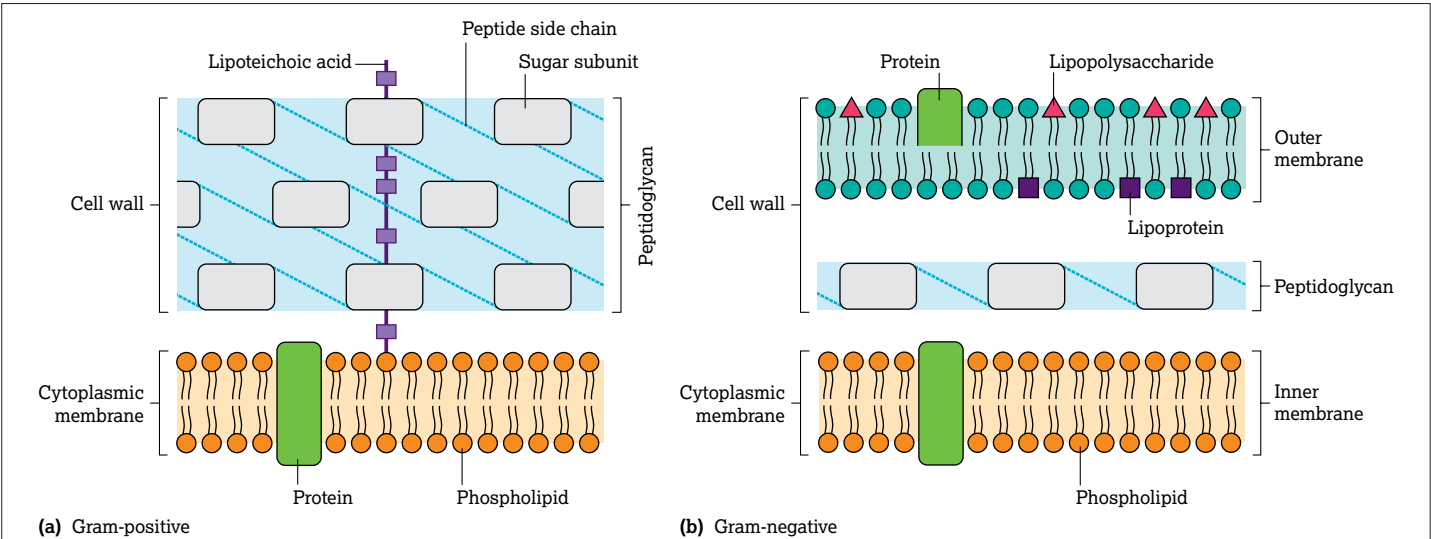


Figure 4.2 (a) Gram-positive and (b) gram-negative bacterial cell walls. Source: Adapted from Elliot et al. (2007) with permission of John Wiley & Sons.

Table 4.3 Medically significant bacteria

	Spherical	Rod-shaped
Gram positive	<i>Staphylococcus aureus</i> <i>Streptococcus</i> spp.	<i>Clostridioides difficile</i> <i>Clostridium tetani</i> <i>Bacillus</i> spp.
Gram negative	<i>Neisseria meningitidis</i> <i>Neisseria gonorrhoeae</i>	<i>Escherichia coli</i> <i>Pseudomonas aeruginosa</i> <i>Klebsiella pneumoniae</i> <i>Acinetobacter baumannii</i> <i>Salmonella</i> spp. <i>Legionella pneumophila</i>

bacterial cell, which can then reproduce (Goering et al. 2012). Spores are extremely tough and durable. They are not easily destroyed even by boiling or via the alcohol-based handrubs widely used for hand hygiene, hence the need to physically remove them from the hands by washing with soap and water when caring for a patient with *C. difficile* infection. Commonly used disinfectants containing quaternary ammonium compounds (such as benzalkonium chloride) are ineffective against spores.

Some bacteria produce toxins, which are proteins released by the bacteria that can increase the severity of disease. Endotoxins are pieces of the cell wall of gram-negative bacteria; these initiate a strong immune response from the body, which can cause catastrophic damage. For example, endotoxins of *Neisseria meningitidis* cause the breakdown of blood vessels, leading to anoxic tissue and the need for amputation. Antibiotics may kill the bacteria but in doing so flood the body with deadly endotoxins.

Some medically significant bacteria are listed in Table 4.3. A few bacteria do not easily fit into the gram-positive/negative dichotomy. The most medically significant of these are the mycobacteria, which have a waxy coat and are responsible for diseases including tuberculosis and leprosy (Goering et al. 2012).

Culture and sensitivity testing

When a sample arrives in the laboratory, it is put onto agar plates to culture any organisms present. The site of the specimen and clinical information may dictate which tests are deployed and what media are used, which is why it is very important to fill out the microbiology request form with as much detail as possible (for more detail see Chapter 13: Diagnostic tests). The provision of accurate and comprehensive information assists the microbiologist in interpreting the findings in the laboratory and simple information, such as the site of the specimen (if a wound), the type of urine, recent travel and current antibiotic use, can also be helpful.

Different types of agar plate may be used to grow different bacteria. Once the organism has been grown, it can be subjected to further tests to identify it, including a gram stain to see whether it is gram positive or gram negative, examination for the presence of pus cells and sensitivity testing. Sensitivity testing usually involves spreading the organism over an agar plate that contains small antibiotic discs. If the bacteria grow all the way up to the disc, they are resistant to that antibiotic. A 'zone of inhibition' around the disc implies they are sensitive to the antibiotic and that the antibiotic may be used to treat that infection. A faster and more modern technique to identify and speciate microbes involves the use of matrix-assisted laser desorption ionization time-of-flight mass spectrometry (MALDI-TOF MS) (Croxatto et al. 2012).

Modern laboratories use molecular technology to diagnose patients without the need for culture. These techniques include polymerase chain reaction (PCR) and enzyme immuno-assay.

Viruses

Viruses are much smaller, and even simpler, than bacteria. Nobel laureate Peter Medawar is said to have described viruses as 'bad news wrapped in protein' and indeed they are little more than a

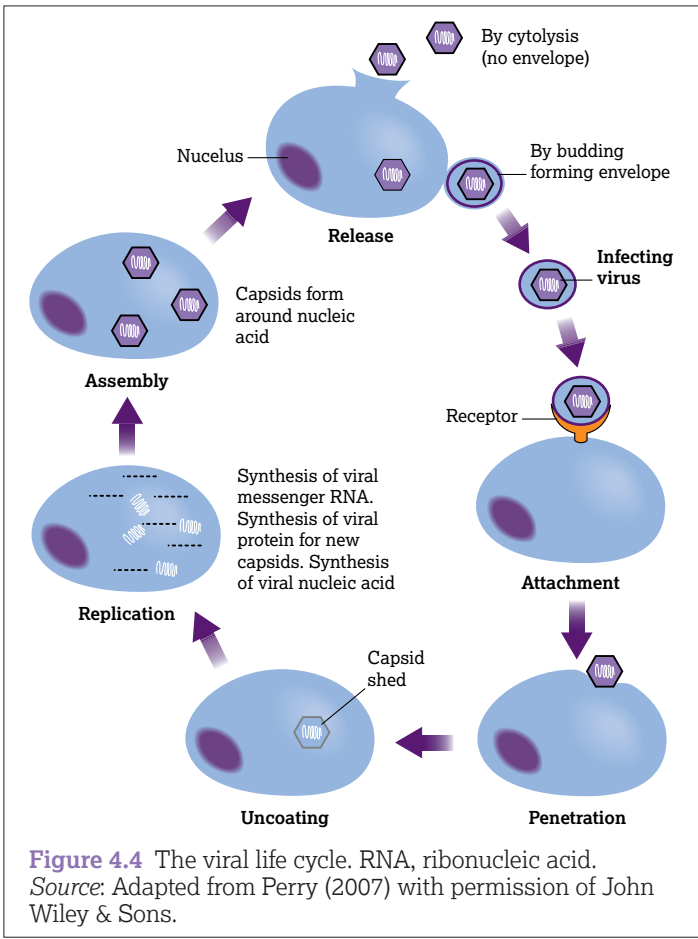


Figure 4.4 The viral life cycle. RNA, ribonucleic acid. Source: Adapted from Perry (2007) with permission of John Wiley & Sons.

protein capsule containing some genetic material. They rely on other organisms for their survival and reproduce within a host cell, using the cell's own mechanisms to reproduce, which leads to the death of the host cell (Goering et al. 2012). The life cycle of a virus is illustrated in Figure 4.4. The small size of viruses (e.g. poliovirus is only 30 nanometres across) means that most are smaller than the wavelengths of visible light. They can only be 'seen' with a specialist instrument such as an electron microscope, which will only be available in a very few hospital microbiology laboratories. Diagnosis of viral infections is normally based on the patient's symptoms, with confirmation by laboratory tests designed to detect either the virus itself or antibodies produced by the patient's immune system as a response to infection (Goering et al. 2012). Modern laboratories use PCR to amplify the genes in the sample to make them detectable quickly.

There are viruses that specifically infect humans, other animals or plants, or even bacteria. This is one characteristic that can be used in classifying them. However, the main basis for classification is by the type of genetic material they contain – DNA (deoxy-ribonucleic acid) or RNA (ribonucleic acid), in either a double or single strand. Other characteristics include the shape of the viral particle and the sort of disease caused by infection (Gillespie and Bamford 2012).

A final point to consider in relation to viral structure and infection prevention and control is the presence or absence of a lipid envelope enclosing the viral particle. Viruses that have a lipid envelope, such as herpes zoster virus (responsible for chickenpox and shingles), are much more susceptible to destruction by alcohol than those without. Norovirus and rotavirus, which are common causes of viral gastroenteritis (WHO 2009a), are examples of viruses without a lipid envelope. For this reason, alcohol hand sanitizers are not recommended during outbreaks of norovirus in hospitals.

Fungi

Like bacteria, fungi exist in many environments on earth, including occasionally as commensal organisms on human beings. Fungi are familiar to us as mushrooms and toadstools and the yeast that is used in brewing and baking. They also have many uses in the pharmaceutical industry, particularly in the production of antibiotics. Fungi produce spores, both for survival in adverse conditions, as bacteria do, and to provide a mechanism for dispersal in the same way as plants (Goering et al. 2012).

A few varieties of fungi are able to cause opportunistic infections in humans. These are usually found in one of two forms: either as single-celled yeast-like forms, which reproduce in a similar fashion to bacteria (by dividing or budding), or as plant-like filaments called 'hyphae'. A mass of hyphae together forms a 'mycelium'. Some fungi may appear in either form, depending on environmental conditions. Fungal infections are referred to as 'mycoses'. Superficial mycoses, such as ringworm and thrush (*Candida albicans*), usually involve only the skin or mucous membranes and are normally mild, if unpleasant; however, deeper mycoses involving major organs can be life threatening. These occur in patients who have severely impaired immune systems and may be an indicator of such impairment; for example, pneumonia caused by *Pneumocystis jirovecii* (previously *carinii*) is considered a clinical indication of AIDS (acquired immune deficiency syndrome). Superficial infections are generally transmitted by physical contact, whereas deeper infections can result from spores being inhaled. This is why it is important to ensure that patients with impaired immunity are protected from situations where the spores of potentially pathogenic fungi, such as *Aspergillus* spp., are likely to be released, for example during building work (Goering et al. 2012).

Protozoa

Protozoa are single-celled animals, some species of which are medically important parasites of human beings, particularly in tropical and subtropical parts of the world, where diseases such as malaria are a major public health issue. Unlike bacteria, their relationship with humans is almost always parasitic. The life cycles of protozoa can be complex and may involve stages in different hosts.

Medically important protozoa include *Plasmodium* spp., the cause of malaria; *Giardia* spp. and *Cryptosporidium* spp., which can cause gastroenteritis; and *Trichomoniasis* spp., which is a sexually transmitted cause of vaginitis (Gillespie and Bamford 2012).

The most common routes of infection of protozoa are by consuming them in food or water or via an insect vector such as a mosquito (Goering et al. 2012). Cross-infection in the course of healthcare is uncommon but not unknown.

Helminths

'Helminths' is a generic term for parasitic worms. A number of worms from three different groups affect humans: tapeworms (cestodes), roundworms (nematodes) and flukes (trematodes). Transmission generally occurs via ingestion of eggs or larvae, or infected animals or fish, but some are transmitted via an insect vector and some, notably the nematode *Strongyloides* spp., have a larval stage that is capable of penetrating the skin (Gillespie and Bamford 2012).

Helminth infections can affect almost every part of the body, and the effects can be severe. For example, *Ascaris* worms can cause bowel obstruction if there are large numbers present; *Brugia* spp. and *Wuchereria* spp. obstruct the lymphatic system and eventually cause elephantiasis as a result; and infection with *Toxocara* spp. (often after contact with dog faeces) can result in epilepsy or blindness (Goering et al. 2012). However, cross-infection in healthcare is not normally considered a significant risk.

Arthropods

Arthropods (insects) are most significant in infectious disease in terms of their function as vectors of many viral, bacterial, protozoan and helminth-caused diseases. Some flies lay eggs in the skin of mammals, including humans, and the larvae feed and develop in the skin before pupating into the adult form, whereas some, such

as lice and mites, are associated with humans for the whole of their life cycle. Such arthropod infestations can be uncomfortable, and there is often significant social stigma attached to them, possibly because the creatures are often visible to the naked eye. The activity of the insects and the presence of their saliva and faeces can result in quite severe skin conditions that are then vulnerable to secondary fungal or bacterial infection (Goering et al. 2012).

Lice

Species of *Pediculus* infest the hair and body of humans, feeding by sucking blood from their host. The adult animal is around 3 mm long and wingless, moving by means of claws. It cannot jump or fly, and dies within 24 hours if away from its host, so cross-infection normally occurs via direct contact or transfer of eggs or adults through sharing personal items (Cummings et al. 2018).

Scabies

Scabies is caused by the mite *Sarcoptes scabiei*, an insect less than 1 mm long that burrows into the top layers of skin. The female mites lay eggs in these burrows and the offspring can spread to other areas of the body. Infestation usually starts around the wrists and in between the fingers because acquisition normally occurs via close contact with an infected individual (e.g. by holding hands). The burrows are visible as a characteristic rash in the areas affected. The skin starts to itch a few weeks after infestation, which is a reaction to the faeces of the mite. A delay in recognition can lead to mass infestation, especially within families or in settings where there is a lot of interpersonal care, such as a nursing home. In immunocompromised hosts and those unable to practise normal levels of personal hygiene, very high levels of infestation can occur, often with thickening of the skin and the formation of thick crusts. This is known as 'Norwegian scabies' and is associated with a much higher risk of cross-infection than the normal presentation.

Scabies is most often associated with long-stay care settings, but there have been outbreaks associated with more acute healthcare facilities (Cassell et al. 2018). Treatment with scabicide must be co-ordinated to ensure untreated hosts do not reinfect those already treated.

Prions

Prions are thought to be the causative agents of a group of diseases called transmissible spongiform encephalopathies (TSEs), the most well known of which are Creutzfeldt-Jakob disease (CJD) and its variant (vCJD) (Table 4.4). These are fatal neurodegenerative diseases with a lengthy incubation period (up to 50 years) and no conventional host response, making them difficult to detect.

TSEs can be naturally occurring, inherited or acquired (Table 4.4). They are characterized by 'plaques' in the brain that are surrounded by holes that give the appearance of a sponge, hence the name.

Table 4.4 Types of transmissible spongiform encephalopathies

Type	Examples
Idiopathic (just happens for no clear reason)	Sporadic (classical) CJD Sporadic fatal insomnia
Inherited (genetic)	Familial CJD Gerstmann-Sträussler-Scheinker syndrome and variants Fatal familial insomnia
Acquired	Derived from humans: <ul style="list-style-type: none">• kuru (cannibalism)• iatrogenic CJD (contaminated medical devices or blood products) Derived from bovines: vCJD (diet – meat infected with bovine spongiform encephalopathy)

CJD, Creutzfeldt-Jakob disease; vCJD, variant Creutzfeldt-Jakob disease.

The causative 'organism' is a prion, defined in 1982 by Stanley Prusiner as a proteinaceous infectious particle resistant to procedures that modify nucleic acid.

From an infection control perspective, the key point is that prions contain no genetic material; therefore, it can be argued that they are not alive and so cannot be killed. Control is achieved via recognition of risk and physical removal through cleaning procedures. Prions are not affected by routine decontamination processes such as autoclaving or chemical disinfection. This has led to extensive reviews of decontamination procedures in the UK with increased emphasis on effective washing to remove any residual organic material, and on the tracking of instruments to individual patients to facilitate any look-back exercise. Modern decontamination services are now capable of removing prions from the surface of even complex instruments; however, where risk is identified, single-use instruments are usually recommended, especially for neurological work.

In the 1990s there was a lot of concern about the emergence of vCJD, which was associated with consumption of contaminated beef from cattle who had bovine spongiform encephalopathy (BSE). With intense input from public health initiatives and what was then called the Ministry of Agriculture, Fisheries and Food, beef was made safe again. However, UK citizens born before 1992 are still considered at risk of vCJD due to its long incubation period.

There were also several cases of CJD associated with contaminated medical products, such as human pituitary hormone, dura mater grafts and medical instruments. For this reason, all patients undergoing surgery should be assessed for risk of CJD by asking the following questions:

- Do you have a blood family member who has suffered from CJD?
- Have you ever received hormones derived from a human pituitary gland (e.g. growth hormone)?
- Have you ever had a corneal transplant or a dura mater graft?
- Have you been told that 'you may be at risk of CJD for public health purposes'?

A patient with CJD or vCJD is not infectious to other people under routine circumstances so no special precautions are required other than if dealing with cerebrospinal fluid (CSF). A spillage of CSF should be cleaned up with a strong disinfectant such as 10,000 ppm of chlorine.

Sources of infection

An individual may become infected with organisms already present on their body (endogenous infection) or introduced from elsewhere (exogenous infection). The majority of HCAIs are endogenous, hence the importance of procedures such as effective skin decontamination prior to invasive procedures (NHS England and NHSI 2019).

Indicators and effects of infection

Generally, infection is said to have occurred when infectious agents enter a normally sterile area of the body and cause symptoms as a result. There are obvious exceptions (e.g. the digestive tract is not sterile, being home to trillions of micro-organisms, but many types of infectious gastroenteritis are caused by particular organisms entering this area), but this is a useful working definition. The symptoms of infection are listed below. Not all symptoms will be present in all cases, and it should be noted that many symptoms are caused by the body's response to infection and so may not be present in severely immunocompromised patients (Fishman 2011).

Symptoms of infection

The cardinal signs of inflammation will often be present:

- *Heat*: the site of the infection may feel warm to the touch, and the patient may have a raised temperature.
- *Pain*: at the site of the infection.

- *Swelling*: at the site of the infection.
- *Redness*: at the site of the infection
- *Loss of function*: the affected area may not work properly.

In addition, there may be other signs, such as:

- pus
- raised white cells in blood results
- raised C-reactive protein (CRP) in blood results
- altered blood gases
- feeling of general malaise
- aching joints
- abdominal pain and tenderness
- nausea, diarrhoea and/or vomiting
- oliguria or anuria
- urinary frequency and/or pain on passing urine (strangury)
- confusion (notably in the elderly)
- loin pain.

It is important to look for these clinical signs of infection before making a diagnosis based on the result of a specimen alone.

Related theory

Healthcare-associated infection

An HCAI is acquired while receiving care in a hospital or other healthcare setting and must not have been present prior to that episode of healthcare; 6.6% of people who go into hospital in the UK will develop an HCAI. The figure for Europe is about 4 million people every year, with around 37,000 deaths occurring as a direct result (PHE 2017). The majority of these infections result from the procedures and interventions that patients undergo as treatment, such as insertion of invasive devices, surgery or the administration of antimicrobials that alter natural bacterial flora; all of these ultimately breach the body's natural defences and thereby increase vulnerability to infection. The greater the number of devices and the longer they are *in situ*, the more likely it is that an infection will occur. If the patient is also immunocompromised, the infection risk can be much higher. One report found that patients receiving treatment under oncology or haematology specialities were almost four times as likely to have an HCAI (a similar rate to those in intensive care units) compared to other patients in the same hospital and were twice as likely to be receiving an antibiotic (PHE 2018a).

In addition, bringing many vulnerable people together in a healthcare setting increases the likelihood of exposure to infection and the risk of cross-infection. Patients are often expected to share a room and bathroom facilities with those who may be carrying infection or different normal flora to them. This can lead to cross-infection, for example a patient who has diarrhoea may contaminate a shared toilet, thereby passing the infection to others using the same facilities.

The greater the number of patients that staff are caring for and the greater their workload, the greater the risk of cross-infection between patients. Overcrowding, lack of time and lack of facilities also contribute to non-compliance with best practice (Borg 2003, Eiamsitrakoon et al. 2013, Harbarth et al. 1999, Kampf et al. 2009, WHO 2009a).

Prevalence of healthcare-associated infection

The national Point Prevalence Survey of Healthcare-Associated Infections and Antimicrobial Use in European Acute Care Hospitals (ECDC 2016), conducted by Public Health England and the European Centre for Disease Prevention and Control, identified a prevalence rate of 6.6% (PHE 2017) (Figure 4.5). In acute hospitals, 1 in 15 patients had an HCAI on the day of survey, with the highest prevalence rates in intensive care units (17.6% of patients) followed by surgery (8.5%) and medicine (5.8%).

The most common types of infection were pneumonia and lower respiratory tract infection, urinary tract infections, and surgical site infections. There was very little change from the patterns seen

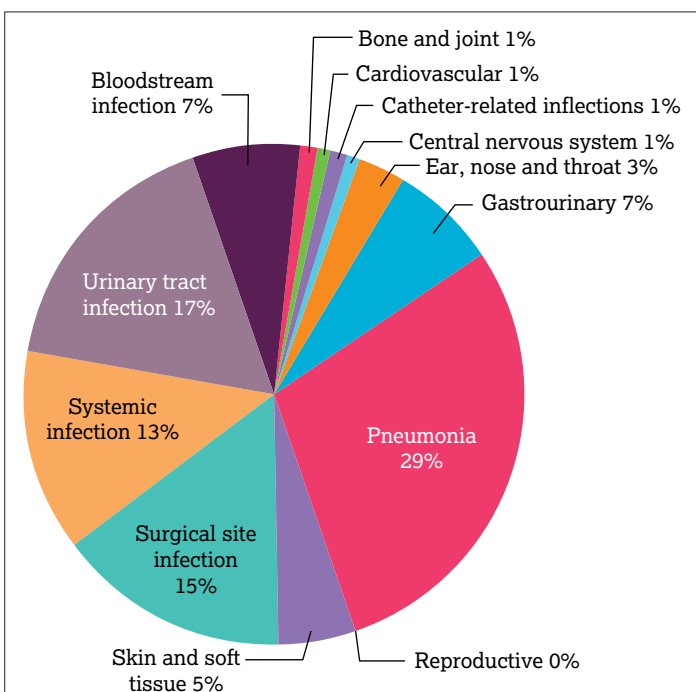


Figure 4.5 Results from the national Point Prevalence Survey in ESPAUR, 2016. Source: Data from *English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR): Report 2018* (PHE 2018a).

from the previous survey, conducted in 2011 (ECDC 2013). While bacteraemia (bacteria infecting the bloodstream) was less common, it can still have serious consequences for patients. Of the infections identified, gram-negative bacteria species were responsible for 35% of bloodstream HCAIs, which justifies the focus of national prevention strategies in this area.

The most commonly isolated micro-organisms were *E. coli* (18.9%), *S. aureus* (17.6%), *C. difficile* (8.1%), *Pseudomonas aeruginosa* (7.8%), *Klebsiella pneumoniae* (4.9%) and *Enterobacter cloacae* (2.8%). *E. coli* was the most commonly isolated micro-organism in urinary tract infections (50.9%), whereas *S. aureus* was the most commonly isolated micro-organism in pneumonia and lower respiratory tract infections (19.3%), surgical site infections (30.2%) and bloodstream infections (19.2%).

The challenge of antimicrobial resistance

Over the past century, there have been many changes in the types of organism that cause problems in healthcare, largely mirroring advances in medicine. The advent of penicillin and then other antibiotics in the 1940s allowed such advances in medicine and surgery. More complex surgery became possible, such as surgeries requiring implants (joint replacements) or organ transplants, and patients were able to tolerate treatments such as chemotherapy. More and more patients began to survive previously untreatable conditions, largely due to the ability to treat complications such as infection.

With the increasing use of antibiotics, new challenges began to emerge, including *C. difficile* infections (CDI) in the 1970s and epidemic strains of methicillin-resistant *S. aureus* (MRSA) in the 1980s. During the 1990s and early 2000s there was a significant rise in both MRSA and CDI in the UK. Concerted effort engineered by the UK government saw impressive reductions in both these infections (DH 2019); however, the 2000s saw a rise in the prevalence of gram-negative organisms with increasing resistance to antibiotics and an associated increase in untreatable infections. It is fair to argue that increasing antimicrobial resistance is the biggest challenge to healthcare across the world. As stated by the UK Chief Medical Officer Professor Dame Sally

Box 4.1 Tackling Drug-Resistant Infections Globally: Final Report and Recommendations (O'Neill 2016)

'The magnitude of the problem is now accepted. We estimate that by 2050, 10 million lives a year are at risk due to the rise of drug-resistant infections if we do not find proactive solutions now to slow down the rise of drug resistance. Antibiotics are a special category of antimicrobial drugs that underpin modern medicine as we know it: if they lose their effectiveness, key medical procedures (such as gut surgery, caesarean sections, joint replacements, and treatments that depress the immune system, such as chemotherapy for cancer) could become too dangerous to perform.'

Davies, 'We have reached a critical point and must act now on a global scale to slow down antimicrobial resistance' (DH 2014) (see also Box 4.1).

Nurses, along with other healthcare workers, have a duty to reduce the burden of antimicrobial resistance through effective infection prevention in their everyday work and help to preserve antimicrobials for future generations. An infection prevented means an antibiotic not required.

The term 'antimicrobial stewardship' is widely used to describe efforts to improve and rationalize antimicrobial prescribing. Much of this effort is targeted at doctors, who are the main prescribers of antimicrobials. Examples include the *Start Smart – Then Focus* toolkit (PHE 2015) and *Antimicrobial Stewardship: Systems and Processes for Effective Microbial Medicine Use* (NICE 2015), which exist to improve antimicrobial prescribing and develop a wider understanding of antimicrobial stewardship. 'Start smart' means:

- not starting antimicrobial therapy unless there is clear evidence of infection (ideally supported by appropriate microbiology samples)
- following local antibiotic guidance and taking into account a clear allergy history
- ensuring review dates and rationales for prescribing are all clearly documented.

'Then focus' means:

- reviewing the clinical diagnosis and continuing need for antimicrobials at 48–72 hours
- then clearly documenting a prescribing decision to stop, switch (from intravenous to oral), change (to a narrower-spectrum antibiotic in light of microbiology results), continue (and document the next review date) or use outpatient parenteral antibiotic therapy.


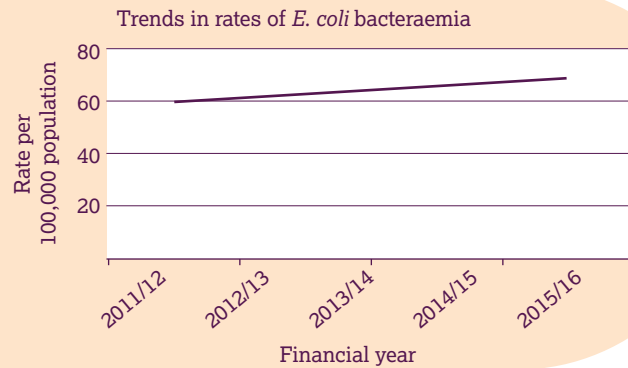
Nurses also have an important role in antimicrobial stewardship even if they are not themselves prescribers. This should include not being afraid to question the use of antimicrobials and encouraging good documentation.

Current infection challenges

In the UK, *E. coli* has increasingly been implicated as a source of bloodstream infection, as can be seen in Figure 4.6. *E. coli* and other gram-negative bloodstream infections caused by organisms such as *Klebsiella* spp. and *P. aeruginosa* are subject to mandatory reporting and reduction targets. A significant proportion of these isolates are showing increasing resistance to antimicrobials, which makes recognition and reduction of risk factors very important in controlling their spread. Such gram-negative infections seem predominantly to originate in the community and are often associated with older age, dehydration and urinary tract problems. Examples include an elderly gentleman with an enlarged prostate that leads to repeated urinary tract infection and an elderly lady becoming dehydrated because she is not drinking due to anxiety about incontinence (PHE 2018b).

Overall rate


70 people out of every
100,000
will acquire an
E. coli bacteraemia

Risk greater among elderly


Adult male rate

50
adult males
out of every
100,000
(age 45–64)




Adult female rate

51
adult females
out of every
100,000
(age 45–64)



Elderly male rate

824
elderly males
out of every
100,000
(age ≥85)

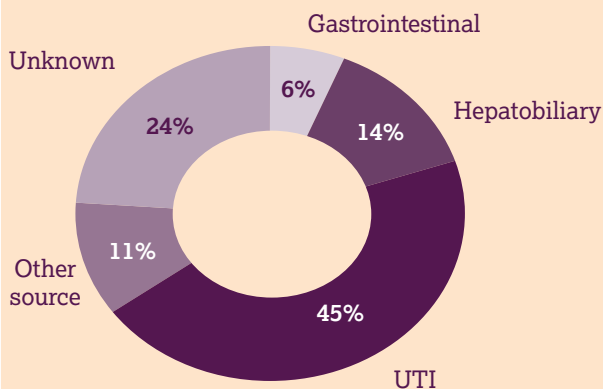


Elderly female rate

568
elderly females
out of every
100,000
(age ≥85)



Most common source of infection

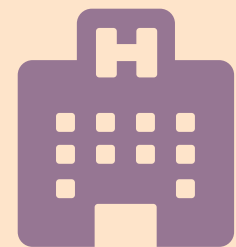


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Most cases are community onset



73%
<2 days



27%
≥2 days

For full report, please see
<https://www.gov.uk/government/statistics/mrsa-mssa-and-e-coli-bacteraemia-and-c-difficile-infection-annual-epidemiological-commentary>

Figure 4.6 *E. coli* bacteraemia rates in England, 2015/2016. Source: NHS Improvement (2017). © Crown copyright.

Evidence-based approaches

With good infection prevention and control practice, many HCAIs can be prevented. This has been demonstrated by the significant reductions in MRSA bloodstream infection in English NHS hospitals between 2005 and 2018 (PHE 2018b, 2018c) and the dramatic fall in the number of cases of *C. difficile* infection in England (PHE 2018b, 2018d). These reductions were achieved via the systematic application and monitoring of established practices for the prevention and control of infection, including diligent hand hygiene and correct aseptic technique.

The use of effective infection prevention practices, including hand hygiene, environmental cleaning and care of invasive devices, leads to less cross-transmission, less infection, and less

need for antimicrobials and other remedial treatments. It is therefore safer for patients and more cost-effective, and it contributes to reducing the burden of antimicrobial resistance.

Infection prevention and control underpins the clinical practices of all disciplines of healthcare and is fundamental to patient safety. As in other disciplines, robust evidence should underpin and improve practice and be used to ensure patients are receiving optimal care. However, it is not always possible to carry out robust randomized controlled trials (RCTs) to evidence all interventions and in some cases it is very difficult to ascertain which of several interventions implemented concurrently has made a difference. For instance, in early evidence on the importance of hand hygiene, a paper describing a *S. aureus* outbreak in a neonatal unit in the

1960s (Mortimer et al. 1962) demonstrated that babies who were cared for by nurses who were instructed not to wash their hands after coming into contact with a baby who was colonized with *S. aureus* were more likely to acquire the organism than infants cared for by nurses who used the antiseptic hexachlorophene to clean their hands between contact with each baby. This controlled study provided strong evidence that hand washing with an antiseptic agent between patient contact reduces transmission of healthcare-associated pathogens; however, it has never been repeated due to the obvious ethical drawbacks. Hand hygiene must be accepted as good practice on the basis of the results of a multitude of non-RCT studies (Pittet et al. 2000) and experience.

The published studies relating to infection prevention are mostly a mixture of RCTs, cohort studies, case studies, time series intervention analyses, surveillance and feedback, observation and an element of common sense. In many cases, a change may be one of several elements tried at the same time and much of the early evidence was derived from outbreak studies, in which a number of interventions were implemented simultaneously. This ‘multi-modal’ type of study can lead to a situation where it can be difficult to pinpoint which individual measures have made the difference or have been the most beneficial.

One of the most favoured means of presenting best practice is in the form of ‘care bundles’. It can even be argued that a set of measures implemented during an outbreak comprises an ‘outbreak bundle’. A care bundle is a group of evidence-based interventions that have been put together to be practised consistently with the intention that if all the elements are undertaken together, a particular outcome will occur – or, in the case of infection prevention, will not occur. The bundle normally consists of around five elements, each of which have robust evidence indicating that, if they are implemented reliably, for every patient, on every occasion, they will result in the most benefit of all possible interventions (Rochon et al. 2017).

One of the earliest and most influential bundles was presented in a paper by Pronovost et al. (2006). It described the consistent application of an evidence-based bundle of interventions that demonstrated a sustained reduction in catheter-related bloodstream infection rates across the whole state of Michigan.

In the UK, in 2005 the Department of Health issued Saving Lives, which is a package of ‘high impact interventions’. This bundle was put together to reduce infection in key target areas including peripheral vascular devices, central vascular access devices, urinary catheters, surgical wound infection, ventilator-associated pneumonia and nasogastric feeding. The tools were reviewed and

reissued by the Infection Prevention Society in 2017. The suite of tools covers:

- prevention of ventilator-associated pneumonia
- prevention of infections associated with peripheral vascular access devices
- prevention of infections associated with central venous access devices
- prevention of surgical site infection
- prevention of infections in chronic wounds
- prevention of urinary-catheter-associated infections
- promotion of stewardship in antimicrobial prescribing.

Clinical governance

Hygiene Code

Infection prevention and control in England is underpinned by the Health and Social Care Act (2008), which has been summarized in a separate code of practice (DH 2015a). Known as the Hygiene Code, this mandates a set of responsibilities to healthcare providers including hospitals, general practitioners, dentists and care homes. This legislation is monitored and enforced by the Care Quality Commission (CQC), which assesses care providers against the requirements of the Code during periodic inspections. Each provider must be registered with the CQC and declare compliance with the 10 criteria of the Hygiene Code. These criteria are summarized in Table 4.5.

All healthcare organizations are required to appoint a senior manager to the role of ‘director of infection prevention and control’, or DIPC (DH 2003). This person must have the seniority to be able to influence the board of directors to ensure that infection prevention is accorded the highest priority.

All but the smallest healthcare providers should have (or have access to) an infection prevention and control team, who will advise on day-to-day aspects of infection prevention. The team will usually consist of one or more nurses trained in infection prevention along with a consultant microbiologist or infection control doctor and an antimicrobial pharmacist. Some teams will have additional staff working in audit, surveillance, or data collection and analysis. The role of the infection prevention and control team is varied but principally involves providing advice, education and support to healthcare professionals, caregivers and the wider organization to ensure patient and staff safety is maintained and risks are minimized.

Table 4.5 The Hygiene Code

1	Systems to manage and monitor the prevention and control of infection. These systems use risk assessments and consider the susceptibility of service users and any risks that their environment and other users may pose to them.
2	Provide and maintain a clean and appropriate environment in managed premises that facilitates the prevention and control of infections.
3	Ensure appropriate antimicrobial use to optimize patient outcomes and to reduce the risk of adverse events and antimicrobial resistance.
4	Provide suitable accurate information on infections to service users, their visitors and any person concerned with providing further support or nursing/medical care in a timely fashion.
5	Ensure prompt identification of people who have or are at risk of developing an infection so that they receive timely and appropriate treatment to reduce the risk of transmitting infection to other people.
6	Systems to ensure that all care workers (including contractors and volunteers) are aware of and discharge their responsibilities in the process of preventing and controlling infection.
7	Provide or secure adequate isolation facilities.
8	Secure adequate access to laboratory support as appropriate.
9	Have and adhere to policies, designed for the individual’s care and provider organizations that will help to prevent and control infections.
10	Providers have a system in place to manage the occupational health needs and obligations of staff in relation to infection.

Source: DH (2015a). © Crown copyright.

Table 4.6 Legislation significant to healthcare infection control policy

Legislation	Coverage
Control of Substances Hazardous to Health (COSHH) (HSE 2002)	Introduced to prevent or reduce healthcare worker exposure to potentially harmful substances. The guidance includes the need to identify hazards, risk assess the potential for harm, if possible remove the harm, and where needed provide measures to reduce the level of harm. This includes the need to provide suitable equipment, training and where necessary health surveillance. The COSHH regulations have forced changes in areas such as endoscopy, where previously harmful chemicals (such as glutaraldehyde) were used with little control. Modern endoscopy units use safer chemicals in special automated processors to significantly reduce the potential for harm to users.
Health Building Note 00-09: Infection Control in the Built Environment (DH 2013c)	Provides guidance on infection prevention measures for new buildings and refurbishments. Includes guidance on finishes, layout and fittings. Should be read in conjunction with other health building notes (HBNs) for specific facilities, such as Health Building Note 04-01 Supplement 1: Isolation Facilities for Infectious Patients in Acute Settings (DH 2013d).
Legionnaires' Disease: The Control of Legionella Bacteria in Water Systems – Approved Code of Practice and Guidance (HSE 2013a)	Sets out the requirements of employers to control legionella, including identifying and assessing sources of risk; preparing a scheme to prevent or control risk; implementing, managing and monitoring precautions; keeping records of precautions; and appointing a responsible manager.
Water Systems: Health Technical Memorandum 04-01 Addendum – <i>Pseudomonas aeruginosa</i> – Advice for Augmented Care Units (DH 2013a)	Concerned with controlling or minimizing the risk of morbidity and mortality due to <i>Pseudomonas aeruginosa</i> associated with contaminated water outlets. Guidance is provided on assessing the risk to patients, and the document offers remedial actions to take when a water system becomes contaminated with <i>P. aeruginosa</i> , including protocols for sampling, testing and monitoring water. It also offers advice on forming a water safety group and developing water safety plans. This guidance came about in response to an outbreak in Belfast where three babies died and several others were infected via water contamination with <i>P. aeruginosa</i> (Wise 2012).
Health Technical Memorandum 07-01: Safe Management of Healthcare Waste (DH 2013b)	Sets out the necessary handling of waste to reduce harm to people and the environment.
Food Safety Act (1990)	Sets out regulations for the safe handling and preparation of food.

Professional responsibility

In England, nurses must be aware of the measures that are in place in their workplace to ensure compliance with the Hygiene Code. For example, many hospital trusts have a programme of regular visits to clinical areas by senior staff, who carry out inspections against the criteria of the Code as if they were external assessors. This programme ensures that senior staff are familiar with the Code and that everyone is familiar with the inspection process. In addition, nurses may need to carry out activities to promote compliance and provide evidence of assurance, such as audits of hand hygiene performance or compliance with aseptic technique. One such set of audits in place in many hospitals in England is the aforementioned Saving Lives (Infection Prevention Society 2017). Audits are discussed in more detail in the section below on environmental hygiene and the management of waste in the healthcare environment.

Other legal and professional issues

In England, the Health and Safety at Work etc. Act (1974) is the primary piece of legislation relating to the safety of people in the workplace. It applies to all employees and employers, and requires them to do everything that is reasonable and practicable to prevent harm coming to anyone in the workplace. It requires employers to provide training and appropriate protective equipment, and it requires employees to follow the training that they have received, use the protective equipment provided, and report any situations where they believe inadequate precautions are putting anyone's health and safety at serious risk.

The Nursing and Midwifery Council's *Code* (NMC 2018) states that all nurses must work within the limits of their competence. This means, for example, not carrying out aseptic procedures without being competent and confident that this can be done without increasing the risk of introducing infection through lack of knowledge or technique.

In addition to healthcare-specific requirements, items of legislation and regulation have been devised with the objective of reducing the risk of infection; these apply to healthcare as much as they do to any other business or workplace. These include legislation and regulation relating to food hygiene (Food Safety Act 1990), water quality (Water Supply (Water Quality) Regulations 2016), waste management (Waste (England and Wales) Regulations 2011) and other issues that are peripheral to healthcare but must be taken into account when developing policies and procedures for an NHS trust or other healthcare provider. The relevant regulations are summarized in Table 4.6.

Hand hygiene

Definition

Hand hygiene, or hand decontamination as it is also called, is the process used to render the hands physically clean with a reduced microbial load. Hand hygiene may involve the use of soap and water to wash the hands, principally to remove organic soiling, and/or the use of an alcohol-based hand sanitizer, which if applied correctly will remove most micro-organisms (Boyce et al. 2002, Gold and Arva 2018, NHS England and NHSI 2019, Pittet et al. 2000).

Related theory

Hand hygiene is generally accepted as a cornerstone of good infection prevention and so it is essential that wherever care is provided, there are accessible and appropriate facilities for hand hygiene (WHO 2009a). The hands of healthcare workers are a common cause of transmission of micro-organisms between patients and are frequently implicated as the route of transmission in HCIs (Moolenaar et al. 2000, Mortimer et al. 1962, Pittet et al. 2000, Sax

et al. 2007). Transient micro-organisms (bacteria, fungi and viruses) are organisms located on the surface of the skin and beneath the superficial cell of the stratum corneum. The subungual regions of the nails harbour the majority of the micro-organisms found on the hands (AORN 1997, Hedderwick et al. 2000, McNeil et al. 2001). They are acquired from and transfer easily to the animate (patient) and inanimate environments during contact activities. Damaged skin, moisture, false nails and jewellery increase the possibility of colonization with transient micro-organisms (McNeil et al. 2001). Both microbial load and type depend upon the prevalence of micro-organisms in the environment and on the activities being undertaken by healthcare workers. Hands have been found to be contaminated after general ward-based activities including bed making, handling curtains and patients' clothing, and washing materials, and after sluice room activities. Transient micro-organisms, unlike resident bacteria, can easily be removed from the hand surface via effective hand hygiene (Boyce et al. 2002).

There are three main levels of hand hygiene:

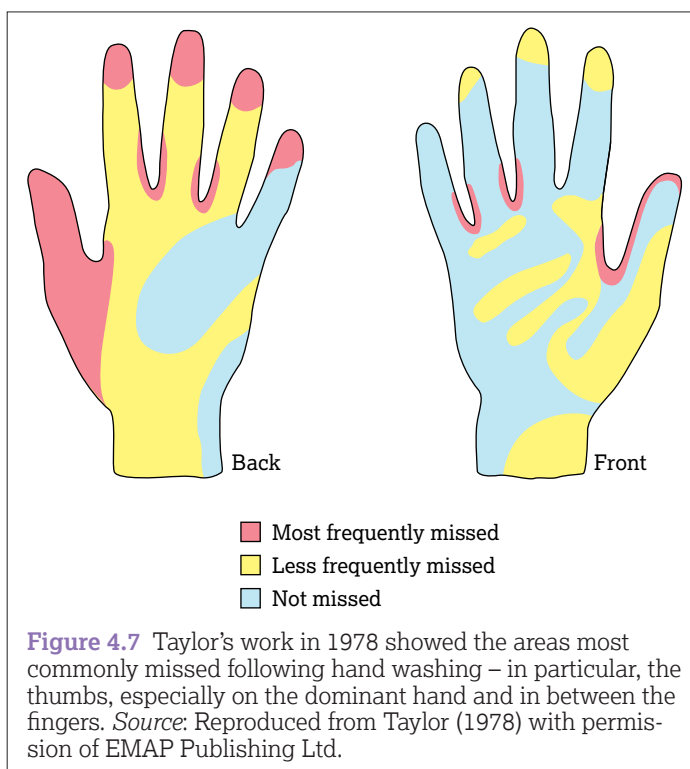
- 1 Hand washing is the process for the physical removal of soil (dirt, blood, body fluids and transient micro-organisms) from the hands (e.g. after using the lavatory or before preparing a meal) using ordinary liquid soap and water. In the clinical setting it should be performed as per the '5 Moments' (discussed below) (Sax et al. 2007, WHO 2009a).
- 2 Aseptic hand decontamination or hand antisepsis is the destruction of micro-organisms on the hands (e.g. prior to a dressing procedure). If carrying out an aseptic procedure, an antiseptic soap may be used as an alternative to ordinary soap (but it is not essential). This will contain a disinfectant such as chlorhexidine or povidone-iodine. Alternatively, it is very acceptable to wash with ordinary soap and water, dry hands and then apply alcohol-based handrub.
- 3 Surgical scrub aims to remove dirt and organic matter, kill transient micro-organisms, and reduce the numbers of resident and transient bacteria on the skin prior to surgery. Surgical scrub technique may be carried out using antiseptic soap or approved alcohol-based handrubs. Antiseptic handwash solutions such as chlorhexidine gluconate or povidone-iodine solution should be used with an appropriate technique and for a minimum of 3 minutes as part of surgical preparation. Approved alcohol-based products may be used on physically clean hands for a 90-second scrub.

Taylor (1978) noted that some nurses could wash their hands for a long time but not cover all the surfaces, whereas others could cover all the surfaces within 30 seconds (Figure 4.7). A six-step hand hygiene technique to cover all areas of the skin was first described by Ayliffe et al. (1978) to test the efficacy of different hand disinfectants. The technique has been adopted by the World Health Organization (WHO) (2009a) as standard and is used worldwide; however, more recently some have queried whether a three-stage technique would be more practical, especially for the use of alcohol-based handrub (Tschudin-Sutter et al. 2017).

Evidence-based approaches

The key considerations for hand hygiene are: when should hands be decontaminated, what with and how? The WHO uses the concept of 'My 5 Moments for Hand Hygiene' as a means to focus hand hygiene where it matters – at the point of patient contact (Sax et al. 2007) (Figure 4.8). The WHO describes the 'patient zone' as an imaginary line around the patient. The patient zone is not necessarily a bed or chair; it is wherever the patient is. The WHO then describes the opportunities for hand hygiene within the patient zone. These are:

- *Moment 1:* Entering the patient zone before patient contact.
- *Moment 2:* Carrying out a clean or aseptic procedure.
- *Moment 3:* Handling blood or body fluids.
- *Moment 4:* Leaving the patient zone after patient contact.
- *Moment 5:* After contact with the patient's immediate environment.



Bare below the elbows

In order to facilitate effective hand hygiene it is expected that all healthcare workers should be 'bare below the elbows' when giving patient care (NICE 2017). This involves wearing short-sleeved clothing, not having false nails or nail varnish, and removing all wrist and hand jewellery to allow effective hand hygiene up to and including the wrists (DH 2010a). A plain, smooth metal ring is usually acceptable; however, it should be moveable to ensure decontamination and drying underneath (NHS England and NHSI 2019). There is some debate as to whether it is necessary to be bare below the elbows in a clinical area if not giving care. This may be acceptable in some organizations for non-uniformed staff if they are having no direct patient contact – for example, a ward clerk sat at a desk, or staff visiting other staff in offices on the ward. However, ideally everyone entering a ward should be able to easily decontaminate their hands and this is best facilitated by being bare below the elbows.

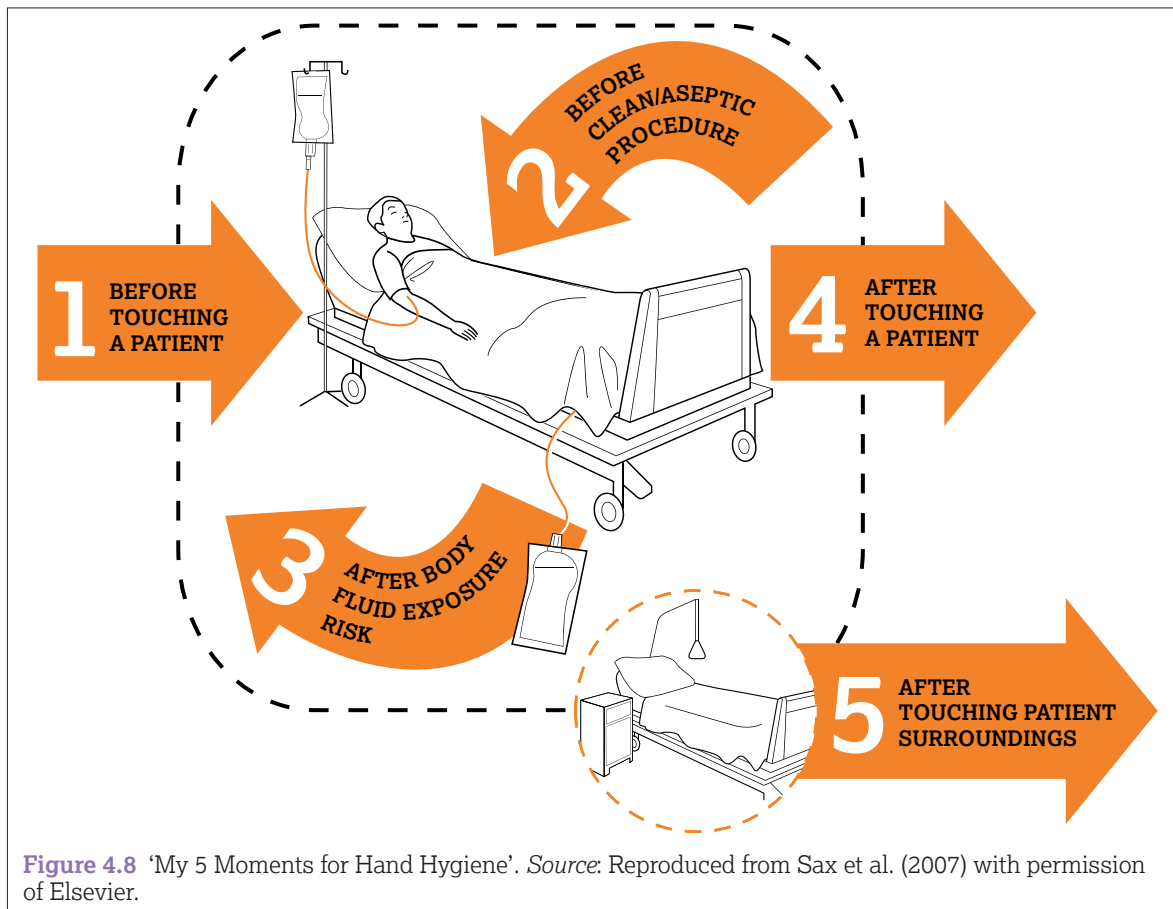
Pre-procedural considerations

Equipment

Hand hygiene equipment

Clinical handwash basins

Clinical handwash basins (CHBs) (Figure 4.9) should be available in sufficient numbers such that a healthcare worker does not have to walk too far to decontaminate the hands. In a hospital, a CHB would be expected for roughly every 4–6 beds. While it is important to have an appropriate number of CHBs to allow easy access to hand washing, it should be noted that if they are poorly sited and underutilized they may become a risk for infection. This is because organisms such as *Legionella pneumophila* can build up in underused pipework – a so-called 'dead leg'. Any water outlet that is not in regular use should be flushed at least twice a week to reduce this risk. Consideration should be given to removal (back to the circulating pipework) of any underused outlets. In some circumstances, point-of-use filters may be employed to ensure water leaving the tap is clean (Garvey et al. 2018, Vonberg et al. 2005).



CHBs should be used solely by clinical staff for hand hygiene. They should have taps that can be turned on and off without using the hands; that is, they should be non-touch or lever operated (NHS England and NHSI 2019). They should not have plugs (to encourage hand washing under running water) or overflows. Water should be able to drain freely and quickly to discourage growth of microbes from drains (Aranega-Bou et al. 2019, Walker and Moore 2015). CHBs should not be used for the disposal of wash water, intravenous fluids, drugs or beverages as this encourages the growth of harmful organisms such as *Pseudomonas aeruginosa* (Garvey et al. 2018, Kotay et al. 2017, Loveday et al. 2014a). Basins that are also used by patients may require plugs, which will require careful management with some client groups to reduce the risk of flooding. In all cases, the taps should be positioned so that water does not fall directly into the outflow as this may lead to splashes containing organisms from within the drain, which has been implicated in outbreaks of infection (Aranega-Bou et al. 2019, Walker et al. 2014, Wise 2012). Taps should be of a mixer type that allows the temperature to be set before hand washing starts. Access to basins must be unobstructed by any furniture or equipment to ensure that they can easily be accessed whenever required.

Liquid soap dispensers

Liquid soap dispensers should be positioned close to handwash basins and care should be taken to ensure that soap cannot drip onto the floor from the dispenser and cause a slip hazard. Soap should be simple and unscented to minimize the risk of adverse reactions from frequent use. There is no advantage to using soap or detergents containing antimicrobial agents for routine hand washing. Antiseptic preparations may carry a higher risk of adverse reactions. Bar soap should not be used as the wet bar can grow micro-organisms between uses. For surgical scrub or hand antisepsis, the most commonly used preparations contain either

chlorhexidine or povidone-iodine; both reduce bacterial counts significantly but chlorhexidine has a residual effect that may reduce rapid regrowth.

Paper towel dispensers

A paper towel dispenser should be fixed to the wall close to each handwash basin. Hand towels should be of adequate quality to ensure that hands are completely dried by the proper use of one or two towels. To conveniently dispose of these towels, a suitable bin with a pedal-operated lid should be positioned close to the basin, but not so that it obstructs access to the basin (WHO 2009a).

Alcohol-based hand sanitizers

Alcohol-based hand sanitizers should be available at the point of care in every clinical area for use immediately before care and between different care activities on the same patient. Dispensers may be attached to the patient's bed or bedside locker, and free-standing pump-top bottles can be used where appropriate, such as on the desk in a room used for outpatient clinics. Dispensers should not be sited close to sinks unless this is unavoidable because of the risk of confusion with soap and the risk of adding organic material to the drains (Kotay et al. 2017). Smaller sized personal-issue bottles are appropriate where there is a risk that alcohol-based handrub may be accidentally or deliberately drunk, such as in paediatric areas or when caring for a patient with alcohol dependency (NPSA 2008).

Pharmacological support

Hand washing is a mechanical process and it is the combination of rubbing and friction to generate a lather that removes dirt, debris and micro-organisms, rather than any 'antiseptic' in the soap. Hands should be washed only with soaps that are designed for hand washing. In a hospital there will usually be one approved brand that meets the European Norms: EN1499 for soap or EN1500



Figure 4.9 Clinical handwash basin.

for surgical hand preparation. The products will usually be unfumed and hypoallergenic. In a patient's home, a healthcare worker should use any reasonable handwash soap provided.

Detergents

Detergents are surfactants designed to remove organic soiling, including grease, from a surface. They do not specifically kill micro-organisms but may remove them as part of the mechanical action of the process of washing. There are many different types of detergent for use on different surfaces, from washing-up liquid to soap designed for washing hands and keeping skin soft.

Alcohol-based handrub

Alcohol-based handrub may be considered the gold standard for hand hygiene and is recommended for use in most circumstances except if hands are visibly soiled or when caring for patients with vomiting or diarrhoeal illness (Gold and Avva 2018, NHS England and NHSI 2019). This is because alcohol is not effective in the presence of organic soiling, against *C. difficile* spores or against non-enveloped viruses such as norovirus. When compared with soap and water hand washing, alcohol-based handrub is more effective at reducing bacteria on hands, causes less skin irritation, requires less time to use and can be made more easily accessible at the point of care (Boyce et al. 2002, Gold and Avva 2018, Voss and Widmer 1997). Antiseptic handrubs based on non-alcoholic antiseptics are available but evidence suggests that alcohol is the most useful agent in terms of the range and speed of antimicrobial activity (Rotter 2001, WHO 2009a).



Figure 4.10 Correct position to wash hands.

Some alcohol-based handrubs may also be used for surgical scrub and there is evidence that they may have greater efficacy than either povidone-iodine or chlorhexidine-based traditional soap products (Kampf and Kramer 2004, NHS England and NHSI 2019, Widmer 2013).

Hand washing

Evidence-based approaches

Hand washing involves three important stages: preparation, washing and rinsing, and drying (NHS England and NHSI 2019).

Hands should always be wet under running tepid water before applying soap. This is to allow the soap to lather when the hands are rubbed together. It is the friction and the lather that removes the dirt and debris and moves the transient organisms to the surface so that they can be effectively rinsed away under the running water. Wetting also reduces the risk of skin irritation. The hands should be rubbed for between 15 and 30 seconds with particular attention paid to the thumbs and the tips of the fingers (Figure 4.10).

It is essential that hands are dried thoroughly after washing; this is because bacteria (especially gram negatives such as *E. coli*) can multiply on a wet surface, leaving hands contaminated. Good-quality paper towels are recommended in hospital settings (NHS England and NHSI 2019). Warm air dryers may be effective but are noisy in clinical areas and there are some concerns that they may increase the number of bacteria in the washroom and lead to them spreading (Best et al. 2018).

Hand care

Hands are used continually by healthcare workers, so it is important that they are maintained in a healthy condition. Dry, excoriated skin is more likely to shed micro-organisms to others and more likely to become contaminated, which may be harmful to the individual. Staff with acute or chronic skin lesions, conditions or reactions, or possible dermatitis, should seek advice from their local occupational health advisor.

Cuts and abrasions must be covered with a water-impermeable dressing prior to clinical contact. It is especially important that staff with skin lesions that cannot be adequately covered seek advice from the occupational health department as it may not be safe for them to work, especially if they are undertaking high-risk aseptic procedures (NICE 2017).

Skin damage and dryness often result from frequent use of harsh soap products, application of soap to dry hands, or inadequate rinsing of soap from the hands. It is essential that correct technique is used to minimize this risk. Alcohol-based sanitizer products may be better for the skin than repeated washing with soap and water, which can remove the skin's natural oils; this is because the alcohol-based products contain emollients, which are rubbed back into the hands as they are decontaminated.

Hand cream may help to prevent dry and chapped skin. This should be supplied from a dispenser or be for personal use, as communal jars may become contaminated and become a source of infection.

Procedure guideline 4.1 Hand washing

Essential equipment

- Handwash basin
- Liquid soap
- Paper towels
- Domestic waste bin

Action	Rationale
Pre-procedure	
1 Remove wristwatch, any rings and/or bracelets and roll up sleeves. <i>Note:</i> it is good practice to remove all hand and wrist jewellery and roll up sleeves before entering any clinical area, and the Department of Health has instructed NHS trusts to implement a 'bare below the elbows' dress code.	Jewellery inhibits good hand washing. Dirt and bacteria can remain beneath jewellery after hand washing. Long sleeves prevent washing of wrists and will easily become contaminated and so a route of transmission of micro-organisms (DH 2010b, C ; WHO 2009a, C). Many organizations' dress codes allow staff to wear wedding rings while providing care. Although it can be argued that a smooth ring is less likely to retain dirt and bacteria than one with a stone or engraving, there is no evidence to suggest that wedding rings inhibit hand decontamination any less than other rings. E
2 Cover cuts and abrasions on hands with waterproof dressings.	Cuts and abrasions can become contaminated with bacteria and cannot be easily cleaned. Repeated hand washing can worsen an injury (WHO 2009a, C). Breaks in the skin will allow the entry of potential pathogens. E
3 Remove nail varnish and artificial nails (most uniform policies and dress codes prohibit these). Nails must also be short and clean.	Long and false nails and imperfections in nail polish harbour dirt and bacteria that are not effectively removed by hand washing (WHO 2009a, C).
Procedure	
4 Turn on the taps and where possible direct the water flow away from the plughole. Run the water at a flow rate that prevents splashing.	The plughole and the associated waste are often contaminated with micro-organisms, which could be transferred to the environment or the user if splashing occurs (Aranega-Bou et al. 2019, R ; Garvey et al. 2016, C).
5 Run the water to a comfortable temperature.	Warm water is more pleasant to wash with than cold so hand washing is more likely to be carried out effectively. E Water that is too hot could cause scalding (DH 2017, C).
6 Wet the surface of the hands and wrists.	Soap applied directly onto dry hands may damage the skin. The water will also quickly mix with the soap to speed up hand washing. E
7 Apply liquid soap and water to all surfaces of the hands.	Liquid soap is very effective in removing dirt, organic material and any loosely adherent transient flora. Tablets of soap can become contaminated, potentially transferring micro-organisms from one user to another, but may be used if liquid soap is unavailable (WHO 2009a, C). To ensure all surfaces of the hands are cleaned. E
8 Rub hands together for a minimum of 10–15 seconds, paying particular attention to between the fingers and the tips of the fingers and thumbs (Action figure 8). The areas that are most frequently missed through poor hand hygiene technique are shown in Figure 4.7.	To ensure all surfaces of the hands are cleaned. Areas that are missed can be a source of cross-infection (Fraise and Bradley 2009, E).

(continued)

Procedure guideline 4.1 Hand washing (continued)

Action	Rationale
9 Rinse soap off hands thoroughly.	Soap residue can lead to irritation and damage to the skin. Damaged skin does not provide a barrier to infection for the healthcare worker and can become colonized with potentially pathogenic bacteria, leading to cross-infection (DH 2017, C).
10 Turn off the taps using a wrist or elbow. If the taps are not lever-type, turn them off using a paper hand towel to prevent contact.	To avoid recontaminating hands. E
Post-procedure	
11 Dry hands thoroughly with a disposable paper towel from a towel dispenser.	Damp hands encourage the multiplication of bacteria and can become sore (DH 2017, C).
12 Dispose of used paper towels in a black bag in a foot-operated waste bin.	Paper towels used to dry the hands are normally non-hazardous and can be disposed of via the domestic waste stream (DH 2013b, C). Using a foot-operated waste bin prevents contamination of the hands. E Electric hand dryers are generally not recommended for use in clinical areas (Best et al. 2018, E).



Action Figure 8 (1) Rub hands palm to palm. (2) Rub the back of each hand with the palm of the other hand with fingers interlaced. (3) Rub palm to palm with fingers interlaced. Rub with the backs of the fingers against the opposing palms with fingers interlocked. Rub the tips of the fingers. Rub the tips of the fingers in the opposite palm in a circular motion. (4) Rub each thumb clasped in the opposite hand using a rotational movement. (5) Rub each wrist with the opposite hand. (6) Rinse hands with water.

Use of alcohol-based handrub

Evidence-based approaches

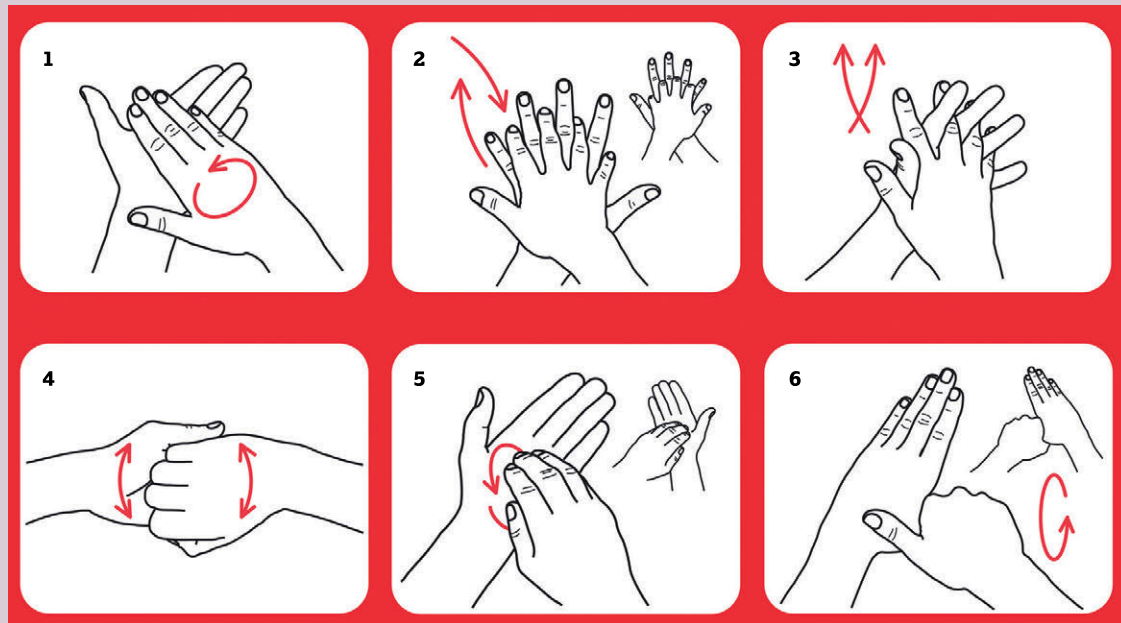
Alcohol-based handrub should be applied in a sufficient quantity to physically clean hands. It should be rubbed into all surfaces until it has evaporated and the hands are dry (NHS England and NHSI 2019).

Procedure guideline 4.2 Hand decontamination using an alcohol-based handrub

Essential equipment <ul style="list-style-type: none">Alcohol-based handrub	
Action	Rationale
Procedure	
1 Dispense the amount of alcohol-based handrub indicated in the manufacturer's instructions into the palm of one hand. If hands are large, a greater amount may be needed to ensure coverage.	Too much handrub will take longer to dry and may consequently cause delays; too little will not decontaminate hands adequately. E

- 2 Rub the alcohol-based handrub into all areas of the hands until the hands are dry, using the illustrated actions in **Action figure 2**.

To ensure all areas of the hands are decontaminated. Alcohol is a rapid-acting disinfectant with the added advantage that it evaporates, leaving the hands dry. This prevents contamination of equipment while facilitating the application of gloves (WHO 2009a, C).



Action Figure 2 Alcohol-based handrub hand hygiene technique for visibly clean hands. After applying a palmful of the product in a cupped hand: (1) rub hands palm to palm. (2) Rub right palm over left dorsum with interlaced fingers and vice versa. (3) Rub palm to palm with fingers interlaced. (4) Rub the backs of the fingers against the opposing palms with fingers interlocked. (5) Rub rotationally, backwards and forwards, with clasped fingers of right hand in left palm and vice versa. (6) Rub rotationally with the left thumb clasped in the right palm and vice versa. *Source:* Reproduced from Stewardson et al. (2014). <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0105866>. Licensed under CC BY 4.0.

Surgical hand antisepsis

Evidence-based approaches

Surgical hand antisepsis is the antiseptic surgical scrub or antiseptic handrub performed before donning sterile attire pre-operatively. The aim is to reduce the number of resident and transient flora to a minimum and also to inhibit their regrowth for as long as possible, not just on the hands but also on the wrists and forearms (AfPP 2017).

Surgical hand antisepsis can be performed using an approved antiseptic surgical scrub such as chlorhexidine gluconate or povidone-iodine, or an approved alcohol-based handrub. There is evidence that alcohol-based handrub is favourable over soap and water as it has a wide spectrum of activity and better dermal tolerance, and removes the risk of contamination from rinse water (NHS England and NHSI 2019). The practitioner should choose between use of soap and water or alcohol-based handrub as the two procedures should not be combined.

Whichever cleansing agent is used, the hands should be physically clean prior to surgical antisepsis, so any dirt should be removed from the skin or under the nails using ordinary soap and water and a nail pick before entering the theatre (Box 4.2).

The principle behind surgical hand antisepsis is to clean the skin thoroughly, moving from the cleanest part (the hands) to the least clean part (the forearm). The procedure should be carried out

Box 4.2 Key steps before starting surgical hand preparation

- Keep nails short and pay attention to them when washing hands – most microbes on hands come from beneath the fingernails.
- Do not wear artificial nails or nail polish.
- Remove all jewellery (rings, watches and bracelets) before entering the operating theatre.
- Wash hands and arms with a non-medicated soap before entering the operating theatre area or if hands are visibly soiled.
- Clean subungual areas with a nail file. Preferably nail-brushes should not be used as they may damage the skin and encourage shedding of cells. If used, nailbrushes must be sterile and single use. Reusable autoclavable nail brushes are available.

Source: Adapted from WHO (2009a).

immediately prior to gowning and gloving for a surgical intervention (AfPP 2017). Each step consists of five strokes rubbing backwards and forwards (AfPP 2017). Hands and forearms should be washed for the length of time recommended by the manufacturer of the alcohol-based handrub or antimicrobial antiseptic solution (WHO 2009a).

Procedure guideline 4.3 Surgical scrub technique using soap and water

Essential equipment

- Surgical scrub sink or handwash basin with sufficient space available under the outlet to allow easy rinsing of hands and forearms
- Antimicrobial antiseptic solution
- Sterile towels
- Domestic waste bin

Optional equipment

- Scrubbing brushes – but note that WHO (2009a) guidelines recommend that scrubbing brushes should only be used for nails and are *not* to be used directly on the skin as they may damage the skin and encourage the shedding of cells (including bacteria)

Action

Rationale

Pre-procedure

- | | |
|--|--|
| 1 Remove any rings, bracelets and wristwatches, and roll up sleeves before entering the operating theatre suite or procedure area. <i>Note:</i> most organizations will require staff entering operating theatres to change into 'scrubs'. | To ensure good hand washing as jewellery inhibits this. Dirt and bacteria can remain beneath jewellery after hand washing. Long sleeves prevent washing of wrists and will easily become contaminated (NICE 2017, C ; WHO 2009a, C). |
| 2 If the skin is damaged with cuts or abrasions, advice should be sought from occupational health as it may not be advisable to proceed with surgical hand antisepsis. | Cuts and abrasions can become contaminated with bacteria and cannot be easily cleaned. Repeated hand washing can worsen an injury. Breaks in the skin will allow the entry of potential pathogens (WHO 2009a, C). |
| 3 Remove nail varnish and artificial nails (most uniform policies and dress codes prohibit these). Nails must also be short and clean. Clean beneath the nails using a pick or brush if needed. | Long and false nails and imperfections in nail polish harbour dirt and bacteria that are not effectively removed by hand washing (WHO 2009a, C). The area under the nails may harbour dirt and micro-organisms not easily removed by the other stages of the procedure (WHO 2009a, C). |

Procedure

- | | |
|---|--|
| 4 Turn on the taps and where possible direct the water flow away from the plughole. Run the water at a flow rate that prevents splashing. | Plugholes are often contaminated with micro-organisms, which could be transferred to the environment or the user if splashing occurs (Aranega-Bou et al. 2019, E ; British Standards Institution 2014, C). |
| 5 Run the water until warm. | Warm water is more pleasant to wash with than cold so hand washing is more likely to be carried out effectively. E
Water that is too hot could cause scalding. E |
| 6 Ensuring no part of the sink or taps is touched, wet the surface of the hands, wrists and forearms up to the elbow, working in one direction only from the fingertips to the elbow, keeping the hands higher than the elbows. | Soap applied directly onto dry hands may damage the skin. The water will also quickly mix with the soap to speed up hand washing. E |
| 7 Wash the hands again from the hand to the middle of the forearm and then wash from the hand to the wrist area. | As the hand moves up the arm, it may become contaminated. By washing after cleaning to the elbow, this risk of contamination is reduced. C |
| 8 Apply appropriate antiseptic soap to all surfaces of the hands in one downwards stroke. Work into the hands palm to palm and then all the areas of the hands and arms just below the elbows as outlined in the following steps. | Liquid soap is very effective at removing dirt, organic material and any loosely adherent transient flora. The bactericidal additive contributes to the reduction in the number of bacteria. Chlorhexidine has a residual effect to prevent regrowth of bacteria for a period after hand decontamination (WHO 2009a, C). |



Step 1

Wet hands and forearms. Apply the specified amount of appropriate solution, according to the manufacturer's recommendations, from dispenser (one downward stroke action). Work into hands palm to palm, and then encompass all areas of the hands and arms to just below the elbows as shown in steps 2–9. Perform the same manoeuvres if using alcohol-based handrub but without water and rinsing.



Step 2

Rub with right palm over back of left and vice versa with fingers interlaced.



Step 3

Rub palm to palm, fingers interlaced.



Step 4

Rotational rubbing backwards and forwards with clasped fingers of right hand into left palm and vice versa.



Step 5

Rotational rubbing of right thumb clasped in left hand and vice versa.



Step 6

Rub finger tips on palms for both hands.



Step 7

Continue with rotating action down opposing arms, working to just below the elbows; do not move back towards the wrist. If using alcohol-based handrub an additional dose may be required here, one for each arm.



Step 8

Rinse and repeat steps 1–7 keeping hands raised above elbows at all times. **This wash should now only cover two thirds of the forearms to avoid compromising cleanliness of hands.** Local policy may include repeating these steps a third time but to wrists only.



Step 9: ending scrub

If using a solution, rinse hands under running water; clean to dirty area. Turn off tap using elbows if necessary. Open gown pack onto a clean surface and take a hand towel. Hands are dried first by placing the opposite hand behind the towel and blotting the skin, then, using a corkscrew movement, drying from hand to elbow; do not move back down towards wrist. Discard towel. Using a second towel, repeat the process on other hand and forearm before discarding. **If using alcohol-based handrub,** allow hands and forearms to dry completely before donning sterile gloves (WHO 2009, 2016).

Procedure guideline 4.3 Surgical scrub technique using soap and water (*continued*)**Action**

- 9 Wash the hands again from the hand to the middle of the forearm and then wash from the hand to the wrist area.
- 10 Wash the hands following the steps below:
- right palm over back of left and vice versa with fingers interlaced (**Action figure 10**, step two)
 - rub palm to palm with fingers interlaced (step three)
 - rotational rubbing backwards and forwards with clasped fingers of right hand into left palm and vice versa (step four)
 - rotational rubbing of right thumb clasped in left hand and vice versa (step five)
 - rub finger tips on palms of opposite hands (step six)
 - continue with rotating action down opposing arms, working to just below the elbows; do not move back to the wrist (step seven).
- All steps should be carried out thoroughly on both the left and right hands and arms. The scrub procedure should take a minimum of 2–5 minutes, depending on local guidelines (AfPP 2017).

- 11 Rinse hands and arms thoroughly from fingertips to elbows, keeping the hands above the elbows at all times. Avoid passing the hands back and forth through the water.
- 12 At all times take care not to splash water onto clothing.

Post-procedure

- 13 Dry hands thoroughly with a sterile paper towel. Hands are dried first by placing the opposite hand behind the towel and blotting the skin, then using a corkscrew movement to dry from hand to elbow (do not move back towards the wrist). Discard the towel and use a second one to repeat the process on the other hand and forearm (**Action figure 10**, step nine).
- 14 Dispose of used paper towels in a black bag in an open or foot-operated waste bin.

Rationale

As the hand moves up the arm, it may become contaminated. By washing after cleaning to the elbow, this risk of contamination is reduced. **C**

To cover all areas of the skin and prevent bacteria-laden soap and water from contaminating the hands (WHO 2009a, **C**).

To prevent recontaminating areas already covered (AfPP 2017, **C**).

To avoid recontaminating the hands with water that has been used to clean the arms (WHO 2009a, **C**).

To avoid contamination. **C**

Damp hands encourage the multiplication of bacteria (DH 2017, **C**). Drying from hands to elbows reduces the risk of contaminating hands with bacteria from parts of the arm that have not been washed. **E**

Paper towels used to dry the hands are normally non-hazardous and can be disposed of via the domestic waste stream (DH 2013b, **C**). Using an open or foot-operated waste bin prevents contamination of the hands. **E**

Procedure guideline 4.4 Surgical scrub technique using an alcohol-based handrub**Essential equipment**

- An approved alcohol-based handrub, e.g. Desderman or Sterillium

Action**Pre-procedure**

- 1 Remove any rings, bracelets and wristwatches, and roll up sleeves before entering the operating theatre suite or procedure area. *Note:* most organizations will require staff entering operating theatres to change into 'scrubs'.
- 2 If the skin is damaged with cuts or abrasions, advice should be sought from occupational health as it may not be advisable to proceed with surgical hand antisepsis.
- 3 Remove nail varnish and artificial nails (most uniform policies and dress codes prohibit these). Nails must also be short and clean. Clean beneath the nails using a pick or brush if needed.

Rationale

To ensure good hand washing as jewellery inhibits this. Dirt and bacteria can remain beneath jewellery after hand washing. Long sleeves prevent washing of wrists and will easily become contaminated (NICE 2017, **C**; WHO 2009a, **C**).

Cuts and abrasions can become contaminated with bacteria and cannot be easily cleaned. Repeated hand washing can worsen an injury. Breaks in the skin will allow the entry of potential pathogens (WHO 2009a, **C**).

Long and false nails and imperfections in nail polish harbour dirt and bacteria that are not effectively removed by hand washing (WHO 2009a, **C**). The area under the nails may harbour dirt and micro-organisms not easily removed by the other stages of the procedure (WHO 2009a, **C**).

Procedure

4 Before commencing the first scrub of the day, the hands should be washed thoroughly with soap and water and dried with a paper towel (see Procedure guideline 4.1: Hand washing). *Note:* WHO guidelines state that surgical procedures may be carried out one after the other without the need for further hand washing if hands are perfectly clean and dry, provided that the below hand-preparation technique is followed with alcohol-based handrub every time (WHO 2009a).

To ensure all physical dirt and soil is removed as alcohol is inactivated in the presence of dirt. **E**

5 Wet the surface of the hands, wrists and forearms with a generous amount of alcohol-based handrub as advised by the manufacturer.

To ensure the correct amount is used and that skin coverage is appropriate. **E**



1 Put approximately 5 mL (3 doses) of alcohol-based handrub in the palm of your left hand, using the elbow of your other arm to operate the dispenser.



2 Dip the fingertips of your right hand in the handrub to decontaminate under the nails (5 seconds).



3 Images 3–7: Smear the handrub on the right forearm up to the elbow. Ensure that the whole skin area is covered by using circular movements around the forearm until the handrub has fully evaporated (10–15 seconds).



4 See legend for image 3.



5 See legend for image 3.



6 See legend for image 3.



7 See legend for image 3.



8 Put approximately 5 mL (3 doses) of alcohol-based handrub in the palm of your right hand, using the elbow of your other arm to operate the dispenser.




9 Dip the fingertips of your left hand in the handrub to decontaminate under the nails (5 seconds).

Action Figure 6 Surgical hand preparation technique with an alcohol-based handrub formulation. *Source:* WHO (2009a). *Source:* Reproduced from WHO (2009a) with permission of the World Health Organization.

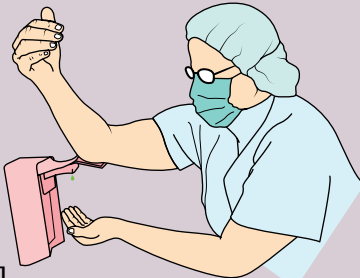
(continued)

Procedure guideline 4.4 Surgical scrub technique using an alcohol-based handrub (continued)

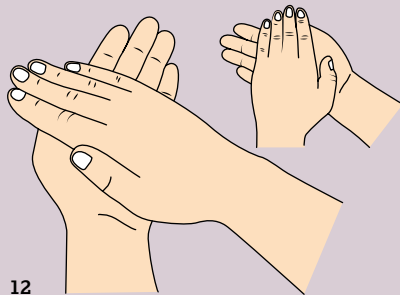
Action	Rationale
6 Use steps 1–17 of the surgical hand preparation technique with an alcohol-based rub (Action figure 6). The scrub procedure should take between 90 seconds and 3 minutes, depending on the manufacturer’s guidelines.	To ensure antimicrobial effectiveness (AfPP 2017, C).
7 Apply more alcohol to the hands and work this into the hands and wrists.	As the hand moves up the arm, it may become contaminated. By applying more alcohol after cleaning to the elbow, this risk of contamination is reduced. C
8 Allow the alcohol solution to dry on the hands before proceeding to don gown and gloves.	Alcohol needs to be allowed to dry. E




10
Smear the handrub on the left forearm up to the elbow. Ensure that the whole skin area is covered by using circular movements around the forearm until the handrub has fully evaporated (10–15 seconds).



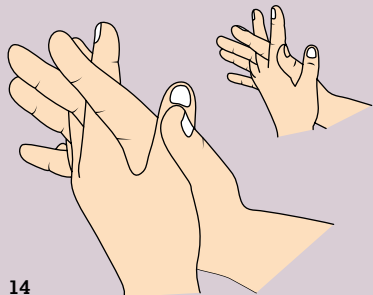
11
Put approximately 5 mL (3 doses) of alcohol-based handrub in the palm of your left hand, using the elbow of your other arm to operate the distributor. Rub both hands at the same time up to the wrists, and ensure that all the steps represented in Images 12–17 are followed (20–30 seconds).



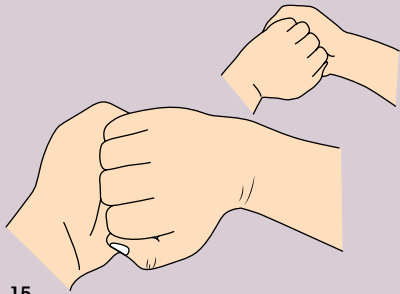
12
Cover the whole surface of the hands up to the wrist with alcohol-based handrub, rubbing palm against palm with a rotating movement.




13
Rub the back of the left hand, including the wrist, moving the right palm back and forth, and vice versa.




14
Rub palm against palm back and forth with fingers interlinked.



15
Rub the back of the fingers by holding them in the palm of the other hand with a sideways back-and-forth movement.



16
Rub the thumb of the left hand by rotating it in the clasped palm of the right hand and vice versa.



17
When the hands are dry, sterile surgical clothing and gloves can be donned.

Action Figure 6 Continued

Personal protective equipment (PPE)

Definition

Personal protective equipment (PPE) is the term for items used to physically protect someone from a potential infection hazard. It can include gloves, aprons, masks, face-shields and gowns.

Related theory

The exact PPE required will depend on the activity being carried out and the organism or risk present. It is a legal requirement in the UK for employers to provide suitable PPE when risks cannot be controlled in other ways, and for employees to use the equipment provided (HSE 2013c).

Basic PPE – that is, non-latex disposable gloves, disposable aprons and eye protection – should be readily available in the clinical area (Loveday et al. 2014a), particularly where regular use is anticipated. For example, it is appropriate to have dispensers for gloves and aprons situated outside isolation rooms. All PPE sold in the UK must comply with the relevant regulations and standards, including being CE marked to demonstrate that it meets these standards (HSE 2013c).

Disposable gloves

Gloves will be necessary in some circumstances but should be worn only when required (Loveday et al. 2014a, RCN 2018, WHO 2009b). Non-sterile disposable gloves are most usefully available packaged in boxes of 100 ambidextrous gloves, in small, medium and large sizes. These boxes should be located close to the point of use, ideally in a fixed dispenser to make removing the gloves from the box as easy as possible. In the past, natural rubber latex was commonly used for these gloves but concerns about latex sensitivity mean that many healthcare organizations have adopted gloves made of alternative materials such as vinyl or nitrile (RCN 2018). All gloves carry a risk of failure, as they may have small holes invisible to the naked eye (Kerr et al. 2004, Korniewicz et al. 2002). The removal process may also contaminate the hands so it is essential that hands are decontaminated after the removal of gloves. Whatever the material, these gloves are single use – they should be used for the task for which they are required and then removed and disposed of. They cannot be cleaned and reused for another task (Loveday et al. 2014a, MHRA 2018).

Disposable aprons

Single-use disposable aprons may be obtained either in a box or linked together on a roll. It is important to ensure that the product is compatible with the dispensers in use and that it meets the requisite standards (i.e. is CE marked). Aprons are normally made of thin polythene and are available in a range of colours. Different coloured aprons can be used to designate staff doing different tasks or working in different areas to give a visible reminder of the risk of cross-infection. As with disposable gloves, disposable aprons should be used for the task for which they are required and then removed and disposed of (Loveday et al. 2014a, MHRA 2018).

Disposable gowns

Non-sterile long-sleeved gowns are sometimes required to provide greater coverage of uniforms or clothing, for example when caring for a patient with a highly resistant pathogen. The gown should be put on and done up fully to cover the uniform. Like aprons, they should be used for the task for which they are required and then removed carefully and disposed of, with hands decontaminated afterwards.

Sterile gloves

Single-use sterile gloves should be available in any area where their use is anticipated. Sterile gloves are packed as a left-and-right pair and are manufactured in a wide range of full and half sizes (similar to shoe sizes) so as to fit closely and provide the best

possible compromise between acting as a barrier and allowing the wearer to work normally. Natural rubber latex is one of the best materials for this; however, if latex gloves are used, care must be taken to ensure alternatives are available for patients and staff with sensitivity to latex (RCN 2018).

Sterile gowns

A sterile, water-repellent gown is required in addition to sterile gloves to provide 'maximal barrier precautions' during surgery and other invasive procedures carrying a high risk of infection, or where infection would have serious consequences to the patient, such as insertion of a central venous catheter.

Face protection

Face protection includes protection for the eyes and/or the mouth and nose and will be required in any situation where the mucous membranes of the face may be exposed to body fluids. This can be from droplets created during aerosol-generating procedures, intubation, surgery with power tools or just close proximity (such as during childbirth). Both single-use and multiple-use options are available. Goggles are normally sufficient for eye protection as long as they are worn in conjunction with a fluid-repellent mask. If greater protection is required, or a mask is not worn for any reason, a face-shield should be used. Face-shields may also be more appropriate for people who wear glasses. Prescription glasses will often not provide sufficient protection and should not be relied upon (DH 1998).

Masks and respirators

When dealing with organisms spread by the airborne or droplet routes, a surgical face-mask or respirator mask will be required. A simple surgical mask will protect the wearer from splashes to the covered area of the face and may impede large droplets. These masks should not be worn for long periods as they can become saturated with water vapour from normal breathing, which will make them permeable.

A respirator mask is a mask that is designed to filter out all but the smallest particles and is usually used to prevent the transmission of respiratory viruses. Masks are available at different grades. Usually the standard FFP3 is accepted in the UK. When using a respirator, a good fit is essential to ensure that there is no leakage around the sides of the mask. Staff who are likely to need to use respirators should be 'fit tested' to ensure that they have the correct size. Fit testing is a formal qualitative test usually performed annually to establish that a particular mask fits a particular face. Fit testing is normally carried out by the occupational health department or infection prevention and control team. Facial hair under the edge of the respirator will prevent a proper seal; staff with beards that prevent a proper seal will not be able to work safely if a respirator is required (HSE 2013d).

Masks and respirators are usually single use; however, reusable respirators are sometimes required where the mask may need to be worn for a long time or for people whose face shape does not allow a good seal with disposable products (DH 2010b). Reusable respirators must be assigned to specific individuals and be cleaned thoroughly every time they are removed.

Removal of personal protective equipment

PPE should be removed in the following sequence to minimize the risks of cross-contamination and self-contamination (Loveday et al. 2014a):

- gloves
- apron
- eye protection (when worn)
- mask/respirator (when worn).

Hands must be decontaminated following the removal of PPE.

Procedure guideline 4.5 Putting on and removing non-sterile gloves

<i>Essential equipment</i> <ul style="list-style-type: none">• Non-sterile gloves	
Action	Rationale
Pre-procedure	
1 Decontaminate hands with either soap and water or an alcohol-based handrub before putting on gloves.	Hands must be decontaminated before and after every patient contact or contact with a patient's equipment (NHS England and NHSI 2019, C ; Wilson 2019, C).
Procedure	
2 Remove gloves from the box one at a time (Action figure 2). If it is likely that more than two gloves will be required (i.e. if the procedure requires gloves to be changed part-way through), consider removing all the gloves needed before starting the procedure.	To prevent contamination of the finger part of the gloves. E
3 Holding the cuff of the glove, pull it into position, taking care not to contaminate the glove from the skin (Action figure 3). This is particularly important when the second glove is being put on, as the gloved hand of the first glove can touch the skin of the ungloved second hand if care is not taken.	To prevent cross-contamination (WHO 2009b, C).
4 During the procedure or when undertaking two procedures with the same patient, it may be necessary to change gloves.	Disposable gloves are single-use items. They cannot be cleaned and reused for the same or another patient (Wilson 2019, C).
5 If gloves become damaged during use, they must be replaced.	Damaged gloves are not an effective barrier (WHO 2009b, C).
6 Remove the gloves when the procedure is complete, taking care not to contaminate the hands or the environment from the outside of the gloves.	The outside of the glove may be contaminated. E
7 Remove the first glove by firmly holding the outside of the glove's wrist and pulling off the glove in such a way as to turn it inside out (Action figure 7).	While removing the first glove, the second gloved hand continues to be protected. By turning the glove inside out during removal, any contamination is contained inside the glove. E
8 Remove the second glove by slipping the thumb of the ungloved hand inside the wrist of the glove and pulling it off while at the same time turning it inside out (Action figure 8).	Putting the thumb inside the glove means they will not be in contact with the potentially contaminated outer surface of the glove. E
Post-procedure	
9 Dispose of used gloves immediately in the appropriate bin as per local policy (Action figure 9).	Waste that is not contaminated with any infectious material should be disposed of in the 'offensive waste' stream. This is usually a yellow and black 'tiger stripe' bag. If the gloves have been used to deal with any infectious agents thought to pose a particular risk, they should be disposed of as hazardous infectious waste in an orange or yellow bag (DH 2013b, C).
10 After removing the gloves, decontaminate hands.	Hands may have become contaminated (NHS England and NHSI 2019, C ; WHO 2009b, C).



Action Figure 2 Remove gloves from the box.



Action Figure 3 Holding the cuff of the glove, pull it into position.



Action Figure 7 Remove the first glove by firmly holding the outside of the glove's wrist, then pull off the glove in such a way as to turn it inside out.



Action Figure 8 Remove the second glove by slipping the thumb of the ungloved hand inside the wrist of the glove and pulling it off while turning it inside out.



Action Figure 9 Dispose of used gloves in an appropriate clinical waste bag (tiger stripe if non-hazardous and non-infectious).

Procedure guideline 4.6 Applying and removing a disposable apron

Essential equipment

- Disposable apron

Action

Rationale

Pre-procedure

- 1 Remove an apron from the dispenser or roll using clean hands and open it out.

To make it easy to put on. **E**

Procedure

- 2 Place the neck loop over your head and tie the ties together behind your back, positioning the apron so that as much of the front of your body is protected as possible (**Action figures 2a and 2b**).

To minimize the risk of contamination being transferred between your clothing and the patient, in either direction. **E**

- 3 If gloves are required, don them as described in Procedure guideline 4.5: Putting on and removing non-sterile gloves. At the end of the procedure, remove gloves first.

The gloves are more likely to be contaminated than the apron and therefore should be removed first to prevent cross-contamination (DH 2010b, **C**).

- 4 Remove the apron by breaking the ties and neck loop. Then grasp the inside of the apron roll it up (**Action figure 4**).

The inside of the apron should be clean. **E**

(continued)

Procedure guideline 4.6 Applying and removing a disposable apron (continued)

Action	Rationale
Post-procedure	
5 Dispose of the used apron immediately in the appropriate bin.	Waste that is not contaminated with any infectious material should be disposed of in the 'offensive waste' stream. This is usually a yellow and black 'tiger stripe' bag. If the apron has been used to deal with any infectious agents thought to pose a particular risk, it should be disposed of as hazardous infectious waste in an orange or yellow bag (DH 2013b, C).
6 After removing the apron, decontaminate hands.	Hands may have become contaminated (NHS England and NHSI 2019, C).



Action Figure 2a Place the neck loop of the apron over your head.



Action Figure 2b Tie the ties together behind your back, positioning the apron so that as much of the front of your body is protected as possible.



Action Figure 4 Remove the apron by breaking the neck loop and ties.

Procedure guideline 4.7 Putting on and removing a disposable mask or respirator

Essential equipment

- Disposable surgical mask or respirator

Action

Rationale

Pre-procedure

- | | |
|--|---|
| 1 Remove surgical-type masks singly from the box, or remove individually wrapped items from their packaging, with clean hands. | To prevent contamination of the item or others in the box or dispenser. E |
| 2 Consider removing glasses, if worn. | Glasses may obstruct the correct positioning of the mask/respirator and may be dislodged or damaged. E |

Procedure

- | | |
|--|--|
| 3 Place the mask or respirator over your nose, mouth and chin (Action figure 3). | To ensure correct positioning. E |
| 4 Fit the flexible nose piece over the bridge of your nose if wearing a respirator. | To ensure the best fit. E |
| 5 Secure the mask/respirator at the back of your head with ties or fitted elastic straps and adjust to fit (Action figure 5). | To ensure the mask or respirator is comfortable to wear and remains in the correct position throughout the procedure. E |

(continued)

Procedure guideline 4.7 Putting on and removing a disposable mask or respirator (continued)

Action	Rationale
6 If wearing a respirator, perform a fit check. First, breathe in – the respirator should collapse or be ‘sucked in’ to the face. Then breathe out – the respirator should not leak around the edges.	To ensure that there is a good seal around the edge of the respirator so that there is no route for non-filtered air to pass in either direction. Note that this check should be carried out whenever a respirator is worn but is not a substitute for prior fit testing (DH 2010b, C).
7 Replace glasses, if previously removed.	To restore normal vision. E
8 At the end of the procedure, or after leaving the room in which the mask/respirator is required, remove the mask/respirator by grasping the ties or straps at the back of the head and either break them or pull them forward over the top of the head (Action figure 8a). Do not touch the front of the mask/respirator (Action figure 8b).	To avoid contaminating the hands with material from the outside of the mask/respirator (DH 2010b, C).
Post-procedure	
9 Dispose of used disposable items as hazardous infectious waste, as per local policy.	All waste contaminated with blood, body fluids, excretions, secretions and/or infectious agents thought to pose a particular risk should be disposed of as hazardous infectious waste (DH 2013b, C).
10 Clean reusable items according to the manufacturer’s instructions, usually with detergent and water or a detergent wipe.	To avoid cross-contamination and ensure the item is suitable for further use (DH 2010b, C).



Action Figure 3 Place the mask over your nose, mouth and chin.



Action Figure 5 Secure the mask at the back of your head with ties.



Action Figure 8a After use, remove the mask by untying or breaking the ties and pulling them forward.



Action Figure 8b Do not touch the front of the mask.

Procedure guideline 4.8 Putting on or removing goggles or a face-shield

The purpose of goggles or a face-shield is to protect the mucous membranes of the eyes, nose and mouth from body fluid droplets generated during aerosol-generating procedures or surgery with power tools.

Essential equipment

- Reusable or disposable goggles or face-shield

Action	Rationale
Pre-procedure	
1 Remove eye protection from any packaging with clean hands.	To prevent cross-contamination. E
2 Apply demister solution according to the manufacturer's instructions, if required.	To ensure good visibility throughout the procedure. E
Procedure	
3 Position the goggles/face-shield over the eyes and/or face and secure using ear pieces or a headband; adjust to fit (Action figure 3).	To ensure the item is comfortable to wear and remains in the correct position throughout the procedure. E
4 At the end of the procedure, remove by grasping the ear pieces or headband at the back or side of the head and lifting forward, away from the face. Do not touch the front of the goggles/face-shield.	To avoid contaminating the hands with material from the outside of the eye protection (DH 2010b, C).
Post-procedure	
5 Dispose of used disposable items as 'hazardous infectious waste' as per local policy.	All waste contaminated with blood, body fluids, excretions, secretions and/or infectious agents thought to pose a particular risk should be disposed of as hazardous infectious waste (DH 2013b, C).
6 Clean reusable items according to the manufacturer's instructions, usually with detergent and water or a detergent wipe.	To avoid cross-contamination and ensure the item is suitable for further use. E



Action Figure 3 Application and removal of protective eye goggles.

Donning theatre attire

Evidence-based approaches

There are two recognized techniques for putting on sterile gloves: a closed and an open method. The open technique may be used on wards for aseptic procedures but is not recommended for use in the operating theatre, where a closed technique should be used.

The open technique is used to create a barrier between the nurse's hands and the patient to prevent the transmission of infectious agents in either direction, and to prevent contamination of a vulnerable area or invasive device. It may be used for aseptic techniques such as inserting a urinary catheter or a sterile wound dressing.

Procedure guideline 4.9 Donning a sterile gown and gloves: closed technique

An assistant is required to open the sterile gloves and tie the back of the gown.

Essential equipment

- Sterile disposable gloves
- Sterile disposable or reusable gown

Action

Pre-procedure

- 1 Prepare the area where gowning and gloving will take place. Open the gown pack with clean hands. Do not touch the inside of the package.
- 2 Wash hands using a surgical scrub technique with either antiseptic handwash or an alcohol-based handrub. Ensure hands are dry.

Rationale

To ensure that there is adequate room to don gown and gloves and to avoid contaminating either. **E**

To both disinfect and physically remove matter and micro-organisms from the hands (WHO 2009a, **C**).

Procedure

- 3 Open the inner layer of the gown pack, if present (**Action figures 3a and 3b**).
- 4 Grasp the gown on its inside surface just below the neck opening (this should be uppermost if the gown pack has been opened correctly) and lift it up, holding it away from the body and any walls or furniture. The gown should fall open with the inside facing towards you (**Action figure 4**).
- 5 Continue to grasp the inside of the gown with one hand. Insert the free hand into the corresponding sleeve of the gown, pulling the gown towards you until your fingers reach, but do not go beyond, the cuff of the sleeve (**Action figure 5**).
- 6 With the other hand, release the inside surface of the gown and insert that hand into the corresponding sleeve, again until your fingers reach but do not go beyond the cuff of the sleeve. The assistant should help to pull the gown on and tie the ties, without touching any part of the gown other than the ties and rear edges (**Action figure 6**).
- 7 The assistant should open a pair of sterile gloves and present the inner packaging for you to take. Take the package with your hands inside your sleeves, and place it on the sterile area of the open gown package so that the fingers of the gloves point towards you (**Actions figure 7a and 7b**).
- 8 Open the inner packaging of the gloves (**Action figure 8a**). The fingers should be towards you, the thumbs uppermost and the cuffs folded over. Keeping your hands within the sleeves of the gown, slide the thumb of your right hand (still inside the sleeve) between the folded-over cuff and the body of the right glove (**Action figure 8b**). Pick up that glove. Grasp the cuff of that glove on the opposite side with the other hand (still inside its sleeve) and unfold it, pulling it over the cuff of the sleeve and the hand inside. Then push your right hand through the cuff of the sleeve into the glove (**Action figures 8c and 8d**). Repeat the process with the left hand (**Action figure 8e**). Adjust the fit once both gloves are on (**Action figure 8f**). Once both hands are inside their respective gloves, there is no risk of contaminating the outside of the gloves or gown with your bare hands. *Note:* never allow the bare hand to touch the gown cuff edge or outside of the glove. Also, the gloves can be put on either hand first; simply exchange 'left' and 'right' in the description if you wish to put on the left-hand glove first.
- 9 If you need to change a glove because it is damaged or contaminated, pull the sleeve cuff down over your hand as you do so and don the replacement glove using the technique above.
- 10 Dispose of used gloves and disposable gowns as 'hazardous infectious waste', unless instructed otherwise by the infection prevention and control team.
- 11 Once gowned and gloved it is important to maintain sterility, so:
 - Never drop your hands below the sterile area at which you are working.
 - Never touch the gown above the level of the axilla or below the sterile area at which you are working.
 - Never touch an unsterile object.
 - Never tuck your hands under your armpits.

To allow the gown to be removed. **E**

To open out the gown while keeping its outer surface sterile. **E**

To pull on the gown while keeping its outer surface sterile. **E**

To pull on the gown while keeping its outer surface sterile. **E**

To prepare the gloves for donning while keeping them and the gown sterile. **E**

To don the gloves while keeping their outer surface sterile and ensure that there is no risk of contaminating the outside of the gown. **E**

To minimize the risk of contaminating the gown or the sterile field. **E**

All waste contaminated with blood, body fluids, excretions, secretions and/or infectious agents thought to pose a particular risk should be disposed of as hazardous infectious waste. **C**

To avoid contamination of the sterile field. The only part of the gown that is considered sterile is the area at the front between the axilla and the sterile area at which you are working. The armpits are a source of micro-organisms. **C**

Post-procedure

- 12 At the end of the procedure, remove gown and gloves as a single unit by pulling the gown away from you so as to turn it and the gloves inside out (**Action figures 12a and 12b**).
- 13 Consign reusable gowns as infected linen according to local arrangements.
- 14 After removing the gloves and gown, decontaminate hands.

To avoid cross-contamination of hands. **E**

To minimize any risk to laundry workers from contaminated items (HSE 2013e, **C**).

Hands may have become contaminated (NHS England and NHSI 2019, **C**).



Action Figure 3a Open the gown pack with clean hands onto a clean surface. Do not touch the inner packet until after the surgical scrub.



Action Figure 3b Open the inner layer of the pack.



Action Figure 4 Lift up the gown by its inner surface and hold it away from the body.



Action Figure 5 Put one hand into the corresponding sleeve and use the other hand to pull the gown towards you. Your hand should not go beyond the cuff.

(continued)

Procedure guideline 4.9 Donning a sterile gown and gloves: closed technique (continued)



Action Figure 6 Put the other hand into the other sleeve. Again, your hand should not go beyond the cuff.



Action Figure 7b Take the gloves, keeping your hands inside your sleeves.



Action Figure 7a The assistant opens a pair of sterile gloves and presents the inner packaging for you to take.



Action Figure 8a Open the inner glove packet onto the sterile open gown package so that the glove fingers point towards you.



Action Figure 8b Slide the thumb of one hand (still inside the sleeve) under the folded-over cuff of the corresponding glove.



Action Figure 8c Push your hand through the cuff and into the glove.



Action Figure 8d Pull the glove into position using the other hand (still inside its sleeve).



Action Figure 8e Repeat the process with the other glove.



Action Figure 8f Adjust the fit when both gloves are on.

(continued)

Procedure guideline 4.9 Donning a sterile gown and gloves: closed technique (continued)



Action Figure 12a At the end of the procedure, remove the gown and gloves as a single unit by pulling the gown away from you.



Action Figure 12b Turn the gown and gloves inside out.

Procedure guideline 4.10 Donning sterile gloves: open technique

Essential equipment

- Sterile disposable gloves
- All other equipment required for the procedure for which the gloves are required

Action	Rationale
Pre-procedure	
1 Clean hands using soap and water or an alcohol-based handrub.	Hands must be cleansed before and after every patient contact or contact with a patient's equipment (NHS England and NHSI 2019, C).
2 Prepare all the equipment required for the procedure, including setting up the sterile field and tipping sterile items onto it from packets if you do not have an assistant, but do not touch any sterile items before putting on gloves.	To avoid contaminating gloves with non-sterile packets. E
Procedure	
3 Open the packet containing the gloves and open out the inside packaging on a clean surface so that the fingers of the gloves are pointed away from you, taking care not to touch the gloves or allow them to come into contact with anything that is non-sterile (Action figure 3).	To prevent contamination of the gloves and to place them in the best position for putting them on. E
4 Clean hands again using soap and water or an alcohol-based handrub.	Hands must be cleansed before and after every patient contact or contact with patient's a equipment (NHS England and NHSI 2019, C).

- 5 Hold the cuff of the right-hand glove with the left hand, at the uppermost edge where the cuff folds back on itself. Lift this edge away from the opposite edge to create an opening (**Action figure 5a**). Keeping them together, slide the fingers of the hand into the glove, taking care not to contaminate the outside of the glove while keeping hold of the folded edge in the other hand and pulling the glove onto the hand (**Action figure 5b**). Spread the fingers of the right hand slightly to help them enter the fingers of the glove (**Action figure 5c**). *Note:* here and in the next step, the gloves can be put on either hand first; simply exchange 'left' and 'right' in the description if you wish to put on the left-hand glove first.
- 6 Open up the left-hand glove with your right-hand fingertips by sliding them beneath the folded-back cuff. Taking care not to touch the right-hand glove or the outside of the left-hand glove with your left hand, and keeping the fingers together, slide the fingers of your left hand into the left-hand glove (**Action figures 6a and 6b**).
- 7 Again, spread your fingers slightly once inside the body of the glove to help them into the glove fingers. When both gloves are on, adjust the fit by pulling on the body of the gloves to get your fingers to the ends of the glove fingers (**Action figures 7a and 7b**).

To prevent contamination of the outside of the glove. **E**

To prevent contamination of the outside of the glove. **E**

To ensure the gloves are comfortable to wear and do not interfere with the procedure. **E**

Post-procedure

- 8 Remove the gloves when the procedure is completed, taking care not to contaminate your hands or the environment from the outside of the gloves.
- 9 First, remove the first glove by firmly holding the outside of the glove wrist and pulling off the glove in such a way as to turn it inside out.
- 10 Then remove the second glove by slipping the fingers of the ungloved hand inside the wrist of the glove and pulling it off while at the same time turning it inside out.
- 11 Dispose of used gloves as 'hazardous infectious waste', unless instructed otherwise by the infection prevention and control team.
- 12 After removing the gloves, decontaminate your hands.

The outside of the gloves is likely to be contaminated. **E**

While removing the first glove, the second gloved hand continues to be protected. By turning the glove inside out during removal, any contamination is contained inside the glove. **E**

By putting the fingers inside the glove, the fingers will not be in contact with the potentially contaminated outer surface of the glove. **E**

All waste contaminated with blood, body fluids, excretions, secretions and/or infectious agents thought to pose a particular risk should be disposed of as hazardous infectious waste. **E**

Hands may have become contaminated (NHS England and NHSI 2019, **C**).



Action Figure 3 Open the packet containing the gloves onto a clean surface and open out the inside packaging so that the fingers of the gloves point away from you.



Action Figure 5a Hold the cuff of the first glove with the opposite hand and slide the fingertips of the other hand (the one that the glove is to go on) into the opening.

(continued)

Procedure guideline 4.10 Donning sterile gloves: open technique (continued)



Action Figure 5b Keep hold of the folded edge and pull the glove onto your hand.



Action Figure 5c Spread your fingers slightly to help them enter the fingers of the glove.



Action Figure 6a Slide the fingertips of your gloved hand beneath the folded cuff of the second glove.



Action Figure 6b Slide the fingertips of your ungloved hand into the opening of the second glove.



Action Figure 7a Pull the glove onto your hand, again spreading your fingers slightly to help them enter the fingers of the glove.



Action Figure 7b When both gloves are on, adjust the fit.

Specific patient-related procedures

Standard precautions

Related theory

The phrase ‘standard precautions’, or ‘standard infection control precautions’ (SICPs), is sometimes used to describe the actions that should be taken by all healthcare staff in every care situation to protect patients and others from infection (it is sometimes used interchangeably with ‘universal precautions’; however, this term is now considered outdated). Standard precautions include:

- appropriate patient placement to minimize any risk of cross-infection
- hand hygiene at the point of care, as described by the WHO (2009a) in ‘My 5 Moments for Hand Hygiene’
- respiratory and cough etiquette
- correct use of PPE for contact with all blood and body fluids
- management of care equipment to ensure it is adequately decontaminated between uses, if not designed for single patient use
- providing care in a suitably clean environment
- safe management of linen, including storage and disposal
- safe management of blood and body fluid spillages
- safe disposal of waste, including care in the use and disposal of sharps
- occupational safety, including prevention and management of inoculation, bite and splash injuries.

Aseptic technique

Definition

Aseptic technique is the practice of carrying out a procedure in such a way as to minimize the risk of introducing contamination into a vulnerable area or an invasive device. The area or device will not necessarily be sterile – wounds, for example, will be colonized with micro-organisms – but the aim is to avoid introducing additional contamination.

Aseptic non-touch technique (ANTT) is the practice of avoiding contamination by not touching key elements, such as the tip of a needle, the seal of an intravenous connector after it has been decontaminated (Figure 4.11), or the inside surface of a sterile dressing where it will be in contact with the wound (Rowley and Clare 2011).

Related theory

As with other infection prevention and control measures, the actions taken to reduce the risk of contamination will depend on the procedure being undertaken and the potential consequences of contamination (Rowley and Clare 2011). Examples of different levels of aseptic technique are given in Table 4.7. It would be

Table 4.7 Examples of different levels of aseptic procedures

Procedure	Precautions required
Surgery	Carried out in an operating theatre with specialist ventilation by a team whose members wear sterile gowns and gloves
Urinary catheterization	Can be carried out in an open ward by a practitioner wearing an apron and sterile gloves
Peripheral intravenous cannulation	Can be performed in an open ward by a practitioner wearing non-sterile gloves and using an appropriate non-touch technique

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difficult to provide a procedure guideline that would apply to the whole range of aseptic procedures; however, the topic is covered in other relevant procedures within this manual, such as those for the insertion of an indwelling urinary catheter (see Chapter 6: Elimination). To provide a context, Procedure guideline 4.11 contains steps for changing a wound dressing but is presented as a guide to aseptic technique in general. Local guidance and training should be sought before carrying out specific procedures.

Pre-procedural considerations

Equipment

Gloves

Gloves are normally worn for ANTT but they are mainly for the practitioner's, rather than the patient's, protection. Non-sterile gloves are therefore perfectly acceptable.

Sterile dressing pack

This may contain gallipots or an indented plastic tray, low-linting swabs and/or medical foam, disposable forceps, gloves, a sterile field and a disposal bag. There are specific packs available for particular procedures, for example intravenous packs. The usage and availability of these vary between organizations, so reference is generally made to a ‘sterile dressing pack’.

Traceability system

This is a system for labelling instruments and equipment in such a way that they can be recorded in the patient record, usually as a sticker or a scanned barcode. It allows the opportunity to look back to identify what equipment has been used, where and on whom, in the event of a problem (e.g. with a batch of a product).

Trolley

Dressing trolleys should be cleaned with a detergent wipe prior to each use to remove any dust or soiling. Disinfectant wipes may be used if the trolley is physically clean.

Pharmacological support

Cleansing agents are discussed in more detail in Chapter 18: Wound management.

Specific patient preparation

Education

Wherever possible, patients should be informed about the rationale behind procedures and the steps being taken to reduce the risk of them being exposed to an HCAI during their care. Patients may be offered additional information to help them make informed choices on things that they can do to stay well and prevent infection while they are in hospital or indeed when they are at home. In particular, programmes that encourage patients to ask healthcare workers ‘Did you wash your hands?’ have been demonstrated to increase healthcare workers’ compliance with hand hygiene (McGuckin et al. 2011). They may also empower patients and increase their confidence in the care they are receiving.



Figure 4.11 Avoiding contamination by avoiding contact with the key elements. *Source:* Reproduced with permission of ICU Medical, Inc.

Procedure guideline 4.11 Aseptic technique example: changing a wound dressing*Essential equipment (will vary depending on procedure)*

- Sterile dressing pack
- Fluids for cleaning and/or irrigation – 0.9% sodium chloride is normally appropriate
- Hypoallergenic tape (if required)
- Appropriate dressing (if required)
- Alcohol-based handrub (hand washing is an acceptable alternative but will take more time and may entail leaving the patient; alcohol-based handrub is the most appropriate method for hand hygiene during a procedure as long as hands are physically clean)
- Any extra equipment that may be needed during the procedure, for example sterile scissors
- Traceability system (sticker or electronic) for any reusable surgical instruments
- Patient record form
- Detergent wipe for cleaning trolley

Action**Rationale****Pre-procedure**

- | | |
|--|--|
| 1 Check that all the equipment required for the procedure is available and, where applicable, is sterile (i.e. that packaging is undamaged, intact and dry, and that sterility indicators are present on any sterilized items and have changed colour where applicable). | To ensure that the patient is not disturbed unnecessarily if items are not available and to avoid unnecessary delays during the procedure. E
To ensure that only sterile products are used (MHRA 2010, C). |
| 2 Introduce yourself to the patient, explain and discuss the procedure with them, and gain their consent to proceed. | To ensure that the patient feels at ease, understands the procedure and gives their valid consent (NMC 2018, C). |

Procedure

- | | |
|--|--|
| 3 Clean hands with an alcohol-based handrub or wash with soap and water and dry with paper towels. | Hands must be cleaned before and after every patient contact and before commencing the preparations for aseptic technique, to prevent cross-infection (NHS England and NHSI 2019, C). |
| 4 Clean the trolley with detergent and water or detergent wipes and dry it with a paper towel. Clean from the top surface and work down to the bottom. If disinfection is also required, use disposable wipes saturated with 70% isopropyl alcohol and allow to dry. | Shared pieces of equipment used in the delivery of patient care must be cleaned and decontaminated after each use with products recommended by the manufacturer (Loveday et al. 2014a). E
To provide a clean working surface (Fraise and Bradley 2009, E).
Alcohol is an effective and fast-acting disinfectant that will dry quickly (Fraise and Bradley 2009, E). |
| 5 Place all the equipment required for the procedure on the bottom shelf of the clean dressing trolley. | To maintain the top shelf as a clean working surface. E |
| 6 Take the patient to the treatment room or screen the bed. Ensure that any fans in the area are turned off and windows closed. Position the patient comfortably and so that the area to be dealt with is easily accessible without exposing the patient unduly. | To allow any airborne organisms to settle before the sterile field (and, in this case, the wound) is exposed. To maintain the patient's dignity and comfort. E |
| 7 Put on a disposable plastic apron. | To reduce the risk of contaminating clothing and of contaminating the wound or any sterile items via clothing. E |
| 8 Take the trolley to the treatment room or patient's bedside, disturbing the curtains as little as possible. | To minimize airborne contamination. E |
| 9 Loosen the adhesive or tape on the existing dressing. | To make it easier to remove the dressing. E |
| 10 Clean hands with an alcohol-based handrub. | Hands should be cleaned before any aseptic procedure (WHO 2009a, C).
Using alcohol-based handrub avoids having to leave the patient to go to a sink. E |
| 11 Verify that the sterile pack is the correct way up and open the outer cover. Slide the contents, without touching them, onto the top shelf of the trolley. | To minimize contamination of the contents. E |
| 12 Open the sterile field using only the corners of the paper. | So that areas of potential contamination are kept to a minimum. E |
| 13 Open any other packs, tipping their contents gently onto the centre of the sterile field. | To prepare the equipment and, in the case of a wound dressing, reduce the amount of time that the wound is uncovered. E |

14 Where appropriate, loosen the old dressing.	To minimize trauma when removing the old dressing. E
15 Clean hands with an alcohol-based handrub.	Hands may have become contaminated by handling outer packets or the old dressing (NHS England and NHSI 2019, C).
16 Carefully lift the plastic disposal bag from the sterile field by its open end and, holding it by one edge of the open end, place your other hand in the bag. Using it as a sterile 'glove', arrange the contents of the dressing pack and any other sterile items on the sterile field.	To maintain the sterility of the items required for the procedure while arranging them so as to perform the procedure quickly and efficiently. E
17 With your hand still enclosed within the disposal bag, remove the old dressing from the wound. Invert the bag so that the dressing is contained within it and stick it to the trolley below the top shelf. This is now the disposal bag for the remainder of the procedure for any waste other than sharps.	To minimize the risk of contamination by containing the dressing in the bag. E To ensure that any waste can be disposed of without contaminating the sterile field. E
18 Pour any required solutions into gallipots or onto the indented plastic tray.	To minimize the risk of contamination of solutions. E
19 Put on gloves, as described in Procedure guideline 4.5: Putting on and removing non-sterile gloves or Procedure guideline 4.10: Donning sterile gloves: open technique. The procedure will dictate whether the gloves should be sterile or non-sterile.	Gloves should be worn whenever any contact with body fluids is anticipated (Loveday et al. 2014a, C). Sterile gloves provide greater sensitivity than forceps for procedures that cannot be carried out with a non-touch technique and are less likely to cause trauma to the patient. E
20 Carry out the relevant procedure according to local guidelines.	
Post-procedure	
21 Make sure the patient is comfortable.	To minimize the risk of causing the patient distress or discomfort. E
22 Dispose of waste, including apron and gloves, in offensive waste bags.	To prevent environmental contamination (DH 2013b, C).
23 Draw back the curtains or help the patient back to the bed area and ensure that they are comfortable.	To minimize the risk of causing the patient distress or discomfort. E
24 Check that the trolley remains dry and physically clean. If necessary, wash it with liquid detergent and water or detergent wipe and dry thoroughly with a paper towel.	To remove any contamination on the trolley and so minimize the risk of transferring any contamination elsewhere in the ward (Loveday et al. 2014a, C).
25 Clean hands with alcohol-based handrub or soap and water.	Hands should be cleaned after any contact with the patient or body fluids (WHO 2009a, C).
26 Document the procedure clearly, including details of who carried it out, any devices or dressings used (particularly any left <i>in situ</i>), and any deviation from the prescribed procedure. Fix any record labels from the outside packaging of the items used during the procedure on the patient record and add this to the patient's notes.	To provide a record of the procedure and evidence that any items used have undergone an appropriate sterilization process (DH 2007, C ; NMC 2018, C).

Nursing care of patients with suspected or known infection: managing safe care

Related theory

The principle of infection prevention and control is preventing the transmission of infectious agents. However, measures taken to reduce the risk of transmission must be reasonable, practicable and proportionate to the transmission risk. They must not lose sight of the need to provide safe and efficient healthcare and keep services running efficiently for the benefit of all patients. For example, while *S. aureus* can cause severe infections, it is carried by around a third of the population and so isolating every patient who carries it would not be practicable or possible. On the other hand, its antibiotic-resistant version (known as MRSA) can cause equally serious infections and is resistant to common first-line antibiotics that would normally be used to treat these infections. It is carried by far fewer people, and it is therefore reasonable and practical to take additional precautions to prevent its spread in healthcare (Coia et al. 2006).

The management of any individual who is infected or colonized with an organism that may pose a risk to other individuals must be based on a risk assessment that takes into account the following factors (Jones 2010):

- What is the organism responsible for the infection?
- What are the possible routes of transmission and how easily can it be spread?
- How susceptible to infection are any other people being cared for in the same area and what would be the likely consequences if they were to become infected?
- How practical would it be to implement specific infection prevention and control precautions within the relevant area or institution (e.g. bearing in mind the number of single rooms available and staffing levels)?
- What are the individual's other nursing needs?

The infection prevention and control policies of health and social care providers are based on generic risk assessments of their

Box 4.3 Transmission routes

Transmission routes can be divided into the following:

- *Direct contact*: person-to-person spread of infectious agents through physical contact.
- *Indirect contact*: where someone comes into contact with a contaminated object.
- *Enteric*: organisms carried in faeces.
- *Parenteral transmission*: where blood or body fluids containing infectious agents come into contact with mucous membranes or exposed tissue. In healthcare, this can occur through transplantation or infusion (which is why blood and organs for transplantation are screened for blood-borne viruses such as HIV) or through an inoculation injury where blood splashes into the eyes or a used item of sharp equipment penetrates the skin.
- *Faecal–oral transmission*: where an infectious agent present in the faeces of an infected person is subsequently ingested by someone else and enters their gastrointestinal tract. This is the route of most gastrointestinal illness as well as water- and foodborne diseases (salmonella, norovirus and *C. difficile* infections are also spread in this manner).
- *Droplets*: large respiratory particles.
- *Airborne*: smaller airborne particles, usually respiratory.

usual client or patient group and should be adhered to unless there are strong reasons to alter procedures for a particular individual's care. In such circumstances, the advice of the infection prevention and control team (IPCT) should be sought first. Nurses working in organizations without an IPCT should identify the most appropriate source from which to seek advice, preferably before it is needed. The local public health unit will be able to signpost appropriate advice providers.

All patients should have an assessment for infection risk on arrival and where possible beforehand if admission is planned. This assessment may need to be repeated at intervals depending on the changing condition of the patient. Based on this assessment, additional transmission-based precautions may be required for patients known or strongly suspected to be infected or colonized with organisms that pose a significant risk to other patients.

The precautions will vary depending on the route by which the organism can travel from one individual to another, but there will be common elements (Box 4.3).

Evidence-based approaches

Transmission precautions can be grouped as follows.

Contact precautions

Patients known or strongly suspected to be infected or colonized with pathogenic micro-organisms that spread via direct contact with the patient or indirectly from the patient's immediate care environment (including care equipment) should be managed with contact precautions.

Contact precautions normally consist of standard precautions enhanced with isolation of the patient in a single room and use of gloves and apron for any procedure involving contact with the patient or their immediate environment.

Enhanced contact precautions

Enhanced contact precautions are used for patients known or strongly suspected to be infected or colonized with highly resistant organisms. This involves the addition of a long-sleeved gown to the normal contact precautions above.

Enteric precautions

Patients suffering symptoms of diarrhoea or vomiting that do not have an obvious mechanical or non-infectious cause should be cared for using enteric precautions. These should be used from the first instance of diarrhoea or vomiting, regardless of whether a causative organism has been identified, until there is a definitive

diagnosis that the symptoms do not have an infectious cause (prompt collection of a stool sample is important). Enteric viruses are highly transmissible and outbreaks occur rapidly if precautions are not speedily implemented.

Enteric precautions consist of prompt isolation of the patient in a single room, ideally with an en suite toilet facility. The door of the room should be closed, and gloves and apron should be used for any procedure involving contact with the patient or their immediate environment (Health Protection Agency 2012).

Droplet precautions

Patients known or strongly suspected to be infected or colonized with pathogenic micro-organisms that are mainly transmitted via droplets of body fluids should be cared for with additional infection control precautions. The infectious agents are most often respiratory secretions expelled during coughing and sneezing but can include droplets from other sources, such as projectile vomiting or explosive diarrhoea.

Droplet precautions consist of isolation of the patient in a single room with the door closed and use of gloves and apron for any procedure involving contact with the patient or their immediate environment. Droplets are heavy and will usually travel no more than a metre from the person before settling on surfaces, so good hand hygiene and frequently touched surface environmental hygiene are essential. The patient should where possible be encouraged to practice good respiratory etiquette. For some infections (high-risk respiratory viruses, e.g. tuberculosis), staff entering the room may be required to wear a mask for close and prolonged contact and during aerosol-generating procedures.

Airborne precautions

Patients known or strongly suspected to be infected or colonized with pathogenic micro-organisms that are transmitted through the airborne route are cared for with airborne precautions. Airborne transmission involves droplets or particles containing infectious agents that are so tiny that the particles can remain suspended in the air for long periods of time. Infections spread via this route include measles and chickenpox.

Airborne precautions consist of isolation of the patient in a single room, if possible with negative pressure ventilation or a positive pressure ventilated lobby, with the door closed. Gloves and apron should be used for any procedure involving contact with the patient or their immediate environment. Staff entering the room should wear a properly fitted respirator (FFP3) mask (Siegel et al. 2007) (Figure 4.12).

Some guidelines merge droplet and airborne precautions in order to provide a single set of instructions for staff caring for



Figure 4.12 A correctly fitted FFP3 mask may be required for aerosol-generating procedures on patients with infections such as tuberculosis or influenza.

patients with any respiratory or airborne infection. A risk assessment should be carried out to determine the most appropriate PPE on a case-by-case basis.

Vector transmission

Many diseases are spread through the action of a vector, most often an insect that travels from one person to another to feed. This route is not currently a concern in healthcare in the UK; however, in some areas of the world, for example where malaria or dengue are endemic, protecting patients from vectors such as mosquitoes is an important element of nursing care. Diseases spread by vector do not generally spread from person to person.

Isolation procedures

Definition

Isolation is the practice of segregating a patient away from others to reduce the risk of spreading infection to others. The type of isolation – source isolation or protective isolation – will depend on the mode of transmission of the pathogen or the risk to the patient.

Source isolation

Definition

Source isolation is used for patients who are infected with, or are colonized by, infectious agents that require additional precautions over and above the standard precautions used with every patient (Siegal et al. 2007) in order to minimize the risk of transmission to other vulnerable persons. The exact precautions needed will depend on the mode of transmission of the organism and are known as ‘transmission-based precautions’. Patients requiring source isolation are normally cared for in a single room, although during an outbreak it may be necessary for patients affected by the same infection to be nursed in a ‘cohort’.

Related theory

A single-occupancy room will physically separate patients who present a risk from others who may be at risk, and will act as a reminder to any staff dealing with patients who present a risk of the need for additional infection control precautions. Single-occupancy rooms used for source isolation should have en suite toilet and bathroom facilities wherever possible, and should contain all items required to meet the patient’s nursing needs during the period of isolation (e.g. instruments to assess vital signs). Ideally, these should remain inside the room throughout the period of isolation. However, if this is not possible because insufficient equipment is available on the ward, any items taken from the room must be thoroughly cleaned and disinfected (with locally approved disinfectant) before being used with any other patient (Health Protection Scotland 2017). Conversely, it is important not to have unnecessary equipment in the room that may have to be discarded when the patient leaves.

The air pressure in a source isolation room should be negative or neutral in relation to the air pressure in the rest of the ward (note that some airborne infections will require a negative pressure room) (Siegal et al. 2007). A lobby will provide an additional degree of security and space for donning and removing PPE and performing hand hygiene. Some facilities have lobbies that are ventilated to have positive pressure with respect to both the rest of the ward and the single-occupancy room; this allows the room to be used for both source and protective isolation (DH 2013d).

Where insufficient single rooms are available for source isolation, they should be allocated to those patients who pose the greatest risk to others. As a general rule, patients with highly multi-resistant organisms and/or enteric symptoms (such as diarrhoea and vomiting) or serious airborne infections (such as tuberculosis) have the highest priority for single-occupancy rooms (Jeanes et al. 2011). If a patient cannot be isolated, this should be escalated to

the site manager and flagged as a risk. While the patient is waiting for an appropriate room, contact precautions will be required in the open ward.

Patients should receive a clear explanation of why they are being isolated and how this is prioritized, or they may be concerned about inconsistency. It is important that the patient’s other nursing and medical needs are always taken into account, and infection control precautions may need to be modified accordingly as isolation can have adverse psychological effects (Guilley-Lerondeau et al. 2017).

Evidence-based approaches

Principles of care

Attending to a patient in isolation

Meals

Meals should be served on normal crockery and the patient provided with normal cutlery. Cutlery and crockery should be washed in a dishwasher able to thermally disinfect items – that is, with a final rinse of 80°C for 1 minute or 71°C for 3 minutes. Disposables and uneaten food should be discarded in the appropriate bag. Contaminated crockery is a potential vector for infectious agents, particularly those that cause enteric disease, but thermal disinfection will minimize this risk (Fraise and Bradley 2009).

Urine and faeces

Wherever possible, a toilet should be kept solely for the patient’s use. If this is not feasible, the patient should be offered a commode. If there is sufficient stock, the commode should be kept in the patient’s room; it should be emptied promptly and cleaned between each use with an appropriate disinfectant. Gloves and apron must be worn by staff when dealing with body fluids. Bedpans and urinals should be covered and taken directly to the sluice for disposal. They should not be emptied before being placed in the bedpan washer or macerator unless the volume of the contents needs to be measured for a fluid balance or stool chart. Weighing scales are recommended for recording volume for fluid balance (1 ml = 1 gram). Gloves and aprons worn in the room should be kept on until the body waste has been disposed of and then removed (gloves first) and discarded as offensive waste.

Spillages

As elsewhere, any spillage must be mopped up immediately to remove the risk of anyone slipping. Blood or body fluids should be cleaned up using a locally approved disinfectant with demonstrable activity against target pathogens, following the manufacturer’s instructions and local guidance.

Bathing

Ideally an en suite bathroom or patient specific bathroom should be used. If this is not possible, the patient should use the ward bathroom, which should be thoroughly cleaned after use to minimize the risk of cross-infection to other patients.

Linen

Follow local procedure and place linen in an infected linen bag. This is usually a red water-soluble alginate polythene bag, which must be secured tightly before being put into a red fabric bag. These bags should await the laundry collection in the area designated for this. Placing infected linen into the appropriate bags confines harmful organisms and allows laundry staff to recognize the potential hazard and avoid handling the linen (DH 2013c).

Waste

Hazardous waste bags should be kept in the isolation room for disposal of clinical waste generated in the room. The top of the bag should be sealed and labelled with the name of the ward or department before it is removed from the room.

Cleaning an isolation room

The following principles should be adhered to regarding the cleaning of an isolation room:

- Domestic or environmental services staff must be instructed on the correct procedure to use when cleaning an isolation room; however, they must not be given any confidential patient information.
- They should understand what disinfectants should be used and if necessary how to make them up (dilution) as well as the correct colour coding for cleaning materials. This will reduce the risk of mistakes and ensure that appropriate precautions are maintained (Curran et al. 2019, DH 2017). Cleaning cloths may be reusable microfibre or disposable, depending on the organization's local policy.
- Separate cleaning equipment must be used for isolation rooms. Cross-infection may result from shared cleaning equipment (Wilson 2019).
- Domestic or environmental services staff must wear gloves and plastic aprons while cleaning isolation rooms to minimize the risk of contaminating hands or clothing. Some PPE may also be required for the safe use of some cleaning solutions.
- Isolation rooms should be cleaned last, to reduce the risk of the transmission of contamination to 'clean' areas (NICE 2017).
- Daily cleaning will reduce the number of bacteria in the environment. Organisms, especially gram-negative bacteria, multiply quickly in the presence of moisture and on equipment (Wilson 2019).

- Furniture and fittings should be damp-dusted daily (by nursing or cleaning staff) using a disposable cloth and a detergent or disinfectant solution, as dictated by local protocol. This is to remove dirt and a proportion of any organisms contaminating the environment (Wilson 2019).
- The toilet, shower and bathroom areas must be cleaned at least once a day and, if they become contaminated, using a non-abrasive hypochlorite powder, cream or solution. Non-abrasive powders and creams preserve the integrity of the surfaces.
- Floors must be washed daily with a disinfectant as appropriate. All excess water must be removed and disposed of in a dedicated disposal sink. Floors should have a hard surface: carpeted rooms should not be used in patient care areas.
- Cleaning solutions must be freshly made up each day and the container emptied and cleaned daily after use. This is because disinfectants may lose their effectiveness over time and cleaning solutions can easily become contaminated (Weber et al. 2007).
- After use, the bucket must be cleaned and dried. Contaminated cleaning equipment and solutions will spread bacteria over surfaces being cleaned (Weber et al. 2007).
- Mop heads and reusable cloths should be laundered daily as they become contaminated easily (Wilson 2019). Current methods for decontamination of reusable mops and cloths include ozone or laundry in water above 71°C (minimum 3 minutes). The exact methods will be dictated by local contract arrangements.

Procedure guideline 4.12 Source isolation: preparing an isolation room	
Essential equipment <ul style="list-style-type: none">• Personal protective equipment• Single-occupancy room• Patient equipment• Hand hygiene facilities• Patient information material	
Action	Rationale
Pre-procedure	
1 Identify the most suitable room available for source isolation, taking into account the risk to other patients and staff and the patient's other nursing needs.	To ensure the best balance between minimizing the risk of cross-infection and maintaining the safety and comfort of the isolated patient. E
Procedure	
2 Remove all non-essential furniture and equipment from the room. The remaining furniture should be easy to clean. Ensure that the room is stocked with any equipment required for patient care and sufficient but not excessive numbers of any disposable items that will be required.	To ensure the availability of everything required for patient care while minimizing the number of items that will require cleaning or disposal at the end of the isolation period and the amount of traffic of people and equipment into and out of the room. E
3 Ensure that a bin with a hazardous waste bag is present in the room. This will be used for clinical waste generated in the room. The bag must be sealed before it is removed from the room. Depending on the infection, it may be possible to have a general waste bag as well for non-infected items.	To contain contaminated rubbish within the room and minimize further spread of infection. E
4 Place a container for sharps in the room.	To contain contaminated sharps within the infected area (DH 2013b, C).
5 Keep the patient's personal property to a minimum. All belongings taken into the room should be washable, cleanable or disposable. Contact the infection prevention and control team for advice as to how best to clean or wash specific items.	The patient's belongings may become contaminated and cannot be taken home unless they are washable or cleanable. E
6 Ensure that all personal protective equipment (PPE) required is available outside the room. Wall-mounted dispensers offer the best use of space and ease of use but, if necessary, set up a trolley outside the door or in the ante room for PPE and alcohol-based handrub. Ensure that these arrangements do not cause an obstruction or other hazard.	To have PPE readily available when required. E

- 7 Introduce yourself to the patient, explain the reason for isolation and the precise precautions, and provide relevant patient information material where available. Allow the patient to ask questions and ask for a member of the infection prevention and control team to visit the patient if ward staff cannot answer all questions to the patient's satisfaction. The patient's family and other visitors may require an explanation but *any explanations given must respect patient confidentiality*.
- 8 Fix a suitable notice outside the room where it will be seen by anyone attempting to enter. This should indicate the special precautions required while preserving the patient's confidentiality.
- 9 Move the patient into the single-occupancy room.
- 10 Arrange for terminal cleaning of the bed space that the patient has been occupying.

Patients and their visitors may be more compliant if they understand the reasons for isolation, and the patient's anxiety may be reduced if they have as much information as possible about their condition. **E**

To ensure all staff and visitors are aware of the need for additional infection control precautions. **E**

For effective isolation. **E**

To remove any infectious agents that may pose a risk to the next patient to occupy that bed (NPSA 2009, **C**; Otter et al. 2012, **C**; Passaretti et al. 2013, **R**).

Post-procedure

- 11 Assess the patient daily to determine whether source isolation is still required; for example, if enteric precautions have been required, has the patient been without symptoms for 48 hours?

There is often limited availability of isolation rooms (Wigglesworth and Wilcox 2006, **R**) so they must be used as effectively as possible. **E**

Procedure guideline 4.13 Source isolation: entering an isolation room

Essential equipment

- Personal protective equipment as dictated by the precautions required: gloves and apron are the usual minimum; a respirator is required for droplet precautions; eye protection is required if an aerosol-generating procedure is planned
- Any equipment required for any procedure intended to be carried out in the room

Action

Rationale

Pre-procedure

- 1 Decontaminate hands and collect all equipment needed.

To avoid entering and leaving the area unnecessarily. **E**

Procedure

- 2 Ensure you are 'bare below the elbow' (see Procedure guideline 4.1: Hand washing).

To facilitate hand hygiene and avoid any contamination of long sleeves or cuffs, as this could cause cross-contamination to other patients. **E**

- 3 Put on a disposable plastic apron.

To protect the front of the uniform or clothing, which is the area most likely to come into contact with the patient. **E**

- 4 Put on a well-fitting mask or respirator of the appropriate standard if droplet or airborne precautions are required, for example if the patient has:
 - meningococcal meningitis and has not completed 24 hours of treatment
 - pandemic influenza
 - tuberculosis, if carrying out an aerosol-generating procedure or the tuberculosis may be multiresistant.

To reduce the risk of inhaling organisms (DH 2010b, **C**; HSE 2013c, 2013d, **C**).

- 5 Don eye protection if instructed by the infection prevention and control team (e.g. for pandemic influenza) or if conducting an aerosol-generating procedure (e.g. bronchoscopy or intubation) in a patient requiring airborne or droplet precautions.

To prevent infection via the conjunctiva (DH 2010b, **C**).

- 6 Clean hands with soap and water or an alcohol-based handrub.

Hands must be cleaned before patient contact (WHO 2009a, **C**).

- 7 Don disposable gloves if you are intending to deal with blood, excreta or contaminated material, or if providing close personal care where contact precautions are required. Gloves may need to be changed while in the room as per 'My 5 Moments for Hand Hygiene' (WHO 2009a).

To reduce the risk of hand contamination (NHS England and NHSI 2019, **C**).

- 8 Enter the room, shutting the door behind you.

To reduce the risk of airborne organisms leaving the room (Kao and Yang 2006, **R**).

To preserve the patient's privacy and dignity. **E**

Procedure guideline 4.14 Source isolation: leaving an isolation room*Essential equipment*

- Hazardous waste bag
- Hand hygiene facilities

Action**Rationale****Procedure**

- | | |
|---|---|
| 1 If there is an ante room or lobby, this should be used for removal of personal protective equipment (PPE). | To minimize the amount of waste in the room and provide space for applying and removing PPE. C |
| 2 If wearing gloves, remove and discard them in the hazardous waste bag. | To avoid transferring any contamination on the gloves to other areas or items (Loveday et al. 2014a, C). |
| 3 Remove apron by holding the inside of the apron and breaking the ties at the neck and waist. Discard it into the hazardous waste bag. | To avoid transferring any contamination on the apron to other areas or items (Loveday et al. 2014a, C). |
| 4 Clean hands with soap and water or an alcohol-based handrub. Do not use alcohol-based handrub when dealing with faeces. | Hands must be cleaned after contact with the patient or their immediate environment (WHO 2009a, C).
Alcohol is less effective against <i>C. difficile</i> spores and some enteric viruses and in the presence of organic material such as faeces (Fraise and Bradley 2009, E). |
| 5 Leave the room, shutting the door behind you. | To reduce the risk of airborne organisms leaving the room (Kao and Yang 2006, R).
To preserve the patient's privacy and dignity. E |
| 6 Clean hands with an alcohol-based handrub on leaving the room. | Hands must be cleaned after contact with the patient or their immediate environment (WHO 2009a, C). |

Procedure guideline 4.15 Source isolation: transporting infected patients outside a source isolation area**Action****Rationale****Procedure**

- | | |
|--|--|
| 1 At the earliest opportunity, inform the department concerned about the procedure and the appropriate infection control precautions required. <i>Maintain patient confidentiality.</i> | To allow the department time to make appropriate arrangements. E |
| 2 If possible and appropriate, arrange for the patient to have the last appointment of the day. If this is not possible, the patient should be seen quickly and returned to their isolation room. | The department concerned and any intervening areas will be less busy, so reducing the risk of contact with other vulnerable individuals. Also, the additional cleaning required following any procedure will not disrupt subsequent appointments. E |
| 3 Inform the portering service of the infection control precautions required. | Explanation will minimize the risk of cross-infection through failure to comply with infection control precautions (Fraise and Bradley 2009, E). |
| 4 Introduce yourself to the patient, and explain and discuss the procedure with them. | To ensure that the patient feels at ease and understands the procedure (NMC 2018, C). |
| 5 If the patient has an infection requiring droplet or airborne precautions, where the infection may present a risk to people encountered in the other department or in transit, the patient will need to wear a mask or respirator of the appropriate standard. Provide the patient with the mask and explain why it is required and how and when it is to be worn (i.e. while outside their single-occupancy room) and assist them to don it if necessary. | To prevent airborne cross-infection. E
Providing the patient with relevant information will reduce anxiety. C |
| 6 Escort the patient if necessary. | To attend to the patient's nursing needs and to remind others of infection control precautions if required. E |

Post-procedural considerations

Discharging a patient from isolation

If the patient no longer requires isolation but is still to be a patient on the ward, inform them of this and the reasons why isolation is no longer required before moving them out of the room. Also inform them if there is any reason why they may need to be returned to isolation, for example if diarrhoea returns.

If the patient is to be discharged home or to another health or social care setting, ensure that the discharge documentation includes details of their condition, the infection control precautions taken while they were in hospital, and any precautions or other actions that will need to be taken following discharge. Accurate information on infections must be supplied to any person involved with providing further support or nursing/medical care in a timely fashion (DH 2015a).

Cleaning an isolation room after a patient has been discharged

The following principles should be adhered to regarding the cleaning of an isolation room after a patient has been discharged:

- The room should be stripped. All bed linen and other textiles must be changed and curtains changed (reusable curtains must be laundered and disposable curtains discarded as offensive waste). Dispose of any unused disposable items. Curtains and other fabrics readily become colonized with bacteria (Shek et al. 2018), and paper packets cannot easily be cleaned.
- Impervious surfaces (e.g. locker, bedframe, mattress cover, chairs, floor, blinds and soap dispenser) should be washed with soap and water, or a sporicidal disinfectant if activity against spores is required, and dried. Relatively inaccessible places, for example ceilings, may be omitted, as inaccessible areas are not generally relevant to any infection risk (Wilson 2019). Wiping of surfaces is the most effective way of removing contaminants. Spores from some sources (e.g. *C. difficile*) will persist indefinitely in the environment unless destroyed by an effective disinfectant, and bacteria will thrive more readily in damp conditions.
- The room can be reused as soon as it has been thoroughly cleaned and restocked. Effective cleaning will have removed infectious agents that may pose a risk to the next patient.
- For some high-risk infections, such as *C. difficile* or multi-resistant gram-negative bacteria, it may be helpful to use additional automated room disinfection technology such as hydrogen peroxide vapour or ultraviolet-C light. However, these are not available in all settings; if they are available, they must only be used by specifically trained staff.

Protective isolation

Definition

Protective isolation is the practice of isolating a patient who does not have a competent immune system in order to protect them from potentially harmful organisms. It was formerly known as 'reverse barrier nursing'.

Related theory

Protective isolation is used to minimize the exposure to infectious agents of patients who are particularly at risk of infection. The evidence that protective isolation successfully reduces the incidence of infection is limited (Abad et al. 2010), probably because many infections are endogenous (i.e. caused by the patient's own bacterial flora). Protective isolation is used to reduce the risk of exogenous infection in groups that have greatly impaired immune systems, such as bone marrow transplant patients. Patients who have compromised immune systems often have greatly reduced numbers of a type of white blood cell called a neutrophil; this condition is known as neutropenia and those affected are described as neutropenic. Neutropenia is graded from mild to severe according to how few neutrophils are in the circulation and hence how severe the risk is (Godwin et al. 2018).

Single-occupancy rooms used for protective isolation should have neutral or positive air pressure with respect to the surrounding area.

Evidence-based approaches

Principles of care

The patient should be given information about the importance of good food hygiene in reducing their exposure to potential pathogens. Neutropenic patients should avoid unpasteurized dairy products, raw or runny eggs, pâté and sushi; other potentially hazardous foods such as raw fruit, salads and uncooked vegetables may be eaten as long as good food hygiene is followed. This includes washing raw ingredients, peeling fruit or vegetables, storing foods at correct temperatures and avoiding reheating food.

It is important that the patient and their family understand the importance of good hand hygiene before eating or drinking (as potential pathogens on the hands may be inadvertently consumed) and the need for good food hygiene. Any food brought in for the patient should be in undamaged, sealed tins and packets obtained from well-known, reliable firms and must be within the expiry date, as correctly processed and packaged foods are more likely to be of an acceptable food hygiene standard. Previously served food should not be reheated.

Procedure guideline 4.16 Protective isolation: preparing an isolation room

Essential equipment

- Personal protective equipment
- Single-occupancy room
- Patient equipment
- Hand hygiene facilities
- Patient information material

Action

Rationale

Pre-procedure

- 1 Identify the most suitable room available for protective isolation, taking into account the risk to the patient, the patient's other nursing needs and other demands on the available single rooms.

To ensure the best balance between minimizing the risk of infection, maintaining the safety and comfort of the isolated patient, and the need for single rooms for other purposes. **E**

(continued)

Procedure guideline 4.16 Protective isolation: preparing an isolation room (*continued*)**Action****Rationale****Procedure**

- | | |
|--|---|
| 2 Remove all non-essential furniture and equipment from the room. The remaining furniture should be easy to clean. Ensure that the room is stocked with any equipment required for patient care and sufficient numbers of any disposable items that will be required. | To ensure the availability of everything required for patient care while minimizing the amount of cleaning required and the amount of traffic of people and equipment into and out of the room. E |
| 3 Ensure that all personal protective equipment (PPE) required is available outside the room. Wall-mounted dispensers offer the best use of space and ease of use but, if necessary, set up a trolley outside the door for PPE and an alcohol-based handrub. Ensure that these arrangements do not cause an obstruction or other hazard. | To have PPE readily available when required. E |
| 4 Ensure that the room is thoroughly cleaned before the patient is admitted. | Effective cleaning will remove infectious agents that may pose a risk to the patient (NPSA 2009, C). |
| 5 Introduce yourself to the patient, explain the reason for isolation and the precise precautions, and provide relevant patient information material where available. Allow the patient to ask questions and ask for a member of the infection prevention and control team to visit the patient if ward staff cannot answer all questions to the patient's satisfaction. The patient's family and other visitors may require an explanation but <i>any explanations given must respect patient confidentiality</i> . | Patients and their visitors may be more compliant if they understand the reasons for isolation, and the patient's anxiety may be reduced if they have as much information as possible about their condition. E |
| 6 Fix a suitable notice outside the room where it will be seen by anyone attempting to enter the room. This should indicate the special precautions required while preserving the patient's confidentiality. | To ensure all staff and visitors are aware of the need for additional infection control precautions. E |
| 7 Move the patient into the single-occupancy room. | To minimize exposure to potentially harmful micro-organisms (Wigglesworth 2003, E). |
| 8 Ensure that surfaces and furniture are damp-dusted according to the cleaning schedule using disposable cloths. High-risk areas should usually be cleaned two or three times per day. | Damp-dusting and mopping remove micro-organisms without distributing them into the air. E
To meet national cleaning standards for a high-risk area. E |

Procedure guideline 4.17 Protective isolation: entering an isolation room**Essential equipment**

- Hand hygiene facilities
- Disposable plastic apron
- Gloves and mask where indicated
- Additional equipment for any procedure to be undertaken

Action**Rationale****Pre-procedure**

- | | |
|---------------------------------|--|
| 1 Collect all equipment needed. | To avoid entering and leaving the room unnecessarily. E |
|---------------------------------|--|

Procedure

- | | |
|---|--|
| 2 Ensure you are 'bare below the elbow' (see Procedure guideline 4.1: Hand washing). | To facilitate hand hygiene and to avoid transferring any contamination to the patient from long sleeves or cuffs. E |
| 3 Put on a disposable plastic apron. | To provide a barrier over the front of the uniform or clothing, which is the area most likely to come in contact with the patient. E |
| 4 Staff who have any coryzal symptoms should not enter the room. If this is unavoidable, they should wear a mask. | To prevent unnecessary exposure of the patient to pathogenic organisms. E |
| 5 Clean hands with soap and water or an alcohol-based handrub. | To remove any contamination from the hands that could be transferred to the patient (WHO 2009a, C). |
| 6 Close the door after entering. | To reduce the risk of airborne transmission of infection from other areas of the ward and ensure that the ventilation and air filtration systems work as efficiently as possible. E |

Visitors

7 Ask the patient to nominate close relatives and friends who may then, after instruction (see steps 1–6 above), visit freely. The patient or their representative should ask other acquaintances and non-essential visitors to avoid visiting during the period of vulnerability.	The risk of infection is likely to increase in proportion to the number of people visiting. Unlimited visiting by close relatives and friends may diminish any sense of isolation in the patient; however, large numbers of visitors may be difficult to screen and educate. E
8 Exclude any visitor who has had symptoms of infection or been in contact with a communicable disease in the previous 48 hours.	Individuals may be infectious both before and after developing symptoms of infection (Goering et al. 2012, E).
9 Educate all visitors to decontaminate their hands before entering the isolation room.	Hands carry large numbers of potentially pathogenic micro-organisms, but these can be easily removed (WHO 2009a, C).
10 Visiting by children, other than very close relatives, should be discouraged.	Children are more likely to have been in contact with infectious diseases but are less likely to be aware of this and are more likely to develop infections because they have less acquired immunity. E

Post-procedural considerations

Discharging a neutropenic patient

Patients who have recently been neutropenic should be advised to avoid crowded areas, for example shops, cinemas, pubs and other entertainment venues (Calandra 2000). They should be advised that pets should not be allowed to lick them, and new or other people's pets should be avoided. Pets are known carriers of potential pathogens (Lefebvre et al. 2006).

Certain foods, for example take-away meals, soft cheese and pâté, should continue to be avoided as these foodstuffs are more likely than others to be contaminated with potential pathogens (Gillespie et al. 2005). Salads and fruit should be washed carefully, dried and, if possible, peeled to remove as many pathogens as possible (Moody et al. 2006).

It is vital that the patient and their family know that any signs or symptoms of infection, such as a temperature, should be reported immediately to the patient's GP or to the discharging hospital. Any infection may have serious consequences if not treated promptly.

Environmental hygiene and the management of waste in the healthcare environment

Definition

The term 'environmental hygiene' refers to the standard of cleanliness expected in a clinical area.

Related theory

Providing a clean and safe environment for healthcare is a key priority for the NHS and is a core standard in the Hygiene Code (DH 2015a). The role of cleaning has been recognized as a vital and cost-effective mechanism for ensuring that the risk to patients from HCIs is reduced to a minimum (Dancer and Kramer 2019, Hall et al. 2016). It is also an important confidence marker for patients and the general public, as a 'dirty' environment is often seen as being synonymous with risk of infection. Many items in the healthcare environment can become contaminated, but the most likely routes for the spread of infection are inadequately decontaminated items of equipment used for diagnosis or treatment. Transmission can be prevented via effective cleaning and decontamination between each use (Curran et al. 2019). Healthcare providers are obliged under the Hygiene Code

to provide reasonable standards of cleanliness with an appropriately staffed and resourced cleaning service.

According to the national standards of cleanliness (NPSA 2009), clinical environments are divided into areas of very high, high, significant and low risk, and cleaning standards and frequencies are determined from this categorization. It can be argued that all clinical areas and equipment will carry some risk and items that are used between patients must be subjected to thorough decontamination (Curran et al. 2019). Regular auditing should be undertaken by the organization, and the nurse in a clinical area may be asked to accompany staff on these audits and verify that cleanliness is at a satisfactory standard. The standards are set out in local cleaning specifications (British Standards Institution 2014, NPSA 2009). Some of the key elements a nurse should be looking for include the presence of dust high up or low down on surfaces, and evidence of organic material on surfaces, including residues of blood or body fluids. Particular attention should be paid to the cleanliness of toilets, handwash basins, baths, showers and high-touch surfaces such as door plates and handles, taps, call bells and light switches. Nurses should also consider auditing the cleanliness of clinical equipment that is not usually cleaned by domestic staff; this may include commodes, drip stands, pulse oximeters, blood pressure equipment and pumps (among others). Decontamination of these items is facilitated by availability of effective and properly used decontamination items at the point of use in the same way that local placement of hand hygiene products facilitates hand hygiene (Curran et al. 2019).

It should be noted, though, that decontamination (which includes cleaning) is an important nursing role, as many pieces of equipment (e.g. blood pressure monitors) are used on multiple patients, meaning that decontamination to an appropriate level should take place between each patient use. Nurses have a duty to ensure high standards of hygiene in the care environment. Particularly, they must ensure that equipment that may be used for multiple patients and that has a high risk of contamination (such as commodes) is safe for use by the next vulnerable patient. Nurses should be trained to decontaminate any equipment that they use in line with local policies and the manufacturer's guidance.

Wipes

Wipes (wet wipes) are a modern alternative to traditional cleaning cloths. They are usually impregnated with a detergent and/or a disinfectant, do not require mixing, can be placed at the point of use to facilitate best practice, and when used appropriately can clean and/or disinfect a surface. Wipes, like other cleaning and

disinfectant products, are licensed for specific uses such as cleaning/disinfecting skin, hard surfaces or medical devices. A wipe must only be used as instructed by the manufacturer on the designated surface. Note that sometimes the same chemical may be licensed for different uses in different products. Such wipes are not interchangeable and the manufacturer’s instructions for use must be respected.

Examples of chemicals that may be found in wipes include quaternary ammonium compounds, chlorine, phenolic, hydrogen peroxide, peracetic acid, chlorhexidine in alcohol, and ethyl or isopropyl alcohol. There are a range of manufacturers that produce wipes. Products chosen for use in healthcare should meet approved standards, should have been tested in appropriate laboratories (accredited or a university laboratory with specific expertise) and be compatible with the surface to which they will be applied.

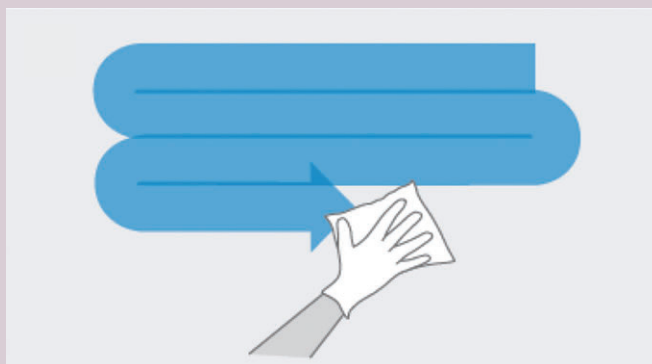
Indicator tape

An indicator label or tape may be applied to an item after cleaning to indicate that it has been decontaminated after its last use. This system is ideally used for shared equipment (e.g. commodes or drip stands), which may be stored between uses.

Automated room disinfection systems

The environment is a known source of HCAI pathogens, and these may persist on surfaces for weeks or months, in some cases presenting a risk to patients. The use of automated room disinfection systems may be considered to eradicate persistent organisms such as *C. difficile* or high-risk organisms such as multiresistant organisms from the environment. Systems that use hydrogen peroxide or ultraviolet light, although quite expensive, have been employed with very favourable results (Otter et al. 2012, Passaretti et al. 2013).

Procedure guideline 4.18 Cleaning a hard surface without recontamination	
Essential equipment <ul style="list-style-type: none">• Personal protective equipment• Appropriate wipes	
Action	Rationale
Pre-procedure	
1 Wash and dry hands.	To reduce the risk of introducing further pathogens into the area to be cleaned. C
2 Undertake a risk assessment of the chemical and the environment in which it is to be used. Select appropriate personal protective equipment (PPE) (gloves and apron, and potentially a face-mask) for the task so as to protect the skin and mucous membranes. Also consider adequate ventilation of the area. Follow the manufacturer’s instructions.	Some chemicals may be harmful to health if not used correctly. C
Procedure	
3 Select an appropriate wipe for the task. ‘Appropriate’ means that the agents contained within and released by the wipe have been demonstrated to act against the target micro-organism. Take one from the packet and use it, following the principle of one wipe, one direction and one surface. Follow the manufacturer’s instructions.	To ensure the product is used effectively. C
4 Remove heavy soiling using the wipe.	If an item is physically dirty, some disinfectants (such as chlorine) may be inactivated by soil, impairing their efficacy. C
5 Wipe all surfaces, including underneath. Pay specific attention to high touch points, which are surfaces that hands regularly come into contact with. Consider what the item is and how it is used to ensure that it is cleaned correctly.	To ensure that all areas are cleaned appropriately. C
6 Wipe items from top to bottom, going from a clean to a dirty area using an S-shaped motion. Overlap the motions slightly, making sure not to go over the same area twice (Action figure 6).	To ensure no area is missed and areas are not recontaminated by going back over an area that has previously been decontaminated. C
7 Dispose of the wipe between surfaces and if it becomes dry or soiled.	To ensure that micro-organisms are not transferred from a surface to another and to ensure that the efficacy of the wipe is not compromised by the agents becoming used up. C
8 Remove any PPE, and wash and dry hands.	To prevent recontamination of surfaces and to render hands clean for the next task. C
9 Apply any indicator tape if required by local policy.	So that items in storage can be identified as having been decontaminated after last use and are understood to now be safe to use for the next patient. C
Source: Procedure guideline adapted from GAMA Healthcare.	



Working from clean to dirty, wipe in an 'S' shaped pattern, taking care not to go over the same area twice.

Action Figure 6 Cleaning with a S-shaped motion. *Source:* © Gama Healthcare.









Waste disposal

Related theory

Waste material produced in the healthcare environment may carry a risk of infection to people who are not directly involved in providing healthcare but who are involved in the transport or disposal of that waste. All waste disposal is subject to regulation

and hazardous waste is subject to further controls, depending on the nature of the hazard (DH 2013b). To ensure that everyone involved in waste management is aware of, and protected from, any hazard presented by the waste with which they are dealing, and that the waste is disposed of appropriately, a colour-coding system is used. The colours in general use are shown in Table 4.8.

Table 4.8 Waste colour codes

Colour	Description
 Yellow	Waste that requires disposal by incineration Indicative treatment/disposal required is incineration in a suitably permitted or licensed facility.
 Orange	Waste that may be 'treated' Indicative treatment/disposal required is to be ' rendered safe ' in a suitably permitted or licensed facility, usually alternative treatment plants. However, this waste may also be disposed of by incineration .
 Purple	Cytotoxic and cytostatic waste Indicative treatment/disposal required is incineration in a suitably permitted or licensed facility.
 Yellow/black	Offensive/hygiene waste Indicative treatment/disposal required is landfill or municipal incineration/energy from waste at a suitably permitted or licensed facility.
 Red	Anatomical waste for incineration Indicative treatment/disposal required is incineration in a suitably permitted facility.
 Black	Domestic (municipal) waste Minimum treatment/disposal required is landfill , municipal incineration/energy from waste or other municipal waste treatment process at a suitably permitted or licensed facility. Recyclable components should be removed through segregation. Clear/opaque receptacles may also be used for domestic waste.
 Blue	Medicinal waste for incineration Indicative treatment/disposal required is incineration in a suitably permitted facility.
 White	Amalgam waste For recovery .

Source: Adapted from DH (2013b). © Crown copyright.

There are several different types of waste containers. They are usually plastic bags or rigid plastic containers of the appropriate colour (Table 4.9). Boxes for disposal of sharps are usually differentiated from rigid boxes for other waste.

Clinical governance

The producer of hazardous waste is legally responsible for that waste, and remains responsible for it until its final disposal by incineration, alternative treatment or landfill (DH 2013b). In order

Table 4.9 Waste containers




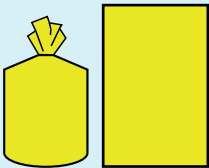
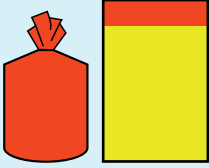
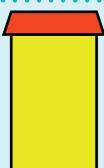
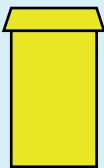
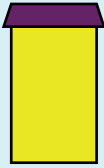
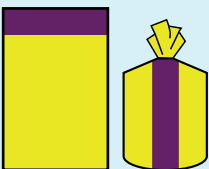
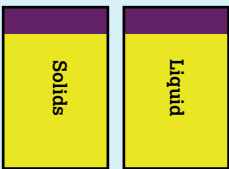
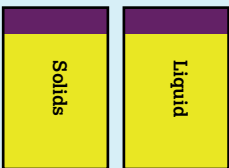
Waste type	Waste receptacle	Example description ¹	Waste management requirements ²	Additional comments
Domestic type waste	 Black bag	Mixed municipal waste	Landfill Municipal incineration Energy from waste Other authorised disposal or recovery	Medical practices must not place any hazardous waste in this waste stream. Recycling options should be considered
Offensive (healthcare)		Offensive waste from human/animal healthcare	Landfill Municipal incineration Energy from waste Other authorised disposal or recovery	This is restricted to offensive wastes from healthcare and related activities (including autoclaved wastes from laboratories)
Offensive (municipal)	Yellow and black striped bag	Offensive waste, municipal		This includes municipal hygiene wastes from medical practices
Anatomical waste (chemically preserved)		Clinical waste, human/animal anatomical, chemically preserved, for incineration only	Clinical waste incineration	If the waste is not classified as infectious then: <ul style="list-style-type: none"> tissue preserved in chemicals remains clinical waste and the transport requirements may be determined by the chemical preservatives, and where not preserved in chemicals, tissue would not normally be clinical waste
Anatomical waste (not chemically preserved)	Red-lidded, rigid yellow container	Clinical waste, human/animal anatomical, not chemically preserved, for incineration only		
Infectious waste contaminated with chemicals		Clinical waste, infectious, containing chemicals from human/animal healthcare, for incineration only	Clinical waste incineration	Waste chemicals must not be placed in this waste stream. It is for infectious materials containing or contaminated with chemicals (eg sample vials and used diagnostic kits)
Infectious waste (not containing chemicals or medicinal contamination)	 Orange bag or Orange-lidded, rigid yellow container	Clinical waste, infectious, from human/animal healthcare, suitable for alternative treatment	Alternative treatment or clinical waste incineration	This assumes healthcare offensive and domestic wastes are also segregated separately

Table 4.9 Waste containers

Waste type	Waste receptacle	Example description ¹	Waste management requirements ²	Additional comments
Sharps, non-medicinally contaminated	 Orange-lidded, yellow sharps box	Clinical waste, sharps, infectious, non-medicinally contaminated, suitable for alternative treatment Clinical waste, sharps, infectious, non-medicinally contaminated, from non-healthcare activities suitable for alternative treatment	Alternative treatment or clinical waste incineration	For producers and disposal sites in England and Wales, sharps that are not contaminated with medicinal products only For producers in Northern Ireland and Scotland whose waste is disposed of in those countries, both sharps that are not contaminated with medicinal products, and fully discharged medicinally contaminated sharps (other than cytotoxic and cytostatic)
Sharps, medicinally contaminated, other than cytotoxic and cytostatic		Clinical waste, mixed sharps and pharmaceutical waste (not cytotoxic and cytostatic), infectious, for incineration only	Clinical waste incineration	This may include associated vials, bottles and ampoules of medicine
Sharps, contaminated with cytotoxic and cytostatic medicines	 Purple-lidded, yellow sharps box	Clinical waste, mixed sharps and cytotoxic and cytostatic waste, infectious, for incineration only	Clinical waste incineration	This may include associated vials, bottles and ampoules of cytotoxic and cytostatic medicines
Other infectious waste contaminated with cytotoxic and cytostatic medicines	 Purple-lidded, rigid yellow container and sack	Clinical waste, cytotoxic and cytostatic waste, infectious, for incineration only		
Cytotoxic and cytostatic medicines (in original packaging)	 Two purple-lidded, rigid yellow containers (one for solids, one for liquids)	Clinical waste, cytotoxic and cytostatic medicines from animal/human healthcare for incineration only	Clinical waste incineration	
Cytotoxic and cytostatic medicines (not in original packaging)	 Two purple-lidded, rigid yellow containers (one for solids, one for liquids)			

(continued)

Table 4.9 Waste containers (*continued*)

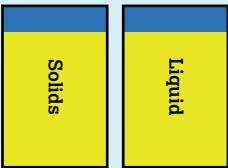
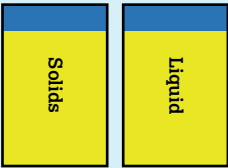
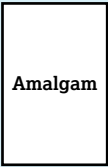




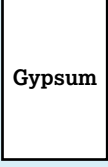

Waste type	Waste receptacle	Example description ¹	Waste management requirements ²	Additional comments
Other medicines (in original packaging)	 <p>Two blue-lidded, rigid yellow containers (one for solids, one for liquids)</p>	Clinical waste, medicines (not cytotoxic and cytostatic) from animal/human healthcare, for incineration only	Clinical waste incineration	
Other medicines (not in original packaging)	 <p>Two blue-lidded, rigid yellow containers (one for solids, one for liquids)</p>			
Dental amalgam	 <p>Leak-proof rigid container with Hg suppressant</p>	Dental amalgam and mercury including spent and out-of-date capsules, excess mixed amalgam and contents of amalgam separators	Recovery	Where teeth containing amalgam are present, H9: Infectious (see DH 2013b) may also apply
Photographic (X-ray) wastes		X-ray fixer	Recovery or treatment	
		X-ray developer (water based)	Recovery or treatment	
Photographic (X-ray) wastes (contd)		Lead foil	Recovery	
		X-ray film containing silver	Recovery	
Gypsum and plaster-cast wastes		Non-infectious gypsum and plaster waste from healthcare	Gypsum recovery or specialist landfill in separate gypsum cell	See supporting text under 'Gypsum and plaster casts' (see DH 2013b) for advice on the small proportion of this material that may be infectious and clinical waste

Table 4.9 Waste containers

Waste type	Waste receptacle	Example description ¹	Waste management requirements ²	Additional comments
Radioactive waste		Healthcare waste contaminated with radioactive material	UN number will depend upon isotope. Radioactivity takes precedence for transport class when above the lower threshold	Incineration in hazardous waste incineration facility subject to Radioactive Substances Act (RSA)
<p>Notes:</p> <p>The information in this table should be used where the assessment framework in 'Healthcare waste definitions and classifications' (see DH 2013b) has identified that it is applicable to the waste in question.</p> <p>¹The three entries are generic and will not be appropriate for all cytotoxic and cytostatic medicines. Some waste medicines will have to be classified in accordance with the provisions of ADR (ADR refers to the <i>Accord européen relatif au transport international des marchandises dangereuses par route</i>, or European Agreement Concerning the International Carriage of Dangerous Goods by Road). In most cases a safety data sheet (SDS) for the medicines should show the appropriate transport classification. If this is not available, advice from a dangerous goods safety adviser (DGSA) should be sought.</p> <p>²The waste must be disposed of, or recovered, at a suitably authorised facility.</p> <p>Source: DH (2013b) <i>Health Technical Memorandum 07-01: Safe Management of Healthcare Waste</i>. Department of Health, London. Figure 11. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/167976/HTM_07-01_Final.pdf</p>				

to track waste to its point of origin, for example if it is necessary to identify where waste has been disposed of into the wrong waste stream, healthcare organizations should have a system of identifying waste according to the ward or department where it is produced. This may be through the use of labelling or dedicated waste carts for particular areas. When assembling sharps bins, always complete the label on the outside of the bin, including the date and the initials of the assembler. When sharps bins are closed and disposed of, they should be dated and initialled at each stage (DH 2013b).

Management of soiled linen in the healthcare environment

Related theory

As with waste, soiled linen must be managed so as to minimize any risk to any person coming into contact with it. This is done by clearly identifying any soiled linen that may present a risk through

the use of colour coding and limiting any contact with such linen through the use of water-soluble bags to contain the linen so that laundry staff do not have to handle it before it goes into the washer (DH 2013e, 2016).

Linen that may present a risk may be described as foul, infected or infested. The management of all hazardous linen is similar, so the following procedure applies to any linen that:

- is wet with blood or other high-risk body fluids (see the section on prevention and management of inoculation injury below) or faeces
- is from a patient in source isolation for any reason (that is, where enteric, contact or droplet/airborne precautions are in place)
- is from a patient who is infested with lice, fleas, scabies or other ectoparasites.

Note that this procedure can be much more easily carried out by two people working together.

Procedure guideline 4.19 Safe disposal of foul, infected or infested linen

Essential equipment

- Personal protective equipment
- Water-soluble laundry bag
- Red plastic or linen laundry bag in holder
- Orange waste bag

Action

Rationale

Pre-procedure

- | | |
|--|---|
| 1 Assemble all the required equipment. | To avoid having to fetch anything else during the procedure and risk spreading contamination to other areas. E |
| 2 Put on disposable gloves and apron. | To minimize contamination of hands or clothing from the soiled linen. E |
| 3 Separate the edges of the open end of the water-soluble laundry bag. | To make it easier to put the soiled linen in the bag. E |

(continued)

Procedure guideline 4.19 Safe disposal of foul, infected or infested linen (continued)

Action	Rationale
Procedure	
4 Gather up the foul, infected or infested linen in such a way that any gross contamination (e.g. blood or faeces) is contained within the linen.	To minimize any contamination of the surrounding area. E
5 If there are two people, one holds the water-soluble laundry bag open while the other puts the soiled linen into it. If there is one person, hold one edge of the open end of the water-soluble bag in one hand and place the soiled linen in the bag with the other. In either case, take care not to contaminate the outside of the bag.	To remove the need for laundry workers to handle foul, infected or infested linen before it is washed (DH 2013c, C).
6 Tie the water-soluble bag closed using the tie provided or by knotting together the edges of the open end.	To keep the soiled laundry inside the bag. E
7 Place the full water-soluble bag of soiled linen into the red outer laundry bag without touching the outside of the red bag.	To identify the linen as requiring special treatment. E
8 Remove gloves and apron and dispose of them in an orange waste bag.	To avoid transferring contamination to other areas (DH 2013b, C).
9 Wash hands and forearms with soap and water. Dry thoroughly with a disposable paper towel.	To avoid transferring contamination to other areas (WHO 2009a, C).
10 Close the red outer laundry bag and transfer it to the designated collection area.	To ensure it does not cause an obstruction and is transferred to the laundry at the earliest opportunity. E

Prevention and management of inoculation injury

Related theory

Healthcare workers are at risk of acquiring blood-borne infections such as human immunodeficiency virus (HIV), the virus that causes acquired immune deficiency syndrome (AIDS), hepatitis B and hepatitis C. While the risk is small, there were 4830 significant occupational exposures to a blood-borne virus reported among healthcare workers between 2004 and 2013. Of these, half were exposed to hepatitis C, a third to HIV and a tenth to hepatitis B. Of these exposures, 71% involved a percutaneous needle stick injury (the majority were sharps injuries involving a hollow-bore needle) and 65% occurred in wards, theatres or A&E (PHE 2014; Woode Owusu et al. 2014). An understanding of the risk of infection and the preventive measures to be taken is essential in promoting a safer work environment (DH 1998).

Blood-borne viruses are present in the blood and in other high-risk fluids, which should be handled with the same precautions as blood. High-risk fluids include:

- cerebrospinal fluid
- peritoneal fluid
- pleural fluid
- pericardial fluid
- synovial fluid
- amniotic fluid
- semen
- vaginal secretions
- breast milk
- any other body fluid or unfixed tissue or organ containing visible blood (including saliva in dentistry).

Body fluids that do not need to be regarded as high risk, unless they are blood stained, are:

- urine
- faeces
- saliva
- sweat
- vomit.

The most likely route of infection for healthcare workers is through the percutaneous inoculation of infected blood via a sharps injury (often called a needle stick injury) or by blood or other high-risk fluid splashing onto broken skin or a mucous membrane in the mouth, nose or eyes. These incidents are collectively known as 'inoculation injuries'. An EU directive incorporated into UK law requires healthcare organizations to use safe devices and systems of work to minimize the risk of inoculation injury (HSE 2013b). Blood or another high-risk fluid coming into contact with intact skin is not regarded as an inoculation injury. It carries little or no risk due to the impervious nature of intact skin. The guidance in Box 4.4 has been shown to reduce the risk of sharps injuries.

Complications

In the event of an inoculation injury occurring, prompt and appropriate action will reduce the risk of subsequent infection. Relevant actions are described in Box 4.5 and should be taken regardless of what is thought to be known about the status of the patient whose blood has been inoculated. HIV, for example, has a 3-month window following infection during which the patient has sufficient virus in their blood to be infectious but before their immune system is producing sufficient antibodies to be detected by the normal tests for HIV status.

Box 4.4 Actions to reduce the risk of inoculation injury

- Use safety devices as an alternative to sharp items wherever these are available (HSE 2013b).
- Do not resheat used needles.
- Ensure that you are familiar with the local protocols for the use and disposal of sharps (e.g. location of sharps bins) and any other equipment before undertaking any procedure involving the use of a sharp item.
- Do not bend or break needles or disassemble them after use; discard needles and syringes into a sharps bin immediately after use.
- Handle sharps as little as possible.
- Do not pass sharps directly from hand to hand; use a receiver or similar receptacle.
- Discard all used sharps into a sharps container at the point of use; take a sharps container with you to the point of use if necessary. Do not dispose of sharps into anything other than a designated sharps container.
- Do not fill sharps bins above the mark that indicates that it is full.
- Sharps bins that are not full or in current (i.e. immediate) use should be kept out of reach of children and with any temporary closure in place.
- Sharps bins in use should be positioned at a height that enables safe disposal by all members of staff and secured to avoid spillage.
- Wear gloves in any situation where contact with blood is anticipated.
- Avoid wearing open footwear in any situation where blood may be spilt or where sharps are used.
- Always cover any cuts or abrasions, particularly on the hands, with a waterproof dressing while at work. Wear gloves if hands are particularly affected.
- Wear facial protection consisting of a mask and goggles or a face-shield in any situation that may lead to a splash of blood or other high-risk fluid to the face. Do not rely on prescription glasses – they may not provide sufficient protection.
- Clear up any blood spillage promptly and disinfect the area. Use any materials or spillage management packs specifically provided for this purpose in accordance with the manufacturer's instructions.

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Box 4.5 Actions to take in the event of inoculation injury

- Encourage any wound to bleed to wash out any foreign material that has been introduced. Do not squeeze the wound, as this may force any virus present into the tissues.
- Wash any wound with soap and water. Wash out splashes to mucous membranes (eyes or mouth) with large amounts of clean water.
- Cover any wound with a waterproof dressing to prevent entry of any other foreign material.
- Ensure the patient is safe then report the injury as quickly as possible to your immediate line manager and occupational health department. This is because post-exposure prophylaxis, which is medication given after any incident thought to carry a high risk of HIV transmission, is more effective the sooner after the incident it is commenced (DH 2015b).
- Follow any instructions given by the occupational health department.
- Co-operate with any action to test yourself or the patient for infection with a blood-borne virus but do not obtain blood or consent for testing from the patient yourself; this should be done by someone not involved in the incident.
- Complete a report of the incident according to local protocols.

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Websites**AMR Local Indicators**

<https://fingertips.phe.org.uk/profile/amr-local-indicators>

Infection Prevention Society

<https://www.ips.uk.net>

Public Health England

<https://www.gov.uk/government/organisations/public-health-england>

World Health Organization: Infection Prevention and Control

<https://www.who.int/infection-prevention/en>

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