Tracing and Preventing Infections

5

Abstract

A total of 10–20% of somatic patients experience hospital infections during/after hospitalization. Pneumonia, sepsis, surgical site infections and urinary tract infections are most often associated with patient-related use of medical devices for approximately 65% of cases, while nontechnical equipment may be linked to 35% of cases. It is resource-intensive to detect the cause of infection outbreaks and even more expensive not to take action. Unexplained causes of outbreaks may lead to uncertainty and reduced activity at the hospital. To trace and prevent hospital outbreaks, joint efforts from hospital management, microbiology and infection control are needed. This chapter is focused on practical measures to trace and prevent hospital outbreaks.

5.1 Purpose

– To prevent spread of infections from patients, the environment or a specific source of contamination (food, water, airborne) to other patients, staff, visitors and environment by good, implemented infection control routines [1–4].
– To control by surveillance incidence of relevant microbes by point prevalence registration, by contact with clinical departments and by daily overview of microbes and resistance patterns, detected in the laboratory.
– To detect and stop the source of infection and transmission routes; risk areas for spread of infection, possibly secondary-infected patients (e.g. cross-infection

between patients in the same room), exposed personnel, visitors, environment, equipment, medicines, etc.

5.2   Comprise

Patients, personnel, visitors, routines, equipment, environment, etc., exposed to infectious patients or other suspected sources of infection.

5.3   Responsibility

The hospital management is responsible for the existence of an *infection control programme* which describes the necessary measures concerning general prevention of infections, biosecurity, survey of pathogenic microbes and infections, tracing of the source and transmission of infections and measures to control or stop the infection [4, 5]. The management is responsible for protection of patients, personnel, visitors and the environment from infections, by always isolating infectious patients. There should be surveillance of prevalence and incidence, daily microbiological reporting and rapid microbiological diagnostics. Infection control and the responsibility for preventing and halting outbreaks are on the hospital management in cooperation with the actual department's management and infection control staff [1, 4–7].

The head of each department is responsible for ensuring that biosecurity procedures and the *infection control programme* are implemented to inform hospital management and infection control personnel concerning suspected outbreak and to participate in tracing work.

The personnel are responsible for following biosecurity procedures and for informing the leader if there is suspected outbreak.

Infection control personnel are responsible for the daily monitoring and control of microbiological agents and unusual occurrence of infections/unusual microbes and for follow-up of contact, information, advice and action.

Others such as occupational health and safety/human sources department/union representatives, etc. are responsible for attending if the workplace/personnel is involved in—or exposed—or subject—regarding the spread of infection [8, 9].

5.4   Practical Measures

Unexplained causes of outbreaks (may take several days to weeks) may lead to uncertainty and reduced activity at the appropriate department(s) [10–13].

General prophylactic measures are often necessary for sustaining activity while tracing progresses [4].

5.4.1   Common Nosocomial Infection

Wound infection, respiratory tract infection, urinary tract infection, diarrhoea, etc., with or without any know microbial cause—onset in the hospital and not known before admission.

- Reviewed with the department management.
  - Microbial agent
  - Number of cases
  - Cross-contamination? Common source of infection?
- Sharpen routines for hand hygiene, and discuss other routines that may have been involved.

Nosocomial cases should be recorded consecutively as undesired events in computer systems to monitor infections over time.

5.4.1.1 Registration
- Name, age, when admitted and from where (other departments, nursing homes, etc.).
- Infection localization and date when discovered.
- Type of infection (pneumonia, wound infection, conjunctivitis, diarrhoea, urinary tract infection, etc.).
- Microbiological findings, possibly.
- The doctor writes a note in the patient's chart about presumed cause and progression.

5.4.2   Unusual, Serious, Extensive Infection with Onset (Infected) in the Hospital

Wound infection, systemic infection, pulmonary infection, renal infection, sepsis, blood-borne infection, etc., onset after admission and not known or in incubation phase upon admission.

Note: Patients with pre-known, isolation-requiring infection are expected to be isolated from the time of admission and should not constitute a risk to others.

Outbreak:

- One case *infected in the hospital* with particularly resistant and/or unusual microbe (MRSA, ESBL, VRE, other MDROs, *C. difficile*, tuberculosis, *Listeria*, *Legionella*, etc.). One case *infected in the hospital* with certain virus (influenza virus, norovirus, etc.). This applies also to personnel and visitors.
- Two or more severe cases infected in the hospital with an identical microbe or with similar clinical symptoms, time-related. This also applies to personnel and visitors.

- Many cases with the same clinical symptoms at the same or different departments, time-related.
- Deaths caused hospital infection; unusual cause or unusual number of patients.

Registration; see above under Sect. 5.1.

5.4.2.1 Information

The department management informs other departments/units/hospitals/nursing homes/home services, etc. that the actual infected patient has been in contact with. This also applies to infections with onset outside the hospital, prior to admission, but only known after admission. The patient's infectious status and risk of transmission are dependent on isolation procedures from the admission. See routines for information. Remember to inform the infection control staff and the director.

5.4.2.2 Tracing/Checking List for Routines

Review the case, as above; see Point I.

- *Break of routines?*—unusual work conditions, failing hygiene when using medical devices, other equipment, accidents, new routines, barrier breaches, etc.
- *Hand hygiene*—are routines for personal hand hygiene followed?
- *Procedures*—review current procedures (patient care, insertion of and care of catheters and needles, wound care, respiratory treatment, etc.) and check if there is discrepancy between practical and written practice of routines. In that case, could it matter? If the routine is changed, when and why?
- *Check*—technical equipment, other equipment, medicines, intravenous equipment; function and temperature of the decontaminator, instrument washing machine, dishwasher, autoclave and hygiene conditions in the decontamination room, kitchen, etc. Use internal control checklists; see separate chapter.
- *Cross infection?*—between two or more patients been on the same room, use the same equipment?
- *Isolation routines*—are contact and air isolation routines understood and followed?
- *Antibiotic consumption*—is there a high consumption of resistance-selecting agents such as clindamycin, third-generation cephalosporins, carbapenem, and ciprofloxacin (associated with ESBL, other resistant gram-negative, unusual rods, *Clostridium difficile*, MRSA)?
- *Contaminated water or ice dispenser?* (*Legionella/Pseudomonas* sp. and other gram-negative rods).
- *Respiratory infections?*—associated with the ventilator or other respiratory equipment/liquids?
- *Sepsis?*—associated with intravascular routines?
- *Urinary tract infection?*—associated with catheter use routines?
- *Imported infection (from abroad)?*—isolation, testing and where the patient has been in the hospital.
- *Exposed* to infection, inside or outside the department?

- *Transferred* from another unit with infection?
- *MRSA?*—MRSA tests of patients, of personnel and of the environment to investigate carrier status in exposed patients and employees.
- *Multiresistant bacteria?*—check the use of antibacterial agents, local and general in the hospital, and if more patients at the unit are infected with the same bacterial strain.
- *Group A streptococcus?*—postoperative wound infections after surgery in two or more consecutive patients. Check for identical bacterial strain and if so, check the operation team for carrier state.
- *Norovirus outbreaks?*—check that isolation procedures are followed, that the actual disinfection process has effect and that personnel and patients are isolated from other patients for at least 2 days after recovery and freedom for symptoms.
- *Clostridium difficile?*—outbreak; check that routines for the cultivation and detection of microbes and toxins and for isolation and disinfection are carried out, and check the use of clindamycin, third generation of cephalosporins and ciprofloxacin that all selects for *C. difficile*.
- *Active pulmonary tuberculosis?*—exposed patients in the same room and personnel; check that all are followed up by tuberculosis control. Search if the source of infection is initiated immediately. Usually by the infection control personnel in hospital together with the primary healthcare and a tuberculosis coordinator.
- *Infected with contaminated blood* (*hepatitis virus*, *HIV*, etc.)*?*—check routines for reporting and reviewing stab wound and other injuries; the first actions with disinfection of the wound, the reporting of injuries, vaccination (hepatitis viruses), spread of blood particles via splashes/drops and other risks in work with contaminated blood.

5.4.2.3 Limit the Spread of Infection

The department leader in collaboration with infection control personnel creates a plan to limit the infection outbreak—spread of infection. In all types of outbreaks, it is important to reinforce routines for hand hygiene, personal hygiene and general work routines (patient care, isolation treatment, serving, information beforehand about patients to be admitted, etc.). Consider the following from the proven or suspected infection:

- Isolation of infected patient—contact or airborne infection?
- Isolation of exposed patients until infection status is clarified—for example, norovirus or MRSA?
- Exposed personnel—the use of personal infection control equipment until infection status is clarified, for example, norovirus or MRSA?
- Exposed personnel—restricted tasks or workplace, in order not to spread the disease. Do not work anywhere else before test answers, for example, outbreak of norovirus or influenza?
- Delimit exposed ward/department to infection status is clarified, for example, norovirus and *C. difficile?*

- Restricted access to the unit? No new personnel into the unit, and no passing through the unit?
- Is information and training of personnel and the patients families needed?
- The extent of environmental disinfection in the unit? Disinfection of technical and other equipment exposed to infectious patients, carriers or the environment and consecutive disinfection of the entire department during major outbreaks.
- Suspected infection via food products (food and beverage)?—see separate chapter.
- Is internal control and risk analysis with regard to infection necessary?
- Does reduction or alternation of antibiotic consumption have an effect on the outbreak? [14, 15].

Depending on the date of infection and the time after the last detected case, special contraceptive measures are terminated in collaboration with infection control personnel. The report is written with feedback to the department and is used for closing deviations and for learning.

5.4.3   Operation Department: Postoperative Infections

Surgical departments have the cleanest rooms in a hospital, with controlled and filtered ventilation with positive air pressure, requirements for clean dressing of personnel and sterile conditions for the equipment. Nevertheless, infections may occur in surgery departments, for example, by introducing unsterile equipment, fluids or unsterile routines into the operating room.

A major outbreak of multidrug-resistant *Enterobacter cloacae* occurred in cardiac surgery patients who inadvertently got this type of bacteria around the heart through contaminated ice water ("sludge") [10, 12]. The bacteria came from the surgery department's room for treating, rinsing and collecting plaster waste into a container below the sink. Plaster is a good growth medium mixed with water, and more than 20 different resistant gram-negative bacteria types were detected in this container, including the special *Enterobacter* strain [10]. Despite a series of septicaemia and severe wound infections, all patients survived the infection, and the epidemic stopped after detection of the transmission routes [10–12]. Similar events are later also reported from other hospitals.

In the case of suspected serious infection occurring during operative treatment/other contact with the operating department:

- Enjoin the *lock function* to the surgical department: the use of special clothing, hand hygiene and controlled access. This applies to personnel, patients and relatives entering the department.
- Review the procedures for *preoperative* preparation of the patient.
- Was the patient infected or exposed to infection before surgery?
- Length of stay before surgery?—more than 1–2 days?

- Review the current *operating procedure*—is it in accordance with written procedures? Skin disinfection and coverage of defined operating area, array of surgical appliances, preparing of the patient, handling and covering of sterile instruments and equipment during surgery, the technique of the surgeon (tissue damage, blood loss, etc.), sterile clothing throughout the operation, safety concerning glove use, problems around and duration of the operative procedure and the use of sterile anaesthetic fluids and ventilation equipment.
- Enjoin the use of attire of the staff and of covering of skin, hair and ears and of removing the jewellery. This applies to all, including the anaesthesia personnel. Sharpen surgical hand wash and use sterile gloves. In the case of ultraclean surgery, air contamination is dominant and most bacteria come from the operating staff. Therefore, fewest (possible) participants should be present during the operation.
- Review written washing and cleaning procedures—wash with soap and water between each operation to remove biological material, disinfect after infected operations and follow procedures for major cleaning and disinfection. Main cleaning of all rooms in the operation department should be done twice a year.
- Check the temperature and the cleanliness of washing machines/decontaminator/autoclave/airing cupboard/sterile stock. This is logged in separate books.
- Check the cleaning, sterilization, storage and handling of sterile and clean equipment.
- Are there restrictions for traffic in and out of the operating room during the surgery? The overpressure on the operating room does not work when the door is open. There is suction of corridor air that has higher bacterial numbers.
- Are there restrictions on how many people can be in the operating room?
- Avoid air turbulence. Do not shake clothes/sheets, etc. and minimum speed of movements.
- Responsible waste treatment?—handle waste/use clothing and equipment carefully so that no aerosol is formed. Review routines.
- Unclean equipment into the surgical ward? Do not bring unsterile equipment, fluids for IV use, etc.—which has often been stored unsterile on corridors—into the operating room. Thoroughly wash/disinfect the surface before taking it in. Place this equipment in a place that does not come close to the operating team or sterile equipment.
- Avoid water sources that could lead to gram-negative bacterial growth in the operating room (heat exchangers, water mattresses, etc.). The connection (if manual, non-sterile) is almost always contaminated by gram-negative rods. Such links must be considered infected. Special connections must be done with utmost caution. Heat exchanger with a temperature scale of 5–45 °C can usually not be sterilized or be rinsed with boiling water (*Legionella* thrive in water of temperature 5–65 °C). Check bacterial and fungal growth in such water sources.
- Is the ventilation in order? Check air filter for regular operation rooms and for the ultraclean (laminar airflow rooms—LAF) × 2/year. Measurements performed by the technical department.
- Have the operating rooms overpressure? Does this work?

- Is the temperate air regulated from the outside? Heaters/refrigeration systems located in the operating department generate uncontrolled air circulation and must not be used (growth of fungi and bacteria are spread into the room together with skin cells and dust).
- Is the bacterial count in air (CFU/m^3) satisfactory?
- Beard is not recommended at work in a surgery department because of possible increased risk of infection.
- The room for surgical hand washing is not storage for sterile/clean equipment. Wet rooms are not storage spaces.

5.4.4   Intensive Department

Intensive care units are particularly vulnerable to outbreaks of resistant bacteria due to the lack of infection control around the patients (often placed in the same common bays), many entry ports for infection (catheter, surgical wounds, etc.), high consumption of broad spectrum antibacterial agents and densification and large spread of microbes in the environment, with a high risk of cross infection [16–18].

Intensive care units are often a "microbiological jungle" and can be a source of spread of resistant bacteria throughout the hospital as it was experienced at a hospital in Singapore with a total of 103 patients infected with multidrug-resistant *Acinetobacter baumannii* [19]. Risk for the spread of multiresistant bacteria such as *Pseudomonas*, related to some patients and a highly contaminated environment, can be reduced by good biosecurity measures in the unit [20]. Particularly neonatal units are relatively often contaminated by resistant bacteria like *Pseudomonas* [21]. Access to rapid identification of resistant bacteria is important to avoid cross infection in such heavily loaded and complicated departments [22].

In case of suspected serious infection during treatment at/other contact with the intensive care unit:

5.4.4.1 Review Written Procedures for
- Hand hygiene, including information of all visitors on arrival to the department.
- Hand hygiene and the use of gloves.
- Hand disinfection between each patient and before clean procedures?
- Uses the staff jewellery? Wristwatches?
- Are mobile phones, calling systems, etc. disinfected daily or more often if needed?
- Are stethoscopes, BP apparatus and other patient equipment disinfected after each use?
- Ventilator treatment; are cleaning and disinfection of the machines satisfying and following the procedures?
- Intravascular treatment—are procedures followed? Are the routines clear and complete? [23].
- For contact, airborne infection and the use of isolation, are hygienic routines followed?
- Attire and the use of patient-related care gowns; changed for every shift and taken from the storage of clean textiles?

- Space for proper suspension of patient-related care gowns—separated from other patients?
- General cleaning of all fixtures and disinfection following the procedure?
- What about washing the curtains and folding screen between patients?
- Cleaning and storage of medical equipment—satisfactory?
- Cleaning and storage of textiles—not exposed to infection?
- Clean and large enough storage area for sterile equipment?
- Cleaning of beds: MRSA, *Acinetobacter* species and many other microbes may survive for weeks and months in contaminated beds and can be transferred to the next patient [24].
- Storage space for large, non-sterile equipment—clean, and not mixed with uncleaned items?
- Treatment of infectious waste, of other wastes and of used textiles according to procedures?

5.4.4.2 Check Routines and Control of
- Washing machine/decontaminator/airing cupboard/sterile stock.
- Air filter, measurements carried out by the technical department.
- Ventilation, optionally target bacterial numbers in air (<150 CFU/m^3)—12–14 air changes per hour.
- New equipment/drugs, etc.
- The technical equipment from other departments are washed/disinfected before it arrives on the ward and after use.

5.4.4.3 Avoid
- Abrupt removal of compresses, shaking linen, etc. that can provide increased bacterial load in the air and increased turbulence.
- Unnecessary water sources (flowers, plants, etc.) where gram-negative bacteria are in continuous growth.
- Aerosols in the environment by suction, coughing, and mechanical ventilation.
- Contaminated curtains and the use of curtains.

5.4.4.4 Consider
- The risk of cross infection.
- The patient/nursing ratio.
- The area per patient, including technical equipment.
- Cleaning routines and opportunities to implement good housekeeping to avoid accumulation of dust generated from the general activity, skin cells, particles, dirt and from unpacking single use equipment, etc.

5.4.5 Other Clinical Departments

If a suspected serious infection occurs in connection with treatment/contact with a particular clinical department:

- Enjoin hand hygiene, hand disinfection and wearing of gloves according to procedures.
- Enjoin cough hygiene—it is not allowed to cough in work clothes.
- Review procedures for the care of the patient [25].
- Review procedures for handling infections and infectious waste [8, 9, 26].
- Check washing machines/decontaminator/airing cupboard/sterile stock. Temperature control.
- Enjoin treatment of contact and airborne infections and the use of isolation rooms.
- Review written procedures for general cleaning, disinfection, cleaning and storage of equipment. Technical equipment borrowed from other departments should be washed/disinfected before and after use.
- Avoid sudden removal of compresses, shaking linen, etc. that can provide increased bacterial load in the air and increased turbulence.
- Review procedures for intravascular and mechanical ventilation, if used.
- Review procedures for storage and the use of bandages and other sterile wound material. Bandages and other sterile equipment for wound change should not be stored in patient rooms or on open instrument tables.
- Ensure the quality of new equipment/drugs, etc.
- Assess the risk of cross infection and isolation conditions.
- Check patient/nursing ratio.
- Consider area per patient, including technical equipment.
- Check conditions with respect to corridor patients, shared toilets and showers.
- Moving and transporting patients between departments and medical institutions (transport of patients with infections) promotes spread of infection [27, 28].
- Check conditions with respect to part-time work at several institutions simultaneously—risk of infection.
- Check influenza vaccination for infection susceptible patients in influenza times.
- Personnel should be protected from air and contact transmission with influenza and other contagious agents and should stay at home while having symptoms.

5.5   Background Information

It is resource-intensive to detect the cause of infection outbreaks and even more expensive not to take action. An outbreak, for example, *Clostridium difficile*, prolongs hospitalization and often exceeds 20,000 USD per patient in extra costs [29].

A total of 10–20% of somatic patients experience hospital infections during/after hospitalization. Pneumonia, sepsis, surgical site infections and urinary tract infections are most often associated with patient-related use of medical devices for approximately 65% of cases, while nontechnical equipment is linked to 35% of cases [30].

Major infection outbreaks as in the Dent-o-Sept oral brush case in Norway, in February 2002, are exceptional [2]. At least 140 patients had serious infections of an oral brush contaminated with *Pseudomonas aeruginosa* and other gram-negative

bacteria. The brush was registered as "antiseptic." Microbiological control of patient-only disposable devices such as oral brushes/pencils did not exist.

Pseudomonas thrive in water and are causing outbreaks from shower, sink and water taps, especially in departments with infection-risk patients with development of sepsis and fatal course of pneumonia [31–33].The bacteria are associated with the lack of hand hygiene and long or artificial fingernails [34]. During a period of 15 months, there were 46 (10.5%) of 439 children in a neonatal intensive care unit infected with *P. aeruginosa*. Of these, 16 died (35%) [34]. The same bacterial types were detected on the hands of 3 out of 104 personnel and were associated with long nails or artificial nails [34].

Outbreaks of infection at the same time in one or more patients can be documented a few times each year. New, rapid gene technology more often detects the relationship between patients with infections, as shown in an outbreak of *Burkholderia cepacia* infection in 14 ICU patients, caused by contaminated indigo-carmine dye used in enteral nutrition [35].

Contaminated drugs often cause large spread of infection. Less serious drug manufacturers are constantly a cause of serious hospital infections such as in 2011 when 19 patients, of which 9 died, received *Serratia marcescens* in contaminated total parenteral nutrition [36]. At the manufacturer was the bacteria detected in environmental samples at a number of places in a sordid and unhygienic production process [36].

Resistant gram-negative bacteria survive in contaminated "sterile" fluids and equipment. This is also reported for fungi, mycobacteria and other new and unknown environmental bacteria such as *Elizabethkingia meningoseptica* [32, 33, 37, 38]. Factory-made food (powdered infant formula) for neonates in intensive care units have been contaminated by environmental bacteria *Cronobacter* (*Enterobacter sakazakii*)—with serious and fatal course [39].

Severe respiratory infections are reported to be caused by environmental contamination with multidrug-resistant bacteria such as *Acinetobacter baumannii* in an intensive care unit where 2% of environmental samples were positive [40]. A high consumption of antibacterial agents may promote risk of resistant *A. baumannii*—epidemics [17, 41]. In a surgical intensive care unit, 36% of 262 patients had hospital infection, and 37% of these were caused by cross-contamination between the patients [18]. Most gram-negative bacteria thrive in water, and resistance is promoted by the use of antibiotics [32, 33].

Hospital microbes are often robust survivors and live for a long period in the environment. The most antibiotic-resistant bacteria, like *Pseudomonas* and *Acinetobacter*, may survive in dry conditions in a "sleep state" in biofilms on surfaces, equipment, beds, respirators, etc. for many months to years. With a little moisture or transferred to the skin and mucous membranes, the bacteria start to grow again with fast propagation and doubling within 8–16 min. Many bacteria retain their resistance for long periods, even in the environment. Outbreaks are usually caused by such robust microbes that are spread by routine failure and failing hygienic barriers.

Staphylococci and enterococci follow the patients and personnel as a part of the normal flora, and resistance development is very common. Resistant MRSA and VRE are easily spread between patients, often via hands of personnel and via contaminated equipment and surfaces [7, 25, 42–44]. It is measured greater amounts of MRSA in the air than on the surfaces in departments with patients infected with MRSA [45]. Air contamination is an important transmission route for the spread of MRSA. Methicillin-sensitive *S. aureus* (MSSA) may have several resistance factors and can be transmitted to many other patients in departments with a high consumption of resistance-selecting antibiotics. A serious outbreak of gentamicin-resistant *S. aureus* occurred among premature at the neonatal intensive care unit, Ulleval University Hospital [46]. For a long period, there had been a high consumption of gentamicin as a standard treatment when suspected infection in the neonates. *S. aureus* isolated from the patients were regularly not tested for resistance against gentamicin [46]. The department was unaware of the resistance to gentamicin, selected out by gentamicin as routine treatment [46]. Children were infected with this gentamicin-resistant strain, causing sepsis and pulmonary infections, and the strain was also detected in several samples from the environment [46].

Legionella infections are usually the result of the lack of control and maintenance of water systems. Legionella attacks the most vulnerable patients with high mortality rates [2, 47–49].

Listeria causes serious infections in patients with severe immunodeficiency, colon disease, and cancer or in pregnant women. The focus must be directed on the quality of food and beverage, unpasteurized food products and fresh toppings that go against the date of end. Also water may contain listeria, especially living in water amoeba [2].

A serious type of hospital infection (septicaemia, mediastinitis, infection in vascular prosthesis, peritonitis, pneumonia, blood-borne infection, etc.) that occurs almost simultaneously *in two or more patients* may give rise to suspect human error, the disruption of routines or error in medical treatment or medical technical equipment. Patients with the same symptomatology and/or apparently identical microbiology may involve a common source of infection or joint pathway.

Limitation of spread of infection depends on rapid and effective microbiological diagnostics, as in MRSA screening with responses within a few hours [50, 51].

5.5.1   Outbreak of Infections in Hospitals (Nosocomial Transmission) Is Described as Follows [4, 52]

(a) Suspected *epidemic* outbreak if many persons (>3–4) are consecutively becoming sick with the same or similar illness (gastroenteritis, respiratory tract infections, etc.) in the ward, department or hospital. This includes both patients and staff.

(b) Suspected outbreaks with microbes obliged to be *isolated* from other patients (see separate chapter):

- *Contact transmission, mostly* (*Salmonella*, *Shigella*, *Campylobacter*, *Yersinia*, other entero-pathogenic bacteria, *Clostridium difficile*, VRE, ESBL, hepatitis A, rotavirus, etc.)
- *Contact and droplet/airborne transmission, mostly* (tuberculosis, MRSA, entero-haemorrhagic *E. coli* (EHEC), respiratory infections with other multidrug-resistant bacteria, influenza, varicella, morbilli, RSV, norovirus, SARS, MERS, haemorrhagic fever viruses, etc.)

(c) C. Repeated instances (two or more) of *serious* postoperative or other infections where there is suspected common source of contamination/infection source/infectious agent and/or breaks in infection barriers. Includes cases infected with unusually resistant bacteria.

(d) D. Suspected serious *blood contamination* (hepatitis, HIV) or other serious infections transferred to the patient or staff.

5.5.2   Important Reasons for the Spread of Nosocomial Infections Are

- Failing hand hygiene and the lack of ability to implement good hand hygiene.
- Lack of infection control programme.
- Missing or misunderstood monitoring of hygiene guidelines.
- Lack of infection control in the handling of medical and medical technical equipment.
- Frequent and high use of antibacterial agents.
- Lack of isolation of patients with contagious infections.
- Infectious disease carriers in the environment.
- Understaffing of health professionals (especially nurses) [6, 7, 42, 53].
- Too many short-term temporary workers, part-time employees and too large rotation of personnel [54].
- Overcrowding; too close between patients and too many patients in each room [6, 7, 42, 43].
- Frequent transfer of patients between departments and institutions (increases risk x 4 for hospital infection) [27, 28, 55].
- Mixing of patient categories (patients with infections in the same room as patients without infections).
- Shared use of medical and other patient associated equipment between patients and wards without adequate cleaning and disinfection after each use.
- A poor structure and functional state of the ward/department; missing or not satisfactory service rooms and bathrooms/toilets for patients; run-down buildings that may complicate cleaning and effective work; two or more patients on the same room, overcrowding, and a capacity that is less than demanded for the population served, leading to corridor patients.
- Hospital network may promote spread of infections. Antibiotic-resistant bacteria and other microbes accompany patients and personal who travel in the hospital networks, including networks of nursing homes, leading to increased spread—

dispersal—of hospital-pathogenic microbes [27, 28, 55]. This is demonstrated for hospital networks in the United Kingdom and is expected to increase by centralization and reorganization of the patient flow [28, 55].

- Inadequate follow-up of cases with infections—from infection control personnel [56].
- See also specific chapters on surgical site infections, pneumonia, urinary tract infections, intravascular infections, neonatal infection, MRSA, etc.

5.6   Notification and Warning on Suspected Infection and Dissemination

5.6.1   What Should be Reported? [57]

(a) Suspected *epidemic* outbreak in which many (> 3–4) eventually become sick with the same/similar clinical symptoms and course of disease (gastroenteritis, respiratory infections, etc.) on ward, department or in hospital. This includes both patients and staff [58].
(b) Suspected microbial agents obliged to isolate. More about the specific microbe in Reference 2.
(c) Repeated instances (two or more) of *serious* postoperative or other infections where one suspect same source of infection/transmission route/infectious agent and/or breaks in infection barriers.
(d) Suspected serious *blood contamination* (hepatitis, HIV) or other serious infections transferred to the patient or staff [2, 57–60].
(e) Suspected of deaths caused by hospital infection.

5.6.2   To Whom Should it be Reported?

- Department management, the doctor on duty and responsible physician in primary care.
- Infection control department.
- The hospital medical officer—occupational health (for suspected infection transferred to personnel, for example, tuberculosis).
- The hospital management (by death, resource-intensive measures).
- The National Institutes of Health and the county administrative officer for some obliged notifiable infections, according to the Infection Control Act or defined routines.
- Remember nominative notifiable diseases.

5.6.3   Who Should Report or Warn?

- Responsible physician, attending physician, nurse, medical supervisor, infection control personnel and responsible physician in primary care.

- Department of microbiology (the detection of special agents/resistance patterns/clinical information).
- The occupational health (for suspected serious infection transmitted to staff).

5.6.4 How to Notify or Warn and How Often?

- Daily when there is outbreak; telephone, telefax (NB not patient name) or written messages.
- Evaluated by the professional responsible for the relevant department together with infection control personnel, according to the extent and severity of the outbreak.

5.6.5 Coercive Measures When Proven Hazardous Infection to Public

In a few cases, leads notification and contact tracing to enforcement action by law; in Norway by the Infection Control Act of 01.01.1995, with compulsory medical examination and compulsory isolation in hospitals; § 5.2 and § 3.5 [61, 62]. It has happened a few times in connection with infectious pulmonary tuberculosis.

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