The general principles of infection prevention, and control.

AIMS

After completing this course, you should be able to:

- **Describe the sources of micro-organisms, routes of transmission and key principles of infection control.**
- **Understand the importance of risk assessment and management in infection control.**
- **List the essential elements of universal precautions**

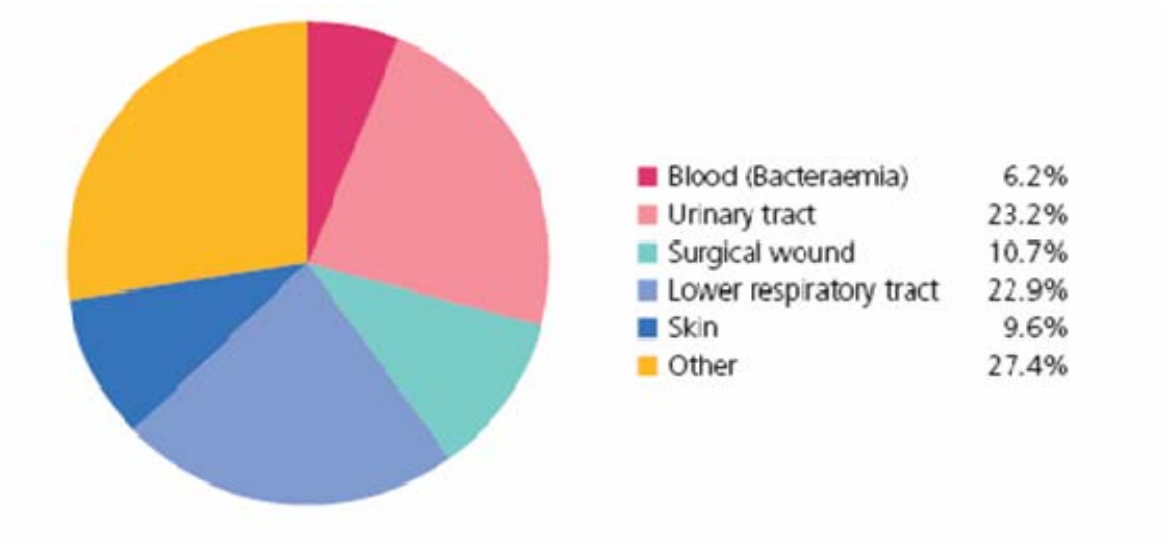
At any one time, approximately 10 per cent of patients in acute hospitals will develop a hospital acquired infection (HAI) (DoH/PHLS 1995). A recent report estimates that these HAIs cost the health sector almost £1 billion each year in England alone (Plowman *et al* 1999). It states that, on average, a patient with an HAI:

- Spends over two and half times longer in hospital.
- Costs just over £3,000 more to treat.
- Often requires additional treatment post-discharge.
- Suffers considerable additional distress and illness which impacts on relatives and carers.
- Will often be absent from work for longer.

Because of the many recent changes in healthcare delivery, many vulnerable and sick patients are now being effectively managed in primary and community care settings, where the risks of acquiring an infection also exist. Thus, the prevention and control of infection must be a priority for all staff involved in the care of patients across all healthcare settings.

Hospital-acquired or nosocomial infection has been described as an infection not present on admission, but acquired during a stay in hospital, that manifests itself either during hospitalisation or in the period following a

hospital stay (Haley 1986). The second national prevalence survey of infection in hospitals identified the most common types of HAI as those affecting the urinary tract, lower respiratory tract, surgical sites and skin (Emmerson *et al* 1996).



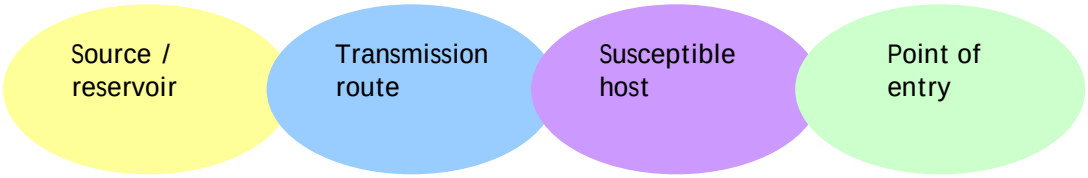
There have also been a number of epidemiological changes that have influenced how infections are prevented and managed :

- Emergence of new micro-organisms, e.g *Clostridium difficile*, hepatitis C
- virus and human Immunodeficiency virus (HIV)
- Technological advancements, e.g fibre optic endoscopy, minimally invasive surgery and increased use of complex invasive devices
- Emergence of antibiotic resistance, e.g methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *enterococci*, resistant gram negative bacilli
- Increased use of immuno-suppression therapy
- Increasingly ageing population
- Changes in staff skill mix
- Increased use of bank/agency staff
- Finite resourcing of health care
- International air travel

Latterly, the government has stressed that infection control and basic hygiene must be at the heart of clinical practice, and that community, as well as hospital settings, must have access to the advice of infection control nurses (NHS Executive 1999a)

The chain of infection

To implement infection control precautions successfully, it is essential that there is a sound understanding of the basic concepts of infection and how it occurs. As education and training relating to infection control has developed in recent years, so the use of a 'chain of infection' has evolved as a popular way of describing the sequence of events necessary for an infection to occur. If one or more of the links in the chain can be broken, the development of an infection can be interrupted.



Thus the aim of infection control is to 'break' one or more links in the chain. This can be achieved by adhering to the basic principles of infection control at all times and in all healthcare settings.

Sources of infection

Micro-organisms originate from a specific source. These sources are endogenous, exogenous, or environmental. It is important to remember that not all microorganisms are capable of causing infection, and those that do require optimum conditions in which to do so. The first requirement of a source of infection is that it contains the microbe in a fully virulent state and in sufficient numbers (Meers *et al* 1995). Second, the microbe needs to retain its aggressive qualities to survive and multiply. These requirements are met if the microbe is supplied with water (for example on damp

surfaces) or if embedded in protein-containing body fluids. Micro-organisms capable of causing disease are termed pathogens.

It can often be difficult, if not impossible, to identify risks from specific body fluids. Therefore, it is routine practice to classify all micro-organisms as potential pathogens and to use standard precautions to reduce or eliminate the risk of transmission. Certain risk factors increase the likelihood of transmission and a comprehensive risk assessment should be undertaken to identify such risks. Additional risk factors include (Bowell 1992):

- Diarrhoea/incontinence.
- Uncontrolled bleeding.
- Exuding wounds with cellulitis.
- Productive cough

Routes of transmission

In susceptible individuals pathogens are transmitted via a number of routes:

- Contact – direct or indirect
- Airborne
- Arthropods

Pathogens may spread through direct contact with the body fluids of an infected individual, as in sexually transmitted diseases or vertical transmission from mother to baby *in utero*.

Indirect contact is probably the most significant route of spread. Modes of transfer include:

- Other people, such as via the hands of healthcare workers.
- Animals, for example Salmonella, *Escherichia coli* 0157.
- Water, for example *Cryptosporidium*, cholera.
- Inanimate objects, for example bedding, respiratory equipment, and patient contact surfaces.
- Food, for example *Listeria*, *Campylobacter*.

Airborne pathogens cannot travel through the air unless carried on airborne particles. Transmission occurs via:

- Respiratory droplets – coughing and sneezing may transmit large or small droplets such as in *Mycobacterium tuberculosis* and influenza.
- Dust, which contains skin cells and can carry bacteria such as s*taphylococcus aureus*, or spores such as *Clostridium difficile* and *Aspergillus*.
- Water – transmission can occur via aerosolisation such as in *Legionella pneumophila*.

Arthropods include bugs, flies, fleas, lice, midges, mites, mosquitoes, and ticks. Arthropod-borne pathogens are normally transmitted by sucking, biting, burrowing, or by their droppings. Diseases include scabies, pediculosis (lice), malaria and viral haemorrhagic fevers.

Susceptible host

The risk of an individual acquiring an infection is influenced by his or her susceptibility. A person's susceptibility is determined by certain characteristics including:

- Immunity – this can be a natural, specific or non-specific response, or it can be acquired, as in active or passive immunity (via the placenta or inoculation). It will vary between individuals, especially those who are immunosuppressed. Lowered immunity is associated with a higher risk of infection.
- Age – here, susceptibility is greater in the extremes of age. Risks relating to age can also be related to immunity as babies have immature immune systems and older people have less efficient immune systems.
- Physical and psychological wellbeing – conditions such as diabetes mellitus, vascular insufficiency, and malignancy all increase the risk of infection

- Medical interventions – drug therapies such as steroids, cytotoxics, antibiotics and invasive procedures such as surgery, urinary catheterisation,
- intravenous cannulation (which breach natural defences) all increase the host's susceptibility to infection.

Points of entry

Pathogens gain entry into the body in different ways via:

- Natural orifices – mouth, nose, vagina, urethra, ear, rectum.
- Artificial orifices – such as tracheostomy, ileostomy, colostomy.
- Mucous membranes – which line most natural and artificial orifices.
- Skin breaks – either as a result of accidental damage or deliberate inoculation/incision.

Key Principles of Managing Infection Control

Every health care worker plays a vital part in helping to minimise the risk of cross infection – for example, by making certain that hands are properly washed, the clinical environment is as clean as possible, ensuring knowledge and skills are continually updated and by educating patients and visitors.

Standard precautions (formerly known as universal precautions) underpin routine safe practice, protecting both staff and clients from infection. By applying standard precautions at all times and to all patients, best practice becomes second nature and the risks of infection are minimised. They include:

- **achieving optimum hand hygiene**
- **using personal protective equipment**
- **safe handling and disposal of sharps**
- **safe handling and disposal of clinical waste**
- **managing blood and bodily fluids**
- **decontaminating equipment**
- **achieving and maintaining a clean clinical environment**
- **managing accidents**
- **good communication – with other health care workers, patients and visitors**
- **training/education.**

Hand hygiene

Hand hygiene is widely acknowledged to be the single most important activity for reducing the spread of disease, yet evidence suggests that many health care professionals do not decontaminate their hands as often as they need to or use the correct technique which means that areas of the hands can be missed. The following series of pictures demonstrates the hand hygiene procedure that should be followed when washing with soap and water :

1. Wet hands and wrists, apply soap.

2. Rub right palm over left hand, and left palm over right hand.

3. Rub palm to palm, fingers interlaced.

4. Rub fingers to fingers, interlaced.

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

6. Rotational rubbing, palm to palm. After this full circumference of the wrists should be rubbed with the palm of the opposite hand.

Each step should take approximately 15 seconds, after which wrists and hands should be rinsed in clean running water, with the fingers pointing downwards so that water runs off the hands at the finger points. Taps should be turned off without using the hands. Hands are then dried thoroughly using disposable paper towels. If the taps are not designed to be turned off using the elbows, then use of the paper towel to turn off the tap is acceptable, as long as the hands do not come into contact directly with the tap.

Where alcohol gel rub has been used, the technique employed can be a little different (use the following link to see a movie demonstrating this (you will need QuickTime to play this movie) :

http://www.rch.org.au/washup/vid.cfm?name=alcohol

Hands should be decontaminated before direct contact with patients and after any activity or contact that contaminates the hands, including following the removal of gloves. While alcohol hand gels and rubs are a practical alternative to soap and water, alcohol is not a cleaning agent. Hands that are visibly dirty or potentially grossly contaminated must be washed with soap and water and dried thoroughly. Hand preparation increases the effectiveness of decontamination. You should:

- keep nails short, clean and polish free
- avoid wearing wrist watches and jewellery, especially rings with ridges or stones
- artificial nails must not be worn
- any cuts and abrasions should be covered with a waterproof dressing.
- Remove your wristwatch and any bracelets and roll up long sleeves before washing your hands (and wrists).

In addition, bear in mind the following points:

Facilities - Adequate hand washing facilities must be available and easily accessible in all patient areas, treatment rooms, sluices and kitchens. Basins in clinical areas should have elbow or wrist lever operated mixer taps or automated controls and be provided with liquid soap dispensers, paper hand towels and foot-operated waste bins (NHS Estates, 2002).Alcohol hand gel must also be available at ‘point of care’ in all primary and secondary care settings (National Patient Safety Agency (2004).

All health care workers should bring any lack of, or inappropriately placed facilities to the notice of their managers. They also have a duty of care

to patients and themselves and must use facilities provided to prevent cross infection.

Hand drying - Improper drying can recontaminate hands that have been washed. Wet surfaces transfer organisms more effectively than dry ones and inadequately dried hands are prone to skin damage. Disposable paper hand towels of good quality should be used to ensure hands are dried thoroughly. Hand towels should be conveniently placed in wall mounted dispensers close to hand washing facilities.

Using personal protective equipment

Personal protective equipment (PPE) is used to protect both yourself and your patient from the risks of cross-infection. It may also be required for contact with hazardous chemicals and some pharmaceuticals. PPE includes items like gloves, aprons, masks, goggles or visors. In certain situations such as theatre, it may also include hats and footwear.

Disposable gloves - Gloves should be worn whenever there might be contact with blood and body fluids, mucous membranes or non intact skin. They are not a substitute for hand washing. They should be put on immediately before the task to be performed, then removed and discarded as soon as the procedure is completed. Hands must always be washed following their removal. The choice of glove should be made following a suitable and sufficient risk assessment of the task, the risk to the patient and risk to the health care worker (ICNA, 2002).Nitrile or latex gloves should be worn when handling blood, blood-stained fluids, cytotoxic drugs or other high risk substances. Polythene gloves are not suitable for use when dealing with blood and/or blood and body fluids, ie. in a clinical setting. Neoprene and nitrile gloves are good alternatives for those who are sensitive to natural rubber latex. These synthetic gloves have been shown to have comparable in-use barrier performance to natural rubber latex gloves in laboratory and clinical studies. Vinyl gloves can be used to perform many tasks in the health care environment, but are not appropriate

when handling blood, blood-stained fluids, cytotoxic drugs or other high risk substances.

Disposable plastics aprons - These should be worn whenever there is a risk of contaminating clothing with blood and body fluids and when a patient has a known infection, for example, direct patient care, bed making or when decontaminating equipment. You should discard them as soon as the intended task is completed and then wash your hands. They must be stored safely so that they don't accumulate dust which can act as a reservoir for infection. Impervious gowns should be used when there is a risk of extensive contamination of blood or body fluids.

Masks, visors and eye protection - These should be worn when a procedure is likely to cause blood and body fluids or substances to splash into the eyes, face or mouth. Masks may also be necessary if infection is spread by an airborne route (see information on the Health Protection Agency website www.hpa.org.uk).You should ensure that this equipment fits correctly, is handled as little as possible and changed between patients or operations. Masks should be discarded immediately after use.

Safe handling and disposal of sharps

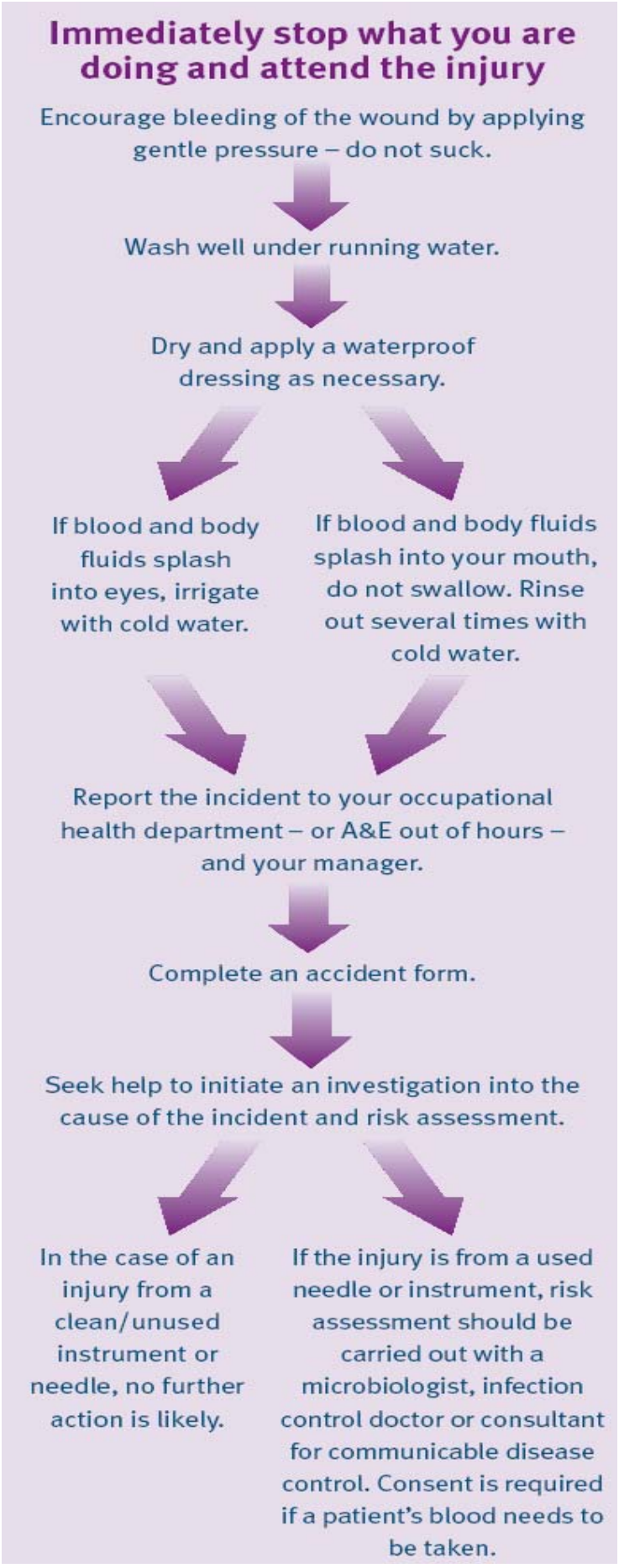
Sharps include needles, scalpels, stitch cutters, glass ampoules and any sharp instrument. The main hazards of a sharps injury are hepatitis B, hepatitis C and HIV. Second only to back injuries as a cause of occupational injuries amongst health care workers, between July 1997 and June 2002, there were 1,550 reports of blood-borne virus exposures in health care workers. To reduce the risk of injury and exposure to blood-borne viruses, it is vital that sharps are used safely and disposed of carefully, following your workplace's agreed policies on safe working procedures. Your employer should provide targeted education and awareness training for all health care workers. You should ensure that:

- sharps are not passed directly from hand to hand
- handling is kept to a minimum

- needles are not broken or bent before use or disposal
- syringes or needles are not dismantled by hand and are disposed of as a single unit
- needles are never re-sheathed
- staff take personal responsibility for any sharps they use and dispose of them in a designated container at the point of use. The container should
- conform to UN standard 3291 and British Standard 7320
- sharps containers are not filled by more than two thirds and are stored in an area away from the public
- sharps are disposed of at the point of use
- sharps boxes are signed on assembly and disposal
- sharps are stored safely away from the public and out of reach of children
- staff are aware of inoculation injury policy.

If you notice that any of the above procedures are not being followed properly by colleagues you should seek advice from your infection control team who will provide education for staff on safe use and disposal of sharps.

Innovative products are available that can reduce the risk of sharps injuries. While they may be more expensive, their cost can be offset against the savings achieved in reducing sharps injuries. For information on what to do in the event of an invasive sharps injury, see the following chart :



"Good practice in infection prevention and control". Royal College of Nursing, April 2005.

Safe handling and disposal of clinical waste

Your workplace should have a written policy on waste disposal, which provides guidance on all aspects, including special waste, like pharmaceuticals and cytotoxic waste, segregation of waste and an audit trail. This should include colour coding of bags used for waste, for example:

- yellow bags for clinical waste
- black bags for household waste
- special bins for glass and aerosols
- colour coded bins for pharmaceutical or cytotoxic waste.

All health care and support staff should be instructed in the safe handling of waste, including disposal and dealing with spillages.

Duty of Care

All health care workers have a duty to ensure that any waste produced is handled safely and in accordance with the law. This is referred to as a 'Duty of Care'.

Under the Duty of Care regulations waste can only be given for disposal to disposal contractors registered with the Environment Agency, the Scottish Environmental Protection Agency or Environment and Heritage Service (Northern Ireland). Failure to do so is a criminal offence and can be very costly if it ends up in court.

Types of waste

Most health care practices will produce four categories of waste that should be handled and disposed of separately;

1. Commercial waste - The kind of waste normally associated with the running of a business, for example old supplies catalogues, telephone directories, etc. This is likely to be very small volumes.

2. Confidential waste - Old case notes from patients not seen for seven years in the case of adults, or after the 25th birthday for persons treated under the age of 18 years. This is likely to be once a year and this waste should be shredded.

3. Clinical waste - Waste associated with treatments, such as used gloves, towels and non pathological debris, e.g. toe nail clippings. This also includes partially discharged local anaesthetic cartridges and sharps.

4. Hazardous waste - Infectious clinical waste, that is clinical waste believed to contain viable micro-organisms or their toxins that are known or reliably believed to cause disease. It also includes fluorescent light tubes, computer monitors and pharmaceuticals known to be cytotoxic and cytostatic.

Hazardous Waste Regulations

The Hazardous Waste Regulations require business producing hazardous waste to register with the Environment Agency. However, practices which generate less than 200kg of hazardous waste in any twelve-month period are exempt, and so do not need to register.

Storage of Clinical Waste

Clinical and hazardous waste should be kept separate from other commercial waste. Blades, syringes and other sharp objects should be disposed of in a yellow sharp safe box. All other clinical waste, hazardous and non hazardous, should be collected in a yellow plastic sack and the bag should be replaced at the end of the day or when ¾ full, which ever occurs sooner.

Health care workers have a ‘duty’ to take all reasonable measures to ensure that no un-authorised persons can interfere with clinical waste prior to

collection. Ideally clinical waste awaiting collection by the waste disposal contractor should be stored in a locked cupboard.

Notifying the waste to disposal contractors of the type of waste

The use of the European Waste Catalogue numbers is required on the Waste Transfer Note or Hazardous Waste Consignment notes to notify the registered carrier of the status of the waste, so that they can ensure the safe management and disposal of the waste.

Keeping records

It is essential to keep a record of all clinical waste transactions, and records should be kept for at least two years so that they can be provided if asked by the Environmental Agency, Waste Collection Authorities or the Scottish Environmental Protection Agency.

Managing blood and bodily fluids

Spillages - These should be dealt with quickly, following your workplace's written policy for dealing with spillages. The policy should include details of the chemicals staff should use to ensure that any spillage is disinfected properly, taking into account the surface where the incident happened – for example, a carpet in a patient's home or hard surface in a hospital.

The spillage of body fluids on to surfaces can pose a risk of accident or of contamination to the healthcare worker clearing the spillage. Suitable protective clothing must be worn and body fluids should initially be soaked up with paper towels or kitchen roll. Then, for blood spills, apply 10,000 parts per million (ppm) (1 per cent) hypochlorite solution or sprinkle with sodium dichloroisocyanurate (NaDCC) granules and leave for several minutes. Clean the area with warm water and detergent, then dry.
For the spillage of all other body fluids (unless bloodstained), and in the absence of disinfectants, the area should be cleaned thoroughly with

detergent and water. All equipment should be discarded into yellow clinical waste bags. Carpets should not be cleaned with disinfectants and, ideally, should not be used in patient treatment areas.

Collecting, handling and labelling specimens - a written policy should be in place for the collection and transportation of laboratory specimens. You should:

- be trained to handle specimens safely collect samples (wearing protective clothing) in an appropriate sterile and properly sealed container
- complete form using patient labels (where available) and check that all relevant information is included
- take care not to contaminate the outside of the container and the request forms
- ensure that specimens are transported in accordance with the Safe Transport of Dangerous Goods Act 1999
- make sure specimens are sent to the laboratory as soon as possible. Under no circumstances should specimens be left on window sills or placed in
- staff pockets

Decontaminating equipment

As inadequate decontamination has frequently been associated with outbreaks of infection in hospitals, it is vital that re-usable equipment is scrupulously decontaminated between each patient. To ensure that control of infection is maintained at a high level, all health care staff must be aware of the implications of safe decontamination and their responsibilities to their patients, themselves and their colleagues.
Use the following table to make an appropriate choice of decontamination method.

	Equipment description	Level of cleaning needed	Examples
High risk	Equipment that: ✦ enters a sterile body cavity ✦ penetrates the skin ✦ touches a break in the skin or mucous membranes.	Equipment must be cleaned and sterilised – fully decontaminated – after each patient use. It should be left in a sterile state for subsequent use.	Examples include surgical instruments.
Medium risk	Equipment that touches intact skin or mucous membranes.	Equipment does not need to be sterile at the point of use but must be cleaned and sterilised (decontaminated) between each patient.	Examples include a foot tray, leg rests on a patient couch.
Low risk	Equipment that does not touch broken skin or mucous membranes, or is not in contact with patients.	Equipment must be cleaned and/or disinfected after use.	Examples include surface of operator's trolley.

Adapted from the Medical Devices Agency publication, *Sterilisation, disinfection and cleaning of medical equipment* (1996).

Decontamination is the combination of processes – cleaning, disinfection and sterilisation – used to ensure a re-usable medical device is safe for further use. Single use equipment (where the item can only be used once) should not be reprocessed or re-used. Devices designated for single patient use (where the item can be repeatedly used for the same patient) will be clearly marked by a symbol.

Cleaning - This uses water and detergent (enzymatic cleaner) to remove visible contamination but does not necessarily destroy micro-organisms, although it should reduce their numbers. Effective cleaning is an essential prerequisite to both disinfection and sterilisation. Manual cleaning should be performed with extreme care and only if no other method or device is available. It is more efficient to use an automated/validated method, for example, an automated washer-disinfector or ultrasonic bath. For more detailed information, see *A protocol for the local decontamination of surgical instruments* (NHS Estates, 2004a).

Disinfection - This uses chemical agents or heat to reduce the number of viable organisms. It may not necessarily inactivate all viruses and bacterial

spores. Where equipment will tolerate sterilisation disinfection should not be used as a substitute. Washer-disinfectors should be used only by those with the correct training and in conjunction with a suitable detergent that has been recommended by the manufacturer. Following the rinse cycle, items should be checked for cleanliness. Machines must be maintained, validated and comply with HTM 2030. If an ultra sonic cleaner is used the machine should be drained, cleaned, dried, covered and left dry until required for further use. Requirements for testing can be found in HTM 2030. Log books and records must be kept by the designated person for both types of machines

Chemical disinfectants are classified generically and their biocidal capabilities vary. While most are capable of inactivating bacteria and enveloped viruses, many are not so effective against non-enveloped viruses – for example, the hepatitis viruses and also cysts and bacterial spores. Efficacy depends on choosing and using the disinfectant correctly. Chemical disinfection is not as effective as heat disinfection. Trusts will have their own policy for the use of appropriate disinfectants and all health care staff who use chemicals must receive education/training before handling. The use of disinfectants is governed by the Control of Substances Hazardous to Health (COSHH) regulations, which ensure that employers must provide staff with information, instruction and training.

Sterilisation - This ensures that an object is free from viable microorganisms, including bacterial spores. Both acute and primary care trusts should actively work towards achieving central sterilising of reusable equipment, using local sterile services department (SSD) where available. All SSDs that supply re-sterilised instruments to other organisations are bound by a European directive (93/42/EEC), which safeguards standards of quality. Advantages include having a cost-effective system that is quality controlled, has a tracking system and is managed and operated by trained

staff in a purpose-built environment. Where using your SSD is not possible, alternatives are:
1. using pre-sterilised, single-use, disposable items - the advantages include convenience and suitability for use in areas where decontamination could be hard to achieve.
2. a bench top vacuum steam steriliser - these must be installed, validated and maintained appropriately according to HTM 2010; MDA DB 9804 and MDA DB 2002(06).

All steam sterilisers are subject to the Pressure Systems Safety Regulations 2000 and must be examined annually by a competent person.

The Medical Devices Agency bulletin DB 2002 (06) provides guidance on purchase, operation and maintenance of bench top steam sterilisers (2002). It draws attention to the need for:

- daily testing by the user
- periodic testing by a qualified engineer
- operator training
- knowledge of the legal and insurance aspects of ownership and use
- comprehensive record keeping of testing.

Finally, bear in mind that the effectiveness of decontamination may be hindered at any stage of the process by:

- poor choice of method
- poor technique
- lack of maintenance of equipment
- inadequate monitoring
- poor handling or storage of equipment

Achieving and maintaining a clean clinical environment

A dirty clinical environment is one of the factors that may contribute towards infection rates. Conversely, high standards of cleanliness will help

to reduce the risk of cross-infection. Good design in buildings, fixtures and fittings is also important to allow efficient cleaning. Cleaning removes contaminants, including dust and soil, large numbers of micro-organisms and the organic matter that may shield them, for example, faeces, blood and other bodily fluids.

Removal of dust and organic matter (spillages) are the most important cleaning tasks, together with thorough damp dusting of horizontal surfaces, especially in treatment rooms. Hot water and detergent are usually sufficient to reduce environmental contamination. Alternatively, disinfectants such as alcohol or chlorine-releasing agents will help to reduce the number of pathogens present, but should not be used indiscriminately. Local disinfection policies must be adhered to. In addition, the environment should be kept uncluttered and easy to clean, particularly in clinical areas.

In general practices there should be a regular planned, written and monitored cleaning schedule that details the items and environments to be cleaned:

- before and after each clinic session
- daily
- weekly
- monthly
- annually

Additionally, cleaning equipment such as vacuums, floor scrubbing machines and polishers should be cleaned and properly maintained. Information on recommended methods of cleaning and disinfection should be available for staff. Detailed guidance is available from *Infection control guidance for general practice* (Infection Control Nurses Association and Royal College of General Practitioners, 2003).

Managing accidental exposure to blood-borne virus

Accidental exposure to blood and body fluids can occur by:

- percutaneous injury – for example, from needles,
- instruments, bone fragments or significant bites that break the skin
- exposure of broken skin – for example, abrasions, cuts or eczema
- exposure of mucous membranes, including the eyes and the mouth.

If accidental exposure to bodily fluids, including blood, occurs, then the advice stated for the management of sharps injuries also applies in this situation (see earlier diagram).

Managing the risk of HIV - If there has been exposure to blood, high risk blood and body fluids or tissue known or strongly suspected to be contaminated with HIV, the Chief Medical Officer's Expert Advisory Group on AIDS recommends the use of antiretroviral post exposure prophylaxis (PEP). Ideally, this is given within an hour of exposure and the full course lasts for four weeks. Where treatment is delayed but the source person proves to be HIV positive, PEP can be given up to two weeks from the time of the injury. Advice and follow-up care from your occupational health department are essential.

Managing the risk of hepatitis B (HBV) - The risk of contracting HBV from needlestick exposure in a health care setting is much higher than HIV because the virus is both more infectious and has greater prevalence. As a result, it is recommended that all potentially at-risk practitioners should be vaccinated against hepatitis B with monitoring of antibody titre levels and boosters, where inoculation injury occurs and titres are low. Staff should take responsibility for this and should contact the occupational health Department or General Practitioner if there are any concerns.

Good communication

Anxiety about HCAIs (health care associated infections), including MRSA, is often based on ignorance about the risks of infection and the precautions to prevent transmission. Practitioners can do a great deal to allay fears by communicating effectively, without breaking confidentiality. For example, you should:

- provide information leaflets for patients, visitors and staff
- provide notices which describe the precautions needed
- talk to patients about how they can help themselves
- include support staff in team meetings
- tell the patient how their care might be affected by a HCAI and how long precautions will be needed
- ensure that other staff understand the actions they need to take – for example, if the community nurse needs to continue care at home
- inform general practitioners if their patient has acquired a HCAI.

Training

All health care professionals who have a clinical responsibility for patients must include infection prevention and control as part of their every day practice. All health care staff should undergo mandatory infection control training as part of their induction and on an ongoing annual basis. It is particularly important that knowledge and skills are continually updated. The training should cover all the general principles of infection prevention and control to emphasise the key role that health care professionals play in minimising the spread of infection; to highlight what can happen as a result of bad practice and underline the importance of good communication.

Training should include:

- practical hand washing sessions/use of alcohol hand sanitizer
- aseptic technique
- the importance of environmental/equipment cleaning and whose responsibility

- who to go to for advice/ more information
- infection and prevention policies
- what you can do to help yourself, your colleagues and your patients (uniform, hair, general hygiene)

KEY LEARNING POINTS.

1. HAI costs the NHS millions of pounds a year to manage.
2. HAI, or nosocomial infection, has been described as an infection not present on admission, but acquired during a stay in hospital, manifesting during hospitalisation or in the period following a hospital stay.
3. For infection to occur, there must be a source, a route, a susceptible host, and a point of entry.
4. Hand hygiene is widely acknowledged to be the single most important activity for reducing the spread of disease.
5. Gloves should be worn whenever there might be contact with blood and body fluids, mucous membranes or non intact skin.
6. A plastic apron should be worn whenever there is a risk of contaminating clothing with blood and body fluids and when a patient has a known infection.
7. Masks should be worn when a procedure is likely to cause blood and body fluids or substances to splash into the eyes, face or mouth.
8. The main hazards of a sharps injury are hepatitis B, hepatitis C and HIV.
9. Your workplace should have a written policy on waste disposal.
10. All health care and support staff should be instructed in the safe handling of waste, including disposal and dealing with spillages.
11. In general practices there should be a regular planned, written and monitored cleaning schedule that details the items and environments to be cleaned.
12. All health care professionals who have a clinical responsibility for patients must include infection prevention and control as part of their every day practice.

Sterilisation and Disinfection.

Health requires the absence of infection, so methods for killing or reducing the numbers of pathogenic microorganisms are important in reducing disease. Like much essential knowledge, this is not particularly exciting, but it is beneficial.

Sterilisation kills all viable (able to multiply) microbes, including viruses, fungi, parasites and their cysts, bacteria and, bacterial spores. Prions can survive conventional sterilisation.

Disinfection by a substance or process is killing or removing most but not all viable microbes. It is divided into high-level, intermediate and low-level disinfection.

Antisepsis is disinfection of the skin using an antiseptic. Skin cannot be sterilised and remain alive.

Principles.

1. **'Clean first, disinfect/sterilise next'**, i.e. reduce the *bio-burden* of organisms and organic material first, so the process is easier, shorter and reliable.
2. **'Strong enough for long enough'**, i.e. rate of kill is proportional to *time* multiplied by *concentration*.
3. **'Horses for courses'**, i.e. choose the appropriate process and details depending on the purpose and risk, hence the extent of microbial killing needed. Consider also the materials, risk of damage, toxicity, time, cost and resources available.
4. **'Control the process not the product'**: adhere to a known, proven and tested process rather than test for unsterile or dangerous equipment afterwards.

Risk classification of items.

1. High risk / critical items – these are items which come into contact with tissues and blood, are they must be sterilised.
2. Intermediate risk / semi-critical items – these contact mucous membranes or non-intact skin. They require high-level disinfection.
3. Low risk / non-critical – these come into contact with intact skin only, and low-level disinfection is sufficient.

Methods of Sterilisation.

There are four methods of sterilisation:

1. Irradiation
2. filtration
3. chemicals
4. heat (the most reliable and widely used)

Irradiation can be by:

- ultraviolet light, used in laboratory safety cabinets; eyes must be shielded to prevent damage
- ionising radiation by electrons from cobalt-60 or a linear accelerator to sterilise heat-sensitive, pre-packed, single-use plastic items, including syringes and catheters.

Filtration - Filtration usually uses nitrocellulose membrane filters, for sterilising heat sensitive-liquids, including serum and antibiotics. However many filters labelled 'sterilising' only filter bacteria, so the filtered fluid may contain viruses or prions.

Chemicals - A few 'high-level' chemicals are sporicidal and viricidal and hence can sterilise. Their use is limited because of their toxicity and irritation.

Formaldehyde is used to disinfect empty rooms after very infectious patients, but this happens rarely. Glutaraldehyde, ortho-phthal-aldehyde (OPA), hydrogen peroxide and peracetic acid are used for invasive instruments which cannot otherwise be sterilised, for example bronchoscopes, cystoscopes, anaesthetic equipment and some plastics. The aldehydes need specially ventilated procedure rooms and operating theatres. Ethylene oxide needs a special chamber, often called a 'bomb' as the gas is explosive in air! It diffuses well into materials and is used for heat-sensitive articles such as plastic, rubber and complex equipment. Hydrogen peroxide gas plasma is newer, promising method, and is currently undergoing evaluation.

Heat - This can be dry or moist heat.

Dry heat is used as:

- red heat - for metal loops during bacterial cultures
- flaming - for lighting microscope slides wetted by methylated spirit (scary thought!)
- hot air ovens - 16O°C for 60 minutes for scalpels, scissors, and substances (oil, grease, wax) impermeable to moist heat
- infrared radiation - seldom used now.

Moist heat is achieved by boiling water, or autoclaving. Boiling in water kills non-sparing microbes but not necessarily all spores. Hence, boiling is unreliable for sterilisation, as there is much variability in efficacy related to length of time.

Autoclaving is the most reliable and efficient sterilising process. It depends on steam under pressure, hence it is hotter than 100°C (e.g. 121°C for 15 minutes or 134°C for 3 minutes). These time-temperature combinations are proven to kill pathogenic spores. Six times longer is needed for prions, on high-risk equipment from high-risk patients.

The load (instruments, drapes, dressings, etc.) is first cleaned to reduce the

bio-burden of organisms, before being carefully packed to ensure steam can penetrate throughout it, locked in the autoclave, air is exhausted, then steam under pressure admitted for the correct ('holding') time. Modern autoclaves then dry the load; pressure must reach atmospheric before opening the door.

When all steps are controlled and the correct temperature held for the correct time, sterility should be assured. In addition, the process is checked, preferably by culturing special spore strips of known heat resistance; autoclave tape, which changes colour, is less reliable.

Disinfection methods

Washing removes some surface microbes, so has some disinfectant action by itself. Detergents including soap make it more effective. In addition, this 'bio-burden' removal makes subsequent disinfection by heat or chemicals more effective.

Heat by boiling, as discussed above, disinfects but does not reliably sterilise.

Pasteurisation is a gentle disinfection by low-temperature heating (63°C for 30 minutes or 72°C for 20 seconds) of milk or other liquid foods which would be unpalatable after more vigorous disinfection such as boiling.

Chemicals are the usual disinfectants. They are used especially on skin, surfaces and some instruments and supplies which cannot be sterilised.

Disinfectants

The success of a disinfectant depends on the:

- Type, time and concentration of disinfectant
- Inactivation by minerals (hard water) or microbes
- Microbial type, state (especially spores), and number
- Environmental pH, temperature and moisture

- Surface disinfected (skin, metal, porous materials).

Control of all these variables is difficult; the process recommended by the manufacturer and relevant authorities must be observed. 'In-use' tests by adding known organisms then culturing samples (after disinfectant dilution or neutralisation) can be done in hospitals, especially for Infection Control investigations.

KEY LEARNING POINTS.

1. Sterilisation is killing all *viable* microbes, including their spores, while disinfection is killing or removing *most but not all* viable microbes.
2. Four principles are: clean first, disinfect / sterilise next; the right process for the purpose; process must be controlled; strong enough for long enough.
3. The four methods are ; irradiation, filtration (special purposes for each), chemicals (chiefly for disinfection) and heat (for sterilisation).