



Abstract

Many bacteria, viruses, parasites, fungi and prions may cause serious infections and lead to the isolation of those who are infected from those who are susceptible. Isolation may be done in single rooms or in special isolation units. A *modern isolate for patients with infections* comprises (1) a sluice with a good space for dressing and undressing of personal protective equipment (PPE) and for hand hygiene, (2) a large patient room and (3) a bathroom/disinfection room with own decontaminator or autoclave and with separate entrance from the patient's room. Isolates for airborne and droplet-transmitted infections have in addition a defined negative air pressure and hepafiltered exhaust. In all isolates, doors must be closed in such a way that contaminants do not escape the isolate. A *modern isolate for patients with impaired immune defence* is similar to the infection isolates, with following exceptions: usually no need for decontaminator, hepafiltered clean air into the room and with a defined *positive* air pressure. A positive pressure isolate should never be used for patients with infections, and a negative pressure isolate should never be used for patients with impaired immune defence, except if the patient also has an infection that needs isolation.

Keywords

Microbial agents · Isolation capacity in the hospital · Information to the patient, family and visitors · Symptoms · Transmission · Protection · PPE · Healthcare personnel · Control

15.1 Purpose

To prevent transmission from an infectious patient to other patients, personnel, visitors and the environment and to protect patients with impaired immune defence against infection [1–8].

15.2 Comprise

- All patients having contagious disease that can easily be transferred directly or indirectly via contact, blood and body fluids, air/droplets or via equipment, textiles and surfaces.
- All patients with significant reduced infection defence or otherwise infection vulnerable and who should be protected against infection.

15.3 Responsibility

Hospital management should ensure necessary capacity and type of isolating units: contact- and air-droplet isolates and protective isolates. Updated isolation routines, adequate protective equipment—including PPE—routines for disinfection of rooms and surfaces and disinfectants and hand hygiene facilities should be available.

Department management should implement isolation procedures, train the use of PPE, control the use of routines and provide sufficient stock and capacity of PPE and means for disinfection and hand hygiene.

The staff should follow current guidelines for treatment of patients with infections and for patients that should be extra protected against infections.

15.4 Practical Measures

The need for isolates varies with type of hospital activity, epidemic and endemic conditions and the condition of the hospital [9–24]. Single rooms with separate bathroom and anteroom prevent the spread of infection more than single rooms and multiple bedrooms with shared toilet and bathrooms. Modern isolates, well designed, ensure other patients and personnel against infection, streamline hospital activity and simplify work [21, 22, 25–27].

15.4.1 Isolates: National and Local Overview

Updated status should be available as to the type (infections or protective) and quality of isolates and single rooms—by national and county health authorities. An overview of the number and types of infection isolates in a radius of at least 10 miles around densely populated areas should be available, and collaboration should be established between the hospitals. Isolates should be checked at least once a year. Contact isolate should have a sluice system (priority) and an own disinfection room with decontaminator. An air-droplet isolate should, in addition, have a defined negative air pressure in the rooms and separate ventilation. Protective isolates should have HEPA filtered, positive air pressure. It is also important to have overview over single rooms with separate bathrooms—which can be used for contact isolation.

Hospital buildings or other healthcare facilities that can be quickly converted into cohort isolates for defined types of outbreaks like the pandemic influenza should be appointed to the emergency.

15.4.2 Infections that Should Be Isolated

Different measures may be done relatively to preparedness whether there is a normal epidemiological situation or if it is smaller or larger outbreaks in the community that also affects the hospitals.

Normal epidemiological condition: in a developed country, like Norway, 20–25% of hospitalized patients have one or more infections, including hospital-associated infections (HAI); 20–30% receive antibacterial agents, and approximately 20% need a minimum-size single room with separate bathroom, due to infection [21, 22, 28–30]. At least 10% of the hospital infections are transmitted via air-droplets.

Local outbreaks, often seasonal, may double isolate needs: this happens nearly every year concerning norovirus, rotavirus, influenza, metapneumovirus and RSV (toddlers and the elderly) and is an increasing problem concerning resistant bacteria from home and abroad (CD, MRSA, VRE, ESBL, etc.).

Large outbreaks, more difficult to control, such as the norovirus, may be organized by cohort isolation of patients with the same type of infection [21, 22].

Closing departments and hospitals happens occasionally during greater nosocomial outbreaks of norovirus or influenza when many are sick at the same time, both patients and personnel. The intake of new patients is often discontinued during norovirus outbreaks; the ward may be emptied and disinfected thoroughly before opening it again [21, 22]. A study of 194 nosocomial outbreaks in medical departments that ended up closing the ward showed that it took a long time before the unit was reopened, median 14 days [16].

Influenza pandemics and other serious pandemics: in the case of pandemic, up to 0.3% of the population will require hospitalization, and approximately 13% need outpatient treatment [1, 31]. Capacity and readiness for escalation should be calculated and included in preparedness plans for countries and counties [30–34]

15.4.3 Isolate: Types and Numbers

Contact isolation: 25–30% of the bed capacity of surgical, paediatric, postoperative department and intensive care unit, preferably with some negative pressure and separate ventilation. In the case of special wards for patients with infections, 50–75% of the capacity should be contact isolates and the rest airborne infection isolates. At all other clinical wards, the minimum is one contact isolate per ward.

Airborne infection isolation units: at least 10% of the bed capacity for adults and 10–15% of children in hospitals should be isolates well equipped with negative pressure, separate ventilation and private bath/disinfection room with decontaminator. There should be minimum one isolate per 30 beds. Contagious and severe

infections like tuberculosis, pandemic influenza, SARS, MERS, Ebola, Lassa and other haemorrhagic viral infections should not have shared ventilation with other patient rooms, service rooms, etc. [12, 21, 22, 30–34].

Single rooms can be used as for contact isolation if separate bathroom. All rooms with the same air pressure as the rest of the ward may result in risk of airborne transmission. Single rooms may only be used an emergency solution for common infectious diseases. There are many who need single bedrooms in hospitals, not only for infectious diseases.

Lack of isolation beds may cause inefficient hospital activity and involves risk of spread of infections [21, 22–24, 28, 29, 35–37].

Protective isolation protects the patient from infection. This patient group is highly immunosuppressed, vulnerable and/or transplanted. The isolate is on positive, HEPA filtered air pressure compared to the corridor and neighbouring rooms. It has its own, separate bathroom [21, 22]. The number of isolates may be in accordance with the hospital activity concerning this type of patients.

NB! A positive pressure isolate should never be used for patients with infections, and a negative pressure isolate should never be converted and used for patients with impaired immune defence. This is due to the high risk of cross infection from microbes in filters and ventilation ducts.

15.4.4 Isolates Needed During Smaller Infection Outbreaks

Patients: The usual need of isolates for the population is covered if—in addition—use of isolates at other hospitals in the area, flexible. Most outbreaks are related to a few patients, one to five [30].

Close contacts/exposed to infection/disease carriers: a short isolation period may be actual if the index case has diphtheria (adults, elderly), plague, Ebola and possibly anthrax and in some cases where infection-prone person or carrier cannot take care of himself/follow preventive measures.

15.4.5 Information and Education

Information and training are important [19]. Everyone must implement appropriate routines in connection with the isolation. Do not forget the information to other departments (including requisitions)!

15.4.6 Isolation Procedures

Contact isolation: suspected or detected transmittable human pathogenic microbes by contact with body fluids, skin and mucous membranes, textiles, clothing, furniture and contaminated equipment (telephone, computer, keyboard, blood pressure set, tourniquet, stethoscope, temperature measure, etc.)

- Use: gloves and gown.
- Surgical cap, surgical mask and eye protection/visor at risk of splashing of blood/liquid and aerosols.
- *Yellow sign* on the door.

Blood contamination isolation: suspected or detected transmittable microbes like hepatitis viruses, HIV and other pathogens. All biological materials can be infectious, which blood and blood products are the dominant carriers of the pathogen.

- Use: gloves and gown/protective clothing on direct contact with blood/body fluids.
- Surgical cap, surgical mask and eye protection/visor at risk of splashing of blood/liquid and aerosols.
- The patient may be placed on ordinary patient rooms, if not unrestricted or uncontrolled secretion/excretion of tissue fluids.

Airborne isolation: suspected human pathogenic microbes transmitted through air, dust particles, aerosols, droplets and droplet nuclei. There is always simultaneous contact contamination. Air and contact isolation with satisfactory negative pressure, a proper sluice system and a separate bathroom/decontamination room

- Use: gloves and gown.
- Surgical cap.
- Surgical mask or respirator mask when needed (follow routines).
- Eye protection goggles/visor if risk of splashing of blood/liquid and aerosols.
- *Pink sign* on the door.

Strict isolation: suspected highly infectious, virulent and pathogenic microbes, highly resistant bacterial strains and agents that are not accepted in any form of distribution in the environment. Examples are suspected unusual infectious agents like completely resistant *Mycobacterium tuberculosis* in the lungs, viral haemorrhagic fevers, pandemic severe influenza, SARS, MERS, etc.

The isolation unit has a defined, negative air pressure (in Pascal), separate ventilation with disinfection of air extraction, a properly interlock function and also direct access from the outside. The waste water is decontaminated (autoclave). The patient room has sluice systems and bathroom with throughput decontaminator/autoclave with direct entrance from the patient room.

- *Red sign* on the door

Protective isolation: used by extensive burns, leukopenia, severely compromised immune systems or other needs for special protection against infections.

- *Blue sign* on the door

15.4.7 Information for Patient and Visitors

Isolation may be necessary for patients with infections to prevent others from getting the same infection. This does not mean that the patient is particularly in a bad condition but that some bacteria or viruses can spread, for example, by coughing, secrets, blood, faeces or urine. In order to prevent spread of infection, the ward needs participation of relatives and other visitors.

The patient must be informed of the following:

1. The patient's room cannot be left without consultation with a nurse or doctor. Use the ring bell.
2. The bedpan and urine bottle must be used if the patient room does not have a separate toilet.
3. Avoid touching wounds, bandages or tubes.
4. Pus or blood/secret on the bandage, in bed linens, or loosened dressing; notify the nurse.
5. Good hand hygiene is important. Always wash your hands after toilet visits; after using the bedpan or urine bottle; after any touch of wounds, bandages or tubes; before eating; before leaving the room; and when you return to the room.
6. Use clothes that can be washed at higher temperatures (>65 °C); preferably use the hospital textiles.

Visitors must be informed about this

1. Contact the nurse for the necessary precautions before entering the patient room.
2. Follow routines for personal use of infection control equipment—you will be notified by a responsible nurse.
3. It may be necessary to reduce the number of visitors. Nurses will report this. Small children should not enter the room without special agreement with the responsible nurse.
4. Disinfect your hands before entering the isolate.
5. Do not sit on the bedside. Use a chair by the bed.
6. Do not eat or drink in the patient's room.
7. Do not use the ward's kitchen or refrigerator or serve on the corridor, etc.
8. There is no access to the ward's service room (disinfection room, textile room, storeroom, etc.).
9. Leave the department immediately after visit—avoid living rooms, etc.
10. Thoroughly wash your hands before leaving the isolate (sink in the sluice), even if you only need a short errand outside.
11. Close all doors after you in a calm and careful manner as you walk in and out of the isolate.

15.4.8 Measures to Make the Isolation Stay Easier

- Dedicated contacts among nurses that the patient accept/like. There should be more contacts so that someone is always present. Interpreting may be used if language problems.
- Visit the patient unmasked. It is better with frequent, short visits than one long.
- Good information and update with regard to the patient's illness is important [38].
- Use a flexible visit time. Check that visitors understand, accept and follow the protective routines and other advices from healthcare professionals.
- Private food to the patient is not allowed, possibly delivered directly to the department by appointment in special situations.
- Good aids are TV, video, radio, telephone, data and papers that are appropriate for the patient.
- Isolates should not have curtains, but washable posters, etc. can be used on the wall.
- Large windows and a good daylight are important.
- The room should be clean, neat and well maintained.
- Isolation involves no more depression or fear than what the patient has upon admission [39].
- Isolation does not involve a poorer patient care experienced by the patient, quite the contrary [40–43].
- Close all doors behind you in a calm and cautious manner when going in and out of the isolate in order not to create unfortunate air currents [44].

15.4.9 Personal Protection Equipment (PPE) for Isolation: See Point 6

Contact isolation: Gloves and disposable infection gown with cuffs (Fig. 15.1).

When certain agents are suspected (norovirus, CD, MRSA, etc.), or gastroenteritis, respiratory tract symptoms etc., use in addition surgical mask, cap, and eventually visor, room-bound shoes/shoe covers. In the sluice, clean off the shoes on a “cloth” with chloramine 5% outside the door to get rid of the agents if not using shoe covers. Replace at each shift. Used especially during CD isolation.

Blood contamination isolation: gloves and disposable infection gown with cuffs by direct contact with blood/body fluid—and double gloving when sharp procedures.

Airborne isolation: surgical mask or respirator, cap, gloves and disposable infection gown with cuffs.

Strict isolation: respiratory protection, surgical cap and hood and disposable fluid-resistant gown with long arms and cuff or overall with hood, boots or shoe covers, double gloving.

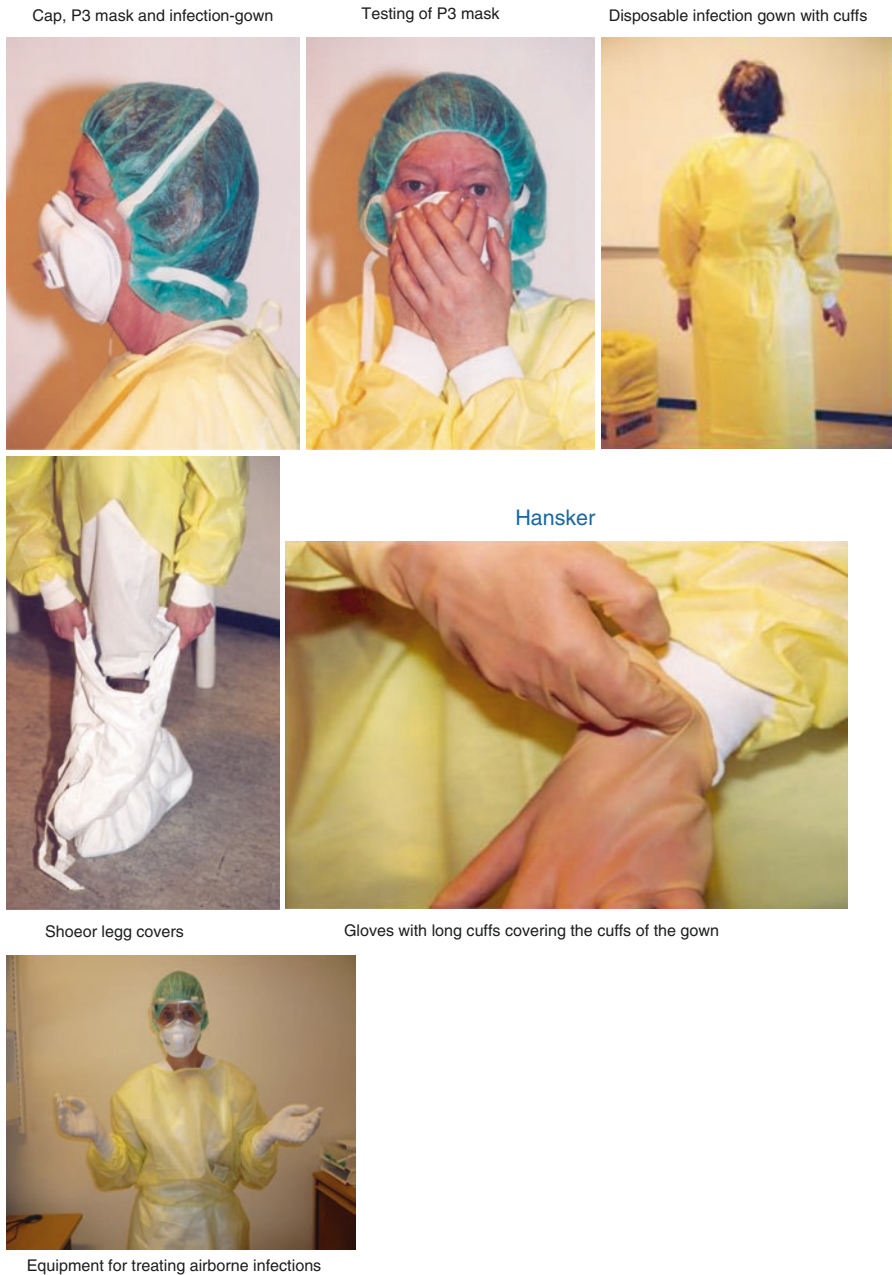


Fig. 15.1 Personal protective equipment-donning. Source: BMA, OUS-Ullevål

Protective isolation: good hand hygiene, clean gown, surgical mask, surgical cap, room-bound shoes.

15.4.10 Where to Take On and Off the PPE: Donning and Doffing?

A *clean, not used PPE* can be taken on in the sluice or on the corridor outside the sluice.

A *used, contaminated PPE* is taken off in the patient sluice, nearby the door of the patient room and is placed directly in an infection waste container. If there is no sluice present, the PPE is removed inside the patient room—at the exit door.

NB! Never take off used PPE in the hallway or corridor—except if a separate sluice is made here.

15.4.11 In This Order Take On (Donning) the PPE *Before Entering the Isolate* [22]

- *Surgical cap* shall *always* be used when the surgical mask or respirator mask is used (by airborne infection, strict isolation and when protective isolation). The surgical cap makes the mask easier to fasten on the head and removes hair from the face and neck. Covering ears and all the hair may protect against exposure to microbes when the patient coughs or sneezes.
- *Surgical masks* (gastroenteritis virus, MRSA, respiratory infections/droplets and protective isolation; see isolation procedures). The mask is attached to the back of the head—one strap—and in the neck, the other strap. Make sure that the mask is properly fitted over the nose. Do not use a mask that attaches to the ears.
- *Respiratory protection mask* instead of a surgical mask (severe airborne infections, tuberculosis and strict isolation—see isolation procedures) was attached to the back of the head—one strap/tie—and in the neck, the other strap/tie. Check that respiratory protection is properly fitted over the nose and around the mouth; check the leak test.
- Gown (for contact, blood contamination, airborne infection, strict isolation), waterproof, long and with good cuffs, tightly around the neck, preferably single use gown that is placed in the infection waste bag after use. **NB** The gown is tied on the back—not tied on the front.
- Gloves with long cuffs—(for contact, contaminated blood, airborne infection, strict isolation) solid and comfortable. Double gloves at high risk of transmission and blood-borne infection.
- Shoe cover—room-bound shoes, boots, overdrafts, etc. (norovirus, *C. difficile*, vomiting, diarrhoea, high pollution in the room, strict isolation).

15.4.12 In This Order, Take Off (Doffing) the PPE After Being on Infection Isolates [21, 22]

- Shoe protection, overdrafts, etc. if used, disinfect gloves (outside) before carefully taking off shoes/cover and place them in infection waste bag or waste container for shoes that can be autoclaved/disinfected. Put a doffed foot on a clean area in the sluice or directly in your own shoes.
- Hand hygiene—disinfect the outside of the glove.
- Gloves; grab the left glove at the wrist (not higher up) and gently turn inside out when doffing.
 - The inside of this glove is usually clean and can be used as a “cloth” placed on the right hand to grab through to remove the other glove.
 - Learn the technique. For left-handed do the opposite.
 - Can also be used to take off double gloves in one operation.
 - (In special situations like strict isolation or if contaminated hands: perform hand hygiene. Then take on new, clean gloves up to the wrists before doffing the gown).
- Hand hygiene.
- Gown; open the closure back.
 - Hand hygiene.
 - Grab the cuffs (clean because the gloves have covered them) and pull successively the cuffs over the wrists.
 - Do the rest of the doffing from inside the gown; arms off and carefully roll the entire coat away from both sides to the middle and then roll downwards—as “packing in” the contaminants of the gown—learn the technique. Place the used gown carefully in the waste container.
- Hand hygiene.
- Goggles: if used, take careful behind the head and bend forward, so the goggles do not come into contact with skin, hair or textiles—put in container for decontamination if using reusable goggles.
- Hand hygiene.
- Surgical mask/respirator mask; do not touch the front of the mask directly—be careful behind the head and neck. Bend forward and gently tilt so that the front of the mask does not come into contact with skin, hair or textiles. Loosen the band in the neck first and then on the head (the mask should not fall on the chest). Carefully place it in the waste bag.
- Hand hygiene.
- Cap or hood; grab the cap carefully back on the head and gently remove it. Bend forward to avoid contact with skin, hair or textiles. The cap is placed in the waste bag.
- Hand hygiene.

NB! In the case of airborne isolation and strict isolation, it is *never appropriate* to remove the PPE before going out from the patient’s room, in the sluice, *and* the door to the patient’s room should be closed. This applies only to an established

sluice function. If this function is missing, approved alternatives may be available, for example, a separate and enclosed corridor defined for this use. Contact infection control personnel.

- Take care with the movements during doffing to not release contaminants from the PPE into the environment.
- Take care when opening and closing doors to avoid unfortunate airflows [44].
- Multi-use of gowns where the same gown can be used for several persons entering the patient's room is not recommended because of problems with cross-contamination. If still in use, it must be properly hang up after use; with the outside of the gown *turned out*—in the patient room (at the door)—and the outside of the gown *turned in*—in the sluice. Gowns that are hang up incorrectly or are dirty or wet should be carefully put into the bag for contaminated textiles. Hand hygiene is done before taking on a new gown. The multi-use gown is changed for each shift or more often when contaminated. Never enter the corridor with a gown used for protection.

Isolation regimens should not be a hindrance for—but included in—diagnostics and treatment.

15.5 Background Information

See Chap. 21.

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