

Infection control

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Infection control is the discipline concerned with preventing nosocomial or healthcare-associated infection, a practical (rather than academic) sub-discipline of epidemiology. It is an essential, though often underrecognized and undersupported, part of the infrastructure of health care. Infection control and hospital epidemiology are akin to public health practice, practiced within the confines of a particular health-care delivery system rather than directed at society as a whole. Anti-infective agents include antibiotics, antibacterials, antifungals, antivirals and antiprotozoals.^[1]

Infection control addresses factors related to the spread of infections within the healthcare setting (whether patient-to-patient, from patients to staff and from staff to patients, or among-staff), including prevention (via hand hygiene/hand washing, cleaning/disinfection/sterilization, vaccination, surveillance), monitoring/investigation of demonstrated or suspected spread of infection within a particular health-care setting (surveillance and outbreak investigation), and management (interruption of outbreaks). It is on this basis that the common title being adopted within health care is "infection prevention and control."

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Infection control in healthcare facilities

Aseptic technique is a key component of all invasive medical procedures. Similarly, infection control measures are most effective when Standard Precautions (health care) are applied because undiagnosed infection is common.^[2]

Hand hygiene

Independent studies by Ignaz Semmelweis in 1846 in Vienna and Oliver Wendell Holmes, Sr. in 1843 in Boston established a link between the hands of health care workers and the spread of hospital-acquired disease.^[3] The U.S. Centers for Disease Control and Prevention (CDC) state that “It is well documented that the most important measure for preventing the spread of pathogens is effective handwashing.”^[4] In the developed world, hand washing is mandatory in most health care settings and required by many different regulators.

In the United States, OSHA standards^[5] require that employers must provide readily accessible hand washing facilities, and must ensure that employees wash hands and any other skin with soap and water or flush mucous membranes with water as soon as feasible after contact with blood or other potentially infectious materials (OPIM).

In the UK healthcare professionals have adopted the 'Ayliffe Technique', based on the 6 step method developed by Graham Ayliffe, JR Babb and AH Quoraishi.^[6]

Drying is an essential part of the hand hygiene process. In November 2008, a non-peer-reviewed^[7] study was presented to the European Tissue Symposium by

Mean percentage changes in bacterial numbers

Method used	Change in bacteria present
Paper towels (2-ply 100% recycled).	- 48.4%
Paper towels (2-ply through-air dried, 50% recycled)	- 76.8%
Warm air dryer	+ 254.5%
Jet air dryer	+ 14.9%

the University of Westminster, London, comparing the bacteria levels present after the use of paper towels, warm air hand dryers, and modern jet-air hand dryers.^[8] Of those three methods, only paper towels reduced the total number of bacteria on hands, with "through-air dried" towels the most effective.

The presenters also carried out tests to establish whether there was the potential for cross-contamination of other washroom users and the washroom environment as a result of each type of drying method. They found that:

- the jet air dryer, which blows air out of the unit at claimed speeds of 400 mph, was capable of blowing micro-organisms from the hands and the unit and potentially contaminating other washroom users and the washroom environment **up to 2 metres away**
- use of a warm air hand dryer spread micro-organisms **up to 0.25 metres** from the dryer
- paper towels showed **no significant spread** of micro-organisms.

In 2005, in a study conducted by TUV Produkt und Umwelt, different hand drying methods were evaluated.^[9] The following changes in the bacterial count after drying the hands were observed:

Drying method	Effect on bacterial count
Paper towels and roll	Decrease of 24%
Hot-air drier	Increase of 117%

Sterilization

Sterilization is a process intended to kill all microorganisms and is the highest level of microbial kill that is possible. Sterilizers may be heat only, steam, or liquid chemical.^[10]

Effectiveness of the sterilizer (e.g., a steam autoclave) is determined in three ways.^[10] First, mechanical indicators and gauges on the machine itself indicate proper operation of the machine. Second heat sensitive indicators or tape on the sterilizing bags change color which indicate proper levels of heat or steam. And, third (most importantly) is biological testing in which a microorganism that is highly heat and chemical resistant (often the bacterial endospore) is selected as the standard challenge. If the process kills this microorganism, the sterilizer is considered to be effective.^[10]

Sterilization, if performed properly, is an effective way of preventing bacteria from spreading. It should be used for the cleaning of the medical instruments or gloves, and basically any type of medical item that comes into contact with the blood stream and sterile tissues.

There are four main ways in which such items can be sterilized: autoclave (by using high-pressure steam), dry heat (in an oven), by using chemical sterilants such as glutaraldehydes or formaldehyde solutions or by radiation (with the help of physical agents). The first two are the most used methods of sterilizations mainly because of their accessibility and availability. Steam sterilization is one of the most effective types of sterilizations, if done correctly which is often hard to achieve. Instruments that are used in health care facilities are usually sterilized with this method. The general rule in this case is that in order to perform an effective sterilization, the steam must get into contact with all the surfaces that are meant to be disinfected. On the other hand, dry heat sterilization, which is performed with the help of an oven, is also an accessible type of sterilization, although it can only be used to disinfect instruments that are made of metal or glass. The very high temperatures needed to perform sterilization in this way are able to melt the instruments that are not made of glass or metal.

Steam sterilization is done at a temperature of 121 C (250 F) with a pressure of 209 kPa (15 lbs/in²). In these conditions, rubber items must be sterilized for 20 minutes, and wrapped items 134 C with pressure of 310 kPa for 7 minutes. The time is counted once the temperature that is needed has been reached. Steam sterilization requires four conditions in order to be efficient: adequate contact, sufficiently high temperature, correct time and sufficient moisture.^[11] Sterilization using steam can also be done at a temperature of 132 C (270 F), at a double pressure. Dry heat sterilization is performed at 170 C (340 F) for one hour or two hours at a temperature of 160 C (320 F). Dry heat sterilization can also be performed at 121 C, for at least 16 hours.^[12]

Chemical sterilization, also referred to as cold sterilization, can be used to sterilize instruments that cannot normally be disinfected through the other two processes described above. The items sterilized with cold sterilization are usually those that can be damaged by regular sterilization. Commonly, glutaraldehydes and formaldehyde are used in this process, but in different ways. When using the first type of disinfectant, the instruments are soaked in a 2-4% solution for at least 10 hours while a solution of 8% formaldehyde will sterilize the items in 24 hours or more. Chemical sterilization is generally more expensive than steam sterilization and therefore it is used for instruments that cannot be disinfected otherwise. After the instruments have been soaked in the chemical solutions, they are mandatory to be rinsed with sterile water which will remove the residues from the disinfectants. This is the reason why needles and syringes are not sterilized in this way, as the residues left by the chemical solution that has been used to disinfect them cannot be washed off with water and they may interfere with the administered treatment. Although formaldehyde is less expensive than glutaraldehydes, it is also more irritating to the eyes, skin and respiratory tract and is classified as a potential carcinogen.^[11]

Other sterilization methods exist, though their efficiency is still controversial. These methods include gas, UV, gas plasma, and chemical sterilization with agents such as peroxyacetic acid or paraformaldehyde.

Cleaning

Infections can be prevented from occurring in homes as well. In order to reduce their chances to contract an infection, individuals are recommended to maintain a good hygiene by washing their hands after every contact with questionable areas or bodily fluids and by disposing of garbage at regular intervals to prevent germs from growing.^[13]

Disinfection

Disinfection uses liquid chemicals on surfaces and at room temperature to kill disease causing microorganisms. Ultraviolet light has also been used to disinfect the rooms of patients infected with *Clostridium difficile* after discharge.^[14] Disinfection is less effective than sterilization because it does not kill bacterial endospores.^[10]

Personal protective equipment

Personal protective equipment (PPE) is specialized clothing or equipment worn by a worker for protection against a hazard. The hazard in a health care setting is exposure to blood, saliva, or other bodily fluids or aerosols that may carry infectious materials such as Hepatitis C, HIV, or other blood borne or bodily fluid pathogen. PPE prevents contact with a potentially infectious material by creating a physical barrier between the potential infectious material and the healthcare worker.

The United States Occupational Safety and Health Administration (OSHA) requires the use of Personal protective equipment (PPE) by workers to guard against blood borne pathogens if there is a reasonably anticipated exposure to blood or other potentially infectious materials.^[15]

Components of PPE include gloves, gowns, bonnets, shoe covers, face shields, CPR masks, goggles, surgical masks, and respirators. How many components are used and how the components are used is often determined by regulations or the infection control protocol of the facility in question. Many or most of these items are disposable to avoid carrying infectious materials from one patient to another patient and to avoid difficult or costly



disinfection. In the US, OSHA requires the immediate removal and disinfection or disposal of a worker's PPE prior to leaving the work area where exposure to infectious material took place.^[16]

Antimicrobial surfaces

Microorganisms are known to survive on non-antimicrobial inanimate ‘touch’ surfaces (e.g., bedrails, over-the-bed trays, call buttons, bathroom hardware, etc.) for extended periods of time.^{[17][18]} This can be especially troublesome in hospital environments where patients with immunodeficiencies are at enhanced risk for contracting nosocomial infections.

Products made with antimicrobial copper alloy (brasses, bronzes, cupronickel, copper-nickel-zinc, and others) surfaces destroy a wide range of microorganisms in a short period of time.^[19] The United States Environmental Protection Agency has approved the registration of 355 different antimicrobial copper alloys and one synthetic copper-infused hard surface that kill *E. coli* O157:H7, methicillin-resistant *Staphylococcus aureus* (MRSA), *Staphylococcus*, *Enterobacter aerogenes*, and *Pseudomonas aeruginosa* in less than 2 hours of contact. Other investigations have demonstrated the efficacy of antimicrobial copper alloys to destroy *Clostridium difficile*, influenza A virus, adenovirus, and fungi.^[19] As a public hygienic measure in addition to regular cleaning, antimicrobial copper alloys are being installed in healthcare facilities in the U.K., Ireland, Japan, Korea, France, Denmark, and Brazil. The synthetic hard surface is being installed in the United States as well as in Israel.^[20]

Vaccination of health care workers

Health care workers may be exposed to certain infections in the course of their work. Vaccines are available to provide some protection to workers in a healthcare setting. Depending on regulation, recommendation, the specific work function, or personal preference, healthcare workers or first responders may receive vaccinations for hepatitis B; influenza; measles, mumps and rubella; Tetanus, diphtheria, pertussis; *N. meningitidis*; and varicella.^[21]

Post-exposure prophylaxis

In some cases where vaccines do not exist, post-exposure prophylaxis is another method of protecting the health care worker exposed to a life-threatening infectious disease. For example, the viral particles for HIV-AIDS can be precipitated out of the blood through the use of an antibody injection if given within four hours of a significant exposure.

Surveillance for infections

Surveillance is the act of infection investigation using the CDC definitions. Determining the presence of a hospital acquired infection requires an infection control practitioner (ICP) to review a patient's chart and see if the patient had the signs and symptom of an infection. Surveillance definitions exist for infections of the bloodstream, urinary tract, pneumonia, surgical sites and gastroenteritis.

Surveillance traditionally involved significant manual data assessment and entry in order to assess preventative actions such as isolation of patients with an infectious disease. Increasingly, computerized software solutions are becoming available that assess incoming risk messages from microbiology and other online sources. By reducing the need for data entry, software can reduce the data workload of ICPs, freeing them to concentrate on clinical surveillance.

As of 1998, approximately one third of healthcare acquired infections were preventable.^[22] Surveillance and preventative activities are increasingly a priority for hospital staff. The *Study on the Efficacy of Nosocomial Infection Control* (SENIC) project by the U.S. CDC found in the 1970s that hospitals reduced their nosocomial infection rates by approximately 32 per cent by focusing on surveillance activities and prevention efforts.^[23]

Isolation

In the health care context, isolation refers to various physical measures taken to interrupt nosocomial spread of contagious diseases. Various forms of isolation exist, and are applied depending on the type of infection and agent involved, to address the likelihood of spread via airborne particles or droplets, by direct skin contact, or via contact with body fluid

Outbreak investigation

When an unusual cluster of illness is noted, infection control teams undertake an investigation to determine whether there is a true outbreak, a pseudo-outbreak (a result of contamination within the diagnostic testing process), or just random fluctuation in the frequency of illness. If a true outbreak is discovered, infection control practitioners try to

determine what permitted the outbreak to occur, and to rearrange the conditions to prevent ongoing propagation of the infection. Often, breaches in good practice are responsible, although sometimes other factors (such as construction) may be the source of the problem.

Outbreak investigations have more than a single purpose. These investigations are carried out in order to prevent additional cases in the current outbreak, prevent future outbreaks, learn about a new disease or learn something new about an old disease. Reassuring the public, minimizing the economic and social disruption as well as teaching epidemiology are some other obvious objectives of outbreak investigations.^[24]

According to the WHO, outbreak investigations are meant to detect what is causing the outbreak, how the pathogenic agent is transmitted, where it all started from, what is the carrier, what is the population at risk of getting infected and what are the risk factors.

The results of outbreak investigations are always made public in the means of a report in which the findings are communicated to the authorities, media, scientific community and so on. These reports are commonly used as pedagogical tools.

Training in infection control and health care epidemiology

Practitioners can come from several different educational streams. Many begin as nurses, some as medical technologists (particularly in clinical microbiology), and some as physicians (typically infectious disease specialists). Specialized training in infection control and health care epidemiology are offered by the professional organizations described below. Physicians who desire to become infection control practitioners often are trained in the context of an infectious disease fellowship.

In the United States, Certification Board of Infection Control and Epidemiology is a private company that certifies infection control practitioners based on their educational background and professional experience, in conjunction with testing their knowledge base with standardized exams. The credential awarded is CIC, Certification in Infection Control and Epidemiology. It is recommended that one has 2 years of Infection Control experience before applying for the exam. Certification must be renewed every five years.^[25]

A course in hospital epidemiology (infection control in the hospital setting) is offered jointly each year by the Centers for Disease Control and Prevention (CDC) and the Society for Healthcare Epidemiology of America.^[26]

The Association for Professionals in Infection Control and Epidemiology (APIC) offers

training and courses in infection control.^[27]

Standardization

Australia

In 2002, the Royal Australian College of General Practitioners published a revised standard for office-based infection control which covers the sections of managing immunisation, sterilisation and disease surveillance.^{[28][29]} However, the document on the personal hygiene of health workers is only limited to hand hygiene, waste and linen management, which may not be sufficient since some of the pathogens are air-borne and could be spread through air flow.^{[30][31]}

United States

Currently, the federal regulation that describes infection control standards is found at 29 CFR Part 1910.1030 Bloodborne pathogens.^[32]

See also

- Infectious disease
- Nosocomial infection
- Royal Australian College of General Practitioners
- Centre for Infection Prevention and Management

Footnotes

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External links

- Association for Professionals in Infection Control and Epidemiology (<http://www.apic.org>) is primarily composed of infection prevention and control professionals with nursing or medical technology backgrounds
- The Society for Healthcare Epidemiology of America (<http://shea-online.org>) is more heavily weighted towards practitioners who are physicians or doctoral-level epidemiologists.
- Regional Infection Control Networks (<http://www.ricn.org>)
- The Certification Board of Infection Control and Epidemiology, Inc. (<http://www.cbic.org>)
- Association for Professionals in Infection Control and Epidemiology (<http://www.apic.org>)

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