11
Infection Control in the Intensive Care Unit

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General Principles

Many patients admitted to critical care units carry healthcare-associated multiresistant organisms, such as methicillin-resistant *Staphylococcus aureus* (MRSA), or may have a communicable infectious disease, such as pulmonary tuberculosis (TB). Special measures are, therefore, frequently required to prevent the spread of these pathogens to other patients on the unit. In general, these are referred to as infection control procedures.

Risk to Patients

Intensive therapy unit (ITU) patients often differ greatly from patients on a general medical or surgical ward. For example, they may be intubated, have medical devices (such as intravascular cannulae or urinary catheters in situ), require frequent interventions with invasive procedures, and will often be receiving broad-spectrum antibiotics. All of these factors make the prevention of spread of potential pathogens among such patients a vital aspect of patient care in such units.

Risk to Staff

It is important to remember that infection control procedures are also designed to protect staff from infection. Healthcare staff members are usually healthy and, thus, less likely to contract infection from their patients than are patients from infected staff. However, acquisition of infection from patients is by no means uncommon. Such infections include scabies, herpes simplex, chickenpox, TB, viral gastroenteritis, viral hepatitis, and HIV. In addition, staff may become colonized with hospital organisms without ill effects, leading to the possibility of patients becoming infected from a colonized member of staff. MRSA is perhaps the best-known example of this problem. Recommended routine infection control procedures to be followed in the care of any patient are listed in Table 11.1.

Means of Transmission of Infection

The common means of transmission of infection are by:

- The airborne route
- Fecal-to-oral transmission
- Direct or indirect contact

Typical examples of diseases transmitted by the airborne route include respiratory viruses and TB. The agents of gastrointestinal infections are excreted in feces and then must be ingested to cause infection (the fecal-to-oral route), and this includes some healthcare-associated infections, such as infections caused by *Clostridium difficile*. Opportunistic, often multiresistant pathogens, such as MRSA, may be transferred by direct contact between patients, or, more commonly, may be transmitted indirectly via the hands of nursing, medical, or other staff or via contaminated medical equipment.

Table 11.1. Summary of routine infection control procedures

Topic	Main points
Clinical waste	• Dispose of appropriately; do not dispose of clinical waste in domestic waste bags! • Handle sharps safely and correctly; see below • Launder linen and incinerate contaminated disposable equipment
Sharps safety	• Dispose of sharps in the appropriate container—sharps bins are provided for this purpose • Do not attempt to resheath needles, etc., which frequently leads to needlestick injuries • For their own protection, healthcare workers must be vaccinated against hepatitis B, and a range of other immunizations may be required: see your local employer's policy • Report any needle-stick injuries at once and seek appropriate advice; active and/or passive immunization, or the use of antiviral agents, may be required, and this is time critical
Decontamination and disinfection	• A clean environment is essential for prevention of healthcare-associated infection; ITU staff should not tolerate a dirty working environment • Ensure blood and body fluid spills are correctly managed; the hospital will have a policy for the correct procedure • Clean and decontaminate equipment after use; ideally personal equipment such as stethoscopes should be regularly cleaned and decontaminated (e.g., with alcohol wipes)
Hand hygiene	• Ensuring good hand hygiene is the single most important means of preventing healthcare-associated infection • The use of alcohol hand gel or rub is an alternative to hand washing when there is no visible soiling of the hands • Hand washing is *required* when there is visible soiling of the hands • Hand hygiene procedures must be performed: ◦ on entering or leaving the unit ◦ before and after contact with a patient
PPE	• This includes plastic aprons, gloves, impermeable gowns, visors or goggles, high-efficiency particle masks, etc. • PPE is worn to provide protection for the healthcare worker against infectious agents, or sometimes to prevent contamination of a very vulnerable patient (e.g., one who is very neutropenic) with organisms from staff on the unit • A risk assessment should be performed before any medical procedure and appropriate steps taken; for example, if there is a risk of aerosol formation, then the wearing of eye protection may be recommended • Cuts and abrasions on the skin of the staff member should be covered with occlusive dressings
Staff illness	• Staff with potentially infectious conditions, such as diarrhea, upper respiratory tract infections, skin sepsis, etc., should not work until given clearance to do so from their manager • If in doubt, staff should contact the occupational health department, which will advise on the staff member's fitness to work

Patient Isolation

A key factor in preventing transmission is the isolation of infected or colonized patients (sometimes incorrectly referred to as the *quarantine* of patients). Isolation facilities on an ITU may serve two very distinct patient groups:

- Source isolation: For patients who are sources of microorganisms that may spread from them and infect or colonize other patients and/or members of staff
- Protective isolation: For patients who are rendered highly susceptible to infection by disease or therapy, including immunocompromised and burn patients

The lack of isolation facilities on the ITU or the necessary staffing levels to ensure safe management of the patient is often a key hindrance to the isolation of potentially infective patients. When this occurs, a risk assessment must be performed to determine who (if anyone) should be placed in isolation. A common example would be whether a patient with MRSA or another with *C. difficile* should take priority for isolation, leaving the other patient to be nursed on the open unit. In these circumstances, the hospital infection control team (ICT) can provide help and advice.

Universal Precautions

Since the 1990s, the UK Department of Health has recommended using the same level of protection against infection with bloodborne viruses with all patients rather than attempting to identify individuals who are potential carriers of these viruses.

As a general principle, the following universal precautions should be adopted with all patients:

1. Gloves should be worn when handling blood and body fluids, e.g., amniotic fluid, pericardial fluid, peritoneal fluid, pleural fluid, synovial fluid, cerebrospinal fluid (CSF), semen, vaginal secretions, and any fluid visibly contaminated with blood.
2. Gloves should be changed after contact with every patient and hands washed immediately with hot water and soap after removing gloves.
3. If hands or other skin surfaces become contaminated with blood or body fluids, they should be washed immediately with hot water and soap and thoroughly dried.
4. Needles must not be not resheathed, purposefully bent or broken, routinely removed from disposable syringes, or manipulated by hand. Once used, sharps must be disposed of in puncture-resistant containers for appropriate disposal.
5. Masks and/or visors should be worn to prevent exposure of mucous membranes, e.g., mouth, eyes, and nose, during high-risk procedures; i.e., those that have potential to generate droplets of blood or body fluids.
6. Gowns and/or aprons must be worn during procedures that may cause splashes or sprays of blood or body fluids that soil healthcare workers clothing or uniforms.

The wearing of outdoor clothing on the ITU is not recommended. Ideally, we advocate the wearing of theater-style attire—preferably in a different color to operating theater clothing ("theater blues"). A clean set should be worn at the beginning of every shift and changed every time it becomes stained with blood or body fluids.

Specific Problems

Multiresistant Organisms

MRSA, multiresistant gram-negative bacilli (e.g., *Acinetobacter* species, *Serratia marcescens*, extended-spectrum β-lactamase [ESBL]-producing *E. coli*, and *Pseudomonas aeruginosa*), and glycopeptide-resistant enterococci (GRE) are associated with various infections on the ITU. They are more frequently encountered in patients who have received broad-spectrum antibiotics and, once established in an ITU setting, are extremely difficult to eliminate. It should be noted, however, that some of these organisms, notably MRSA and ESBL producers, may be seen in patients admitted from the community without a prolonged hospital stay before ITU admission. Careful control of antibiotic prescribing may limit their appearance, but the strict adoption of infection control principles and procedures is crucial to prevent their spread from patient to patient.

Many critical care units screen all or selected patients for MRSA on admission by means of nose, throat, and perineal swabs. If the patient is identified as a carrier, they should be nursed in a side room if one is available. It is possible to assess the risk of MRSA carriage on admission. Patients who have had multiple previous hospital admissions, those who have received or are receiving broad-spectrum antibiotics (especially quinolones such as ciprofloxacin), those admitted from nursing homes, and those admitted from hospitals with high rates of MRSA are all at increased risk of colonization with this organism.

Surveillance of positive microbiological results from the ITU may help to identify the emergence of a particular multiresistant gram-negative bacillus. Close liaison with the microbiologist and the ICT is crucial to prevent an outbreak occurring. Often these organisms are present in the environment of the ITU and may require very thorough cleaning to remove them.

The injudicious use of antibiotics may encourage the emergence of multiresistant organisms. The development and strict implementation of an appropriate antibiotic policy will help to reduce this. However, once a patient is colonized with this type of organism, only the careful adoption of infection control procedures will prevent the spread of the organism to other patients.

A number of studies indicate that MRSA can be controlled in critical care units by the implementation of rigorous control of infection policies and protocols. For example, a "before and after" study of an ITU in a French teaching hospital with a high admission and transmission rate of MRSA reported a decrease in MRSA unit acquisition from 7.0% to 2.8% after the introduction of such a program.[1]

Table 11.2. Infections to be placed in respiratory isolation

Infection	Indications for ending isolation
Bronchiolitis in infants (caused by respiratory syncytial virus [RSV])	Clinical recovery. Cohort nursing of infants with RSV infection is acceptable if single-room isolation is not possible
Croup (acute laryngotracheobronchitis; most commonly caused by parainfluenza viruses)	Isolation may be appropriate in some circumstances. Discuss with the ICT
Invasive *Haemophilus influenzae* infection (meningitis, epiglottitis, etc.)	24 hours of appropriate antibiotic therapy
Influenza	Clinical recovery
Measles	5 days after the onset of rash
Mumps	9 days after the appearance of parotid swelling
Rubella	5 days after the onset of rash
Whooping cough	5 days of appropriate antibiotic therapy

TB and Other Respiratory Pathogens

Pulmonary TB represents a risk of infection to patients and staff when the sputum is smear-positive for acid-fast bacilli. The crucial first step in making a diagnosis of TB is to think of the condition, because it is no longer a common infection in the United Kingdom. With the emergence of HIV, patients may be admitted to the ITU with incidental pulmonary TB in addition to whatever condition necessitated an ITU admission. Thus, the admitting clinician must have a high index of suspicion.

Despite the recent abandonment of the childhood Bacille Calmette-Guèrin (BCG) immunization program in the United Kingdom, the use of the BCG vaccine remains an important means of preventing TB in UK healthcare staff. For this reason, every effort should be made to ensure that staff who are to work in an ITU where they may encounter patients with pulmonary TB have been immunized with BCG.

Patients suspected of having pulmonary TB should be nursed in a negative-pressure side room with a closed circuit where this is available. Patients with smear-positive disease can usually leave the side room after 2 weeks of treatment. However, the emergence of multidrug-resistant (MDR) TB presents a difficult problem, and this should be considered in the following circumstances:

- Previous incomplete or noncompliant treatment
- Contact with a patient with known MDR-TB
- Disease acquired in a country with a high incidence of MDR-TB
- Disease not responding to treatment

Advice on the infection control issues these patients present should be sought from a specialized center and isolation may be required in a dedicated isolation unit.

Other respiratory pathogens (examples are given in Table 11.2) may require respiratory isolation, the key points of which are outlined in Table 11.3.

Table 11.3. Key features of respiratory isolation

Aprons	Where these are normally worn for nursing procedures, they will still be required
Masks (this section applies **only** to pulmonary TB)	For the patient: not normally required; patients should be instructed to cough into tissues and to cover their mouth and nose when coughing and sneezing. All smear-positive patients should wear a mask if being transported through patient or public areas of the hospital. A high-efficiency particulate air (HEPA) mask should be worn until the patient is known not to have MDR-TB, after which, a routine surgical mask is satisfactory (which should be changed at hourly intervals). For staff: masks are only required when there is unavoidable exposure to respiratory secretions, e.g., during cough-inducing procedures, bronchoscopy, or prolonged care of a high-dependency patient. A mask is also appropriate when nursing a patient who is unable to cover their mouth and nose when coughing or sneezing. The ordinary type of surgical theater mask is **not** adequate for this purpose and a disposable HEPA mask must be used
Gloves	Not required unless handling blood or body fluids
Equipment	It is not necessary to have a full diagnostic kit in the room dedicated to the patient
Infective secretions	Sputum, sinus secretions, used paper handkerchiefs, and sputum cartons must be treated as infected waste and disposed of in accordance with the clinical waste disposal policy
Crockery and cutlery	No special precautions required. The patient does not require a set of dedicated utensils

Meningitis

Meningococcal meningitis can pose infection control risks to healthcare workers, especially those involved in direct airway management. *Neisseria meningitidis* is transmitted from person to person through nasopharyngeal secretions or large particle respiratory droplets that are unlikely to remain airborne beyond a distance of 1 meter.

Routine prophylaxis for healthcare workers involved in the general care of the patient is not recommended. Chemoprophylaxis is recommended only for those healthcare workers whose mouth or nose is directly exposed to infectious respiratory droplets or secretions within a distance of 1 meter from a probable or confirmed case of meningococcal disease. Very few cases of patient-to-healthcare worker transmission of meningococcal disease have been reported and the risk is, therefore, very low. The appropriate use of protective equipment when dealing with these patients, e.g., wearing masks and using closed suction, will help to reduce the necessity for chemoprophylaxis.

Pandemic Influenza

The Department of Health has produced guidelines[1] in the event of a pandemic of influenza. Pandemics occur because of the emergence of a strain of influenza that, through antigenic shift, is significantly different from previous strains. Of interest at present is the possible emergence of A/H5N1 ("Avian flu") from South East Asia. However, transmission of this strain from person to person, which is essential for a pandemic to occur, is very rare at present. Therefore, at the time of writing, a pandemic would be more likely to occur because of a more typical "human" strain of the influenza virus.

In the event of a pandemic, the Department of Health in England recommends the following measures:

- Good hand hygiene is critical to reduce the transmission of the infectious agent.
- Coughing or sneezing patients should wear surgical masks in transit to the ITU and when transferred to other units (e.g., radiology).
- Personal protective equipment (PPE) should be worn to prevent staff becoming contaminated with body fluids. Staff involved in nonaerosol-producing activities but within 3 feet of the patient should wear gloves, a plastic apron, a surgical mask, and possibly eye protection if there is a risk of splashing with respiratory secretions or other body fluids. High-efficiency respirators (such as those reaching standard EN149: FFP3) are only necessary if conducting aerosol-generating procedures (e.g., intubation, nasopharyngeal aspiration, tracheostomy care, chest physiotherapy, bronchoscopy, and nebulizer care) when a fluid-repellent gown and eye protection are also essential.
- Patients would ideally be nursed in a side room on the ITU. If none are available, it is recommended that the unit be divided into two areas; one area would nurse patients infected by influenza, preferably with their own dedicated staff.
- Disposable respiratory equipment should be used. Closed systems are preferable with the protection of a filter. Noninvasive positive-pressure ventilation should be avoided, along with water humidification.
- Only essential staff should be present when conducting aerosol-generating procedures and these should be wearing the appropriate PPE.

Severe Acute Respiratory Syndrome

The cause of severe acute respiratory syndrome (SARS) has been identified as the SARS coronavirus (SARS-CoV). Close contact with an infected person is thought to pose the highest risk of the infective agent spreading from one person to another. SARS seems to be less infectious than influenza, and the incubation period is thought to be between 2 and 7 days (maximum, 10 d).

After the worldwide concern regarding the spread of SARS, especially to the healthcare workers managing infected patients, the Health Protection Agency in England has made recommendations for the control of this infection in hospitals.[2] A summary of some key recommendations is as follows:

- The patient should be nursed either in an isolation room with negative pressure relative to the surrounding area, or a single room with its own bathroom and toilet facilities
- Protective clothing should be worn by all staff entering the room including:
  - An appropriate protective mask (such as the EN149: FFP3 respirator mask); such respirators should be worn by all personnel performing clinical care or in the room during aerosol-generating procedures
  - A long-sleeved fluid-repellent disposable gown
  - Gloves with tight-fitting cuffs for contact with the patient or their environment
  - Disposable eye protection comprising tight-fitting goggles or face shield (glasses provide inadequate protection against droplets, sprays, and splashes) during direct patient contact
- Only essential staff should enter the isolation room, and a record of all staff caring for the patient should be kept
- Patients should wear a surgical face mask, if able to do so, when in close contact with uninfected persons. The mask should be changed after 8 hours, or sooner if it becomes saturated or breathing is difficult
- If possible, aerosol-producing procedures should be avoided, but, if they are essential, they should be performed in a negative-pressure single room

Table 11.4. Gastrointestinal infections

Infection	Indications for ending isolation
Campylobacter colitis	Cessation of diarrhea for 48 hours
Cholera	Cessation of diarrhea for 48 hours
Clostridium difficile-associated diarrhea or pseudomembranous colitis	Cessation of diarrhea for 48 hours
Diarrhea of unknown cause	Until communicable disease is excluded as the cause of diarrhea, or on cessation of diarrhea for 48 hours
Dysentery (*Shigella* infection or amoebic dysentery)	Cessation of diarrhea for 48 hours
E. coli gastrointestinal infection (all types)	Cessation of diarrhea for 48 hours
Gastroenteritis (viral)	Cessation of diarrhea for 48 hours
Hepatitis A	Until 1 week after onset of jaundice
Salmonella enteritis	Cessation of diarrhea for 48 hours
Typhoid or paratyphoid fever	Negative stool cultures (and urine cultures, if applicable)
Viral gastroenteritis (e.g., norovirus, rotavirus)	Cessation of diarrhea and vomiting for 48 hours

Bowel and/or Enteric Organisms

Bowel or enteric organisms may pose several problems to the ITU in terms of infection control. The patient may be directly admitted from the community with severe dehydration and complications secondary to the bowel infection or may develop the infection while on the ITU. The most commonly encountered problem is likely to be *Clostridium difficile*. However, other bacterial infections, such as *Salmonella* or *Campylobacter* may occur in ITU patients, and viral gastroenteritis with agents such as norovirus or rotavirus are common, but usually self-limiting. Viral infections can, however, spread rapidly between patients and staff.

The management of these infections from an infection control viewpoint is similar. In general, however, any patient with unexplained diarrhea should be cared for in a side room. Standard isolation precautions should be performed as outlined in Table 11.1, with effective hand hygiene a vital component. Table 11.4 gives a summary of the main enteric pathogens likely to be encountered on an ITU.

Intravascular Line Infections

The use of intravascular cannulae is probably the single biggest risk factor for healthcare-associated septicemia in hospital practice today, and no less so on critical care units. Aseptic insertion and manipulation of intravascular devices is crucial, the general principles of infection control; hand washing, sterile environment, and wearing of PPE should be followed to protect both the patient and the healthcare worker. Aseptic technique does not automatically necessitate sterile gloves; a "no-touch" technique may be equally as effective with nonsterile disposable gloves for peripheral cannulae. Where the consequences of infection are increased, especially with central venous

catheters, precautions to prevent infection needs to be more rigorous. Studies have shown that maximal sterile-barrier precautions; mask, sterile gown, sterile gloves, cap, and large sterile drapes are more effective than standard measures.[3,4]

The risks of acquiring an infection from an intravascular device is directly proportional to the length of time that the line/device has been in place. Removal of unneeded lines is, therefore, of great importance. Peripheral lines carry less infection risk than central lines, and substitution of peripheral for central lines should occur as soon as possible. Some studies suggest that antibiotic-coated lines reduce infection risk, but no studies have ever demonstrated efficacy using clinically relevant end points to our knowledge. Routine, prophylactic line changes have not been shown to reduce the risk of infection and are associated with increased complications. Guidelines for the prevention of catheter-related infection have been produced by the North American Center for Disease Control.[5]

Cannulae-related infection is very common in the critically ill. In the pyrexial patient who has been on the ITU for a number of days, line-related sepsis is very likely. In this situation, all lines should be removed, cultured, and replaced as needed.

Infected Staff

Healthcare workers who may be suffering from an infectious disease should refrain from work until no longer infectious. Although this sometimes poses problems in terms of staffing, this is preferable to a unit closing completely because of an outbreak. Common examples of such problems include staff with diarrhea, who should only return to work after 48 hours symptom free, upper respiratory tract infections (including the common cold, which may spread rapidly among patients and staff), and skin conditions such as eczema or psoriasis where there is heavy shedding of skin scales. Influenza vaccine should be offered to all staff within the unit. Advice on these and other issues should be discussed with both ICT and Occupational Health department.

The management of staff colonized with MRSA is controversial. At present, there is no national guidance on who to screen for MRSA and what to do for those who are found to be colonized. Our policy has been to investigate for staff carriage in a critical care unit when there have been two or more cases of MRSA infection that have a temporal link. We also have an active process of screening new staff members for carriage of MRSA.

Conclusions

In many cases, infection control is a matter of commonsense. Its aim is not to obstruct the care of patients by placing barriers in front of healthcare workers but to ensure that both staff members and patients are protected from the spread of potential pathogens. One of the simplest and most effective methods of ensuring this is the use of hand washing or the use of alcohol-based hand rubs. The importance of good hand hygiene cannot be overemphasized.

Finally, liaison with the ICT when the clinician is in doubt regarding suitable infection control procedures is *always* preferable to an outbreak on an ITU!

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Suggested Reading

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