



## Abstract

Scenarios for serious, infectious diseases are important procedures used to understand the special microbe's behaviour (clinical illness, spread of infection, etc.) and how to act most rational during special dangerous outbreaks. Furthermore, scenarios describe how to handle patients, personnel and others possibly exposed to infections,- outside and inside the hospital- to stop spread of the infection as soon as possible. Today, it is not acceptable to place a patient with a known high-risk, serious infection in the same hospital room as other patients with not the same disease (WHO). In this chapter, some seldom but realistic scenario is described to better understand how to react and treat patients to stop spread of microbes during the primary phase of dangerous transmittable diseases.

## Keywords

High-risk microbes · Scenarios · Transmittable dangerous agents · Lassa/Ebola/SARS/MERS/Nipah/avian influenza and other viruses · Anthrax/pest/cholera/diphtheria and other specific dangerous bacteria · Emergency · Preparedness Crisis management · Infection control · Isolation · Disinfection

## 82.1 Purpose

- Describe some rare but not unthinkable scenarios in the primary phase of dangerous transferable diseases.
- Describe certain important scenarios and practical measures to avoid spread of life-threatening disease among roommates, other patients or personnel, equipment or environment [1–3].

*Current agents are described in more detail in: Andersen BM. Part 1. Microbiology and infection protection. Fagbokforlaget 2014.*

## 82.2 Comprise

- All personnel who are the first in contact with the infected/exposed person, relatives, other contacts and environment.
- *It is not acceptable to place a patient (with not defined same disease) in the same room with a patient with known high-risk infectious disease (WHO).*

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## 82.3 Responsibility

*The hospital's management* provides written plans for how to react in situations where personnel and others may be exposed to known/unknown serious communicable disease and a practical arrangement for how to handle the situation.

The *infection control officer* at the level of where the problem occurs, and at the departments/ward where the infection may spread, is responsible for following local emergency plans.

Personnel who unprotected have come in a seriously contagious situation and may have been exposed to infectious agents are responsible for contacting the nearest responsible/infectious unit for advice and of following written guideline and practical advice.

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## 82.4 Practical Measures [4]

- *The patient* (infected/suspected infected) is usually relatively easy to deal with since there are guidelines for preventing spread of infection and treating the patient for the current disease; *see isolation routines*.
- *Contacts exposed to infection* are often worse to handle since it may be larger numbers of people (travel company, etc.) and because fear of being infected itself creates uncertainty. Therefore, some imaginable scenarios are made that deal with infected contacts.
- *Transport by ambulance*. All transport of infectious patients from the place of arrival to the hospital should take place in ambulances using the same infection control regime as for the individual infectious disease (contact infection, airborne infection, strict isolation); *see isolation regimes; Chaps. 14–19 and chapter on transport of patients; 75. The infection regime should be in accordance with information/suspected findings and contact infection control personnel to ensure that this is the correct isolation level*.
- Always use respiratory protection and PPE in case of suspected pulmonary tuberculosis and other highly infectious, severe diseases, and use a surgical face mask or respiratory protective device (P2-P3 mask without valve) on all patients with respiratory symptoms.

## 82.5 Scenarios

### 82.5.1 Suspected *Viral Haemorrhagic Fever (VHF)* or Similar High-Risk Infection [4–6]

(Lassa, Ebola, Marburg, Machupo, Guanarito, Junin, Sabia, Nipah, Congo-Crimean, etc.)

#### 82.5.1.1 Patient: Strict Isolation Airborne Infection in Isolate with Negative Air Pressure

*Example: person from Liberia visiting relatives in Oslo in spring 2014. Sick 10 days after arrival in Oslo.* He attended a number of family gatherings. At the onset of disease (*fever, respiratory symptoms and skin bleeding*), he lived with a family of eight people in Oslo. Medical contact was taken after 3 days of illness. In all, there had been 20 contacts with the patient after he became ill, and before Ebola virus, infection was suspected. He was admitted directly to the isolate for airborne infections with direct access from outside. Ambulance staff was pre-equipped (PPE) for transport of patients suspected of VHF. The municipality's infection control doctor is notified and takes responsibility for the message, measures and follow-up outside the hospital together with the emergency preparedness group for the municipality.

- *Unlikely in countries like Norway.* However a verified Ebola patient was imported autumn 2014. The patient came to the country as a high-risk infection patient and treated as such at Ullevål University Hospital, Oslo.
- *Quarantine disease.* Usually no more than one to two cases that (unexpectedly) get symptoms in Norway or while travelling to Norway. It is most likely that the symptoms come after arriving to Norway (2–21 days of incubation).
- *Registration.* Close contacts (name, address, telephone number and contact level with the patient). If sick on plane/boat/train, etc. to Norway, fellow passengers (same cabin/room/flight) must be registered.
- *Ambulance personnel and other personnel use—in suspicion—infection control routines for VHF on contact and transport of the patient (see serious viral disease and personal infection prevention).* Use respiratory equipment (P3 mask) and personal protective equipment (PPE), and put on a surgical mask on the patient.
- *Remember! Once too much is better than once too little!*
- *Risk of spread of VHF.* There is no significant risk of infection in Norway if the proper use of protective equipment is used when handling such patients. The Ebola outbreak in 3 African countries in 2014 showed that almost 30,000 were registered ill, more than 11,000 died, 800 health professionals became ill and more than half of them died. Lack of use of PPE and proper infection control led to escalation of the epidemic. The staff used only 1 m distance from the patient

as a zone of infection, as recommended by the WHO and CDC, and lacked protection for the head, hair and neck when within the 1 m zone and used only ordinary masks [7–10]. This occurred despite the fact that Ebola is defined as a high-risk, biosafety level 4 infection in which airborne infection could be relevant [11–14]. The epidemic declined from 14 September 2014, following the introduction of more proper use of personal protection equipment and infection control routines [11, 12, 15].

Contacts are differentiated after infection risk:

1. *High-risk contact*: physical contact with VHF, or with blood secretion or excretion. Healthcare staff, ambulance staff, laboratory staff, family or others who have treated the patient before admission.
2. *Low-risk contact*: been in the same room with the patient after the onset of the disease, but not in direct contact with the patient, equipment or others in the room. Examine the contacts; measure temperature two times for 3 weeks.
3. *Transmission from healthy contacts is considered unlikely*. However, everyone who has been in the same place at the same time with a VHF sick patient should be informed and followed up.

### 82.5.1.2 Monitor Contacts at Home

If probable or verified VHF, inform the contacts—low chance of infection:

- The contacts keep calm at home and measure the temperature daily two times for 3 weeks after the last contact with the index patient. No crowding with many people and no use of collective traffic.
- If temperature 38 °C or more, or rash/flu symptoms/sickness, contact the infection medical department.
- If this cannot be achieved at home, the contact may come to defined outpatient clinic for temperature measurement by appointment or is admitted to hospital.
- Served with food, etc. brought out from store to door, possibly, while isolated at home.

### 82.5.2 Multidrug-Resistant Bacteria: Outbreak of Infection

MRSA (methicillin-resistant *Staphylococcus aureus*), vancomycin-resistant MRSA, penicillin-resistant pneumococci, super-resistant gram-negative bacteria (ESBL, CRE, CP, NDM-1 bacteria), multidrug-resistant tubercle bacteria (tuberculosis), vancomycin-resistant enterococci (VRE), etc. evaluated in collaboration with microbiological laboratory. This was especially observed during the major tsunami disaster in 2004 [16]. Serious problems can occur in areas with melioidosis and other highly virulent bacteria.

### 82.5.2.1 Patient: Isolated in Accordance with Bacterial Type and Routines (Contact and/or Air Isolated)

In hospital, not usually many at the same time, but dependent on endemic situation. The patient can be contact or air isolated, depending on the infectious agent.

- *Registering* of direct contacts—depending on the infectious agent (name, address), and include where the patient have been earlier (information).
- *Ambulance* personnel and other personnel use routines for the relevant infection type according to *isolation procedures* and in accordance with emergency department's report. In case of doubt, contact infection control personnel.
- Use respiratory protection, P3 mask, if suspecting pulmonary tuberculosis, and put a surgical mask or P2/P3 mask without a valve on the patient in case of suspected pulmonary tuberculosis or respiratory tract infection.

Contacts/carriers—differentiated follow-up—low chance of getting sick:

1. Treated/controlled by the municipal infection control team in collaboration with infection protection personnel according to the type of infection.
2. Carriers live at home with eventually contact infection restrictions as defined and followed up by the Municipal Infection Surveillance Authority.
3. During stays at nursing homes, other hospitals, and in home nursing, these are followed up by the municipal infection physician/institution's physician in collaboration with infection control personnel.
4. In case of pulmonary tuberculosis, follow the defined guidelines for the control and follow-up of unprotected contacts according to defined routines (tuberculin test, screen check, clinical examination; *see separate chapter*).

## 82.5.3 Notification of Air Passengers with “Cholera” at Oslo Airport

### 82.5.3.1 Patient Is Contact Isolated

*Example:* Three people in a Norwegian travel company get voluminous, watery, painless diarrhoea on return from Bangladesh, just before landing at Oslo Airport, Gardermoen. Due to a loss of fluid, they were transported with an ambulance equipped for “import infection” and admitted directly into contact isolation. Municipal infection control doctor is notified and is responsible for reporting, measures and follow-up outside the hospital together with the municipal emergency response group.

This is one of the old, major quarantine diseases. Only a few get sick (top of the iceberg), i.e. 1–4 patients out of 1000 infected. There is a low mortality by proper treatment (<5%). The transmission risk is relatively low due to good hygiene and good sanitation in today's Norway and other developed countries. Most patients are shedding bacteria in large amounts and are also carriers without symptoms. Patients are isolated with contact isolation regimens.

The infection can reach unmanageable heights in disaster areas, by hunger, contaminated water supply and destroyed infrastructure. Following the natural disaster in Haiti, cholera was introduced with infected helper crew from Asia (carriers), and an epidemic started in 2010, which in 2013 had increased to 670,000 cholera patients, 370,000 hospitalized and 8200 deaths [17].

- *Registering of contacts* and remaining passengers in the airplane and from same travel company (name, address, telephone number).
- *Ambulance staff* and other personnel use the contact regime. If risk of spills, etc., use also surgical mask, visor and cap in addition to gloves and gown/overall.

Contacts/carriers of infection—low chance of getting sick:

1. Sampling (feces sample) from close contacts—those that may have the same source of infection as the index case (same travel company).
2. Enhance hand hygiene and personal hygiene for all.
3. Contact outpatient clinic for infections directly by gastrointestinal symptoms—contact by phone in advance.

## 82.5.4 Diphtheria After a Bus Trip to Moscow

### 82.5.4.1 Patient: Strict Isolation—Airborne Disease Isolation with Negative Air Pressure

*Example:* An elderly woman who recently attended a bus trip to Moscow became sick 2 days after returning to Oslo. She had sore throat, fever, cough and eventually a white, firm-sitting “plaque” in the throat. She was hospitalized after 3 days because of suspected diphtheria. Contact persons and other close contacts were contacted for follow-up and treatment with erythromycin (according to resistance pattern).

Municipal infection control doctor is notified and is responsible for reporting, measures and follow-up outside the hospital together with the municipal emergency response group.

Diphtheria may still be periodic problems in Eastern Europe and many places in the world. Vaccination status is good in children in most countries but more uncertain in elderly, especially in women. This is a contact and airborne infection, relatively highly infectious. There are probably few cases in an outbreak due to herd immunity. Patients are isolated with air and contact isolation regime until free from bacteria (negative culture). A historically serious infectious disease also in Norway, with high mortality rates until the middle of the last century [18]. Ullevål Hospital, Oslo, introduced treatment with the diphtheria serum in 1914 and achieved an impressive response—from 20–35% mortality to 3–5% [19].

- *Registering:* All exposed persons (name, address, telephone number) and follow-up; see below.

- *Ambulance staff* and other personnel use the contact and airborne infection regime when picking up and transporting a patient. Use respiratory protection, visor and cap in addition to gloves and gown/overall, and put a surgical mask on the patient.

Contacts/carriers of diphtheria are differentiated—vaccination protects against disease:

1. Sampling (nasopharynx samples) of *all* exposed persons (even if vaccinated and are not sick, you may be a carrier).
2. Prophylactic/therapeutic treatment with erythromycin may be initiated rapidly.
3. If living at home, others should not be exposed to infection/carrier state.
4. Short-time airborne isolation may be relevant for carrier or exposed to infection until the infection state is clarified/effect of antibacterial therapy.
5. Booster vaccine against diphtheria is considered for all contacts.

## 82.5.5 Lung Pest Plague After Stay in Madagascar, Sick on the Plane Home

### 82.5.5.1 Patient: Strict Isolation—Negative Air Pressure Isolation

*Example:* A person of a family of five who has stayed in Madagascar for a month got sick on his way home to Norway. He coughs, has fever and develops skin rashes that resemble big boils, especially in the groin. He was admitted directly to strict isolation in hospital and suspected of serious import infection.

The municipal infection control doctor is notified and is responsible for reporting, measures and follow-up outside the hospital together with the municipal emergency response group.

- *Quarantine disease:* Periodic problem in the East Asia, especially India, and ongoing outbreaks in Africa, Namibia and Madagascar. Pest may be a war-related disease (biological warfare). Untreated dies more than 50% of the cases while, with streptomycin treatment, less than 5%. This is a typical airborne disease, relatively highly infectious when respiratory tract symptoms. There is usually small outbreak with few cases (1–2). Air and contact infection regime until free for bacteria. In November 2014, new pest outbreaks were reported in Madagascar. About 120 patients got sick, of whom 40 died of bubonic plague [20]. The infection spread rapidly between humans and “killed quickly” [20]. Multidrug-resistant *Yersinia pestis* is described in this country [20].
- *Registering:* All infected persons (same travel company, all in the same flight home) are registered (name, address, telephone number) and followed up.
- *Ambulance staff* and other personnel use the contact and airborne isolation regime when picking up and transporting a patient. Use respiratory protection (P3 mask), visor and cap in addition to gloves and gown/overall, and put a surgical mask on the patient.

All close contacts/carriers are isolated to infection state is clarified—little chance of getting sick:

1. Sampling from all exposed persons
2. Prophylactic/therapeutic treatment, eventually vaccine
3. Short-time airborne isolation of exposed cases until the infection state is clarified/effect of antibacterial therapy

## 82.5.6 Anthrax After Staying in Turkey, Sick on the Plane Home

### 82.5.6.1 Patient: Strict Isolation—Air Pressure Isolate with Pressure [21, 22]

*Example:* Two out of six people who have been on family visits in Turkey for a week, on farms with goats and skin production, are acutely ill on the plane home with cough, shortness of breath and fever. Upon arrival, the emergency outpatient clinic was contacted by the patients who were immediately transferred to intensive care unit for airway symptoms and suspected import infection. At the hospital, anthrax is suspected, and patients are strictly isolated in air isolate and treated.

Municipal infection control doctor is notified and is responsible for reporting, measures and follow-up outside the hospital together with the municipal emergency response group.

- *Endemic problem* in several places (Asia, Africa, Middle East, North and South America), war-related (biological warfare). Varying number of cases of anthrax at outbreaks during peacetime, depending on how many people have eaten, for example, infected food, etc.
- *Symptoms:* 95% are cutaneous, 5% are respiratory, and a few cases are gastrointestinal anthrax. The latter two are two-phasic and almost always fatal.
- *The bacterium *Bacillus anthracis** is a spore-forming, resistant, gram-positive rod that survives nearly infinity in the environment if not removed. The bacteria are usually penicillin-sensitive.
- *Infection:* Person-to-person infection is unlikely, but hospital infection is described. Air and contact regime is conducted around such patients in hospitals until free of bacteria (ca 24 h treatment); however spores may survive for a long time.
- *Registering:* All directly exposed persons are registered (name, address, telephone number) and followed up.
- *Ambulance* personnel use contact and airborne regime for patient pickup and transport. Use respiratory protection (P3 mask), visor and cap in addition to gloves and gown/overall, and put a surgical mask on the patient.

Contacts/carriers—low risk of getting sick:

1. Sampling and antibacterial treatment are offered to all contacts that may have a common source of infection with the index patients (travel company, co-passenger). Person-to-person transmission is unlikely.



2. Vaccine may, in addition to antibacterial treatment, be applicable to people with a common source of infection with the index patients—when risk of large outbreaks (note that vaccination should be discussed due to some serious adverse reactions).
3. While waiting for result of the sampling, close contacts live at home with contact isolation restrictions.
4. In case of detected anthrax in contact (incubation phase for disease 3–7 days), the person is isolated and treated, and vaccination may be assessed for close contacts.

## 82.5.7 Rabies

### 82.5.7.1 Patient Is Isolated

This is an endemic problem among wild animals in most countries. Person-to-person transmission is unlikely. It is almost never reported more than one case at a time, infected by animal bites or licking but occasionally without known exposure. Close contacts/exposed persons are registered.

- *Registering*: All exposed persons are registered (name, address, telephone number) and followed up.
- *Ambulance staff* and other personnel use the contact and airborne regime when picking up and transporting a patient. Use respiratory protection and PPR; put a surgical mask on the patient.

Contacts/exposed—low chance of getting sick:

1. Close contacts/exposed persons are assessed for vaccine and rabies immunoglobulin.
2. Followed up at the infection outpatient clinic.

## 82.5.8 SARS and MERS: See Separate Chapter

Patients and contacts are treated just like at VHF.

## 82.5.9 Avian: Pandemic Flu (API) (See Separate Chapter)

Patients and contacts are treated mainly like VHF.

## 82.5.10 New Contagious Severe Disease: Unknown Agent and Pathway

See also SARS and bird flu.

New infectious diseases and agents still appear, for example, SARS, avian viruses (H5N1), HTLV and other retroviruses, HPV, sindbis virus, parvovirus, bocavirus, coronavirus, etc., or bacteria like *Legionella* and *Borrelia*, or agents with virulence changes, like group A streptococci, meningococci, etc.

- *Biological terrorism* made anthrax, plague, botulism, *Coxiella*, *Brucella*, VHF, poxviruses and a number of other unusual agents more appropriate as biological weapons [21–41].
- *Bacteria* sensitive to common antibacterial agents will probably not be a major problem.
- *Viruses* with no vaccine or treatment against low infection dose and high capacity to survive will be a major problem if associated with incurable disease, disability or death.
- It is probable that this will be a problem first in countries with low hygiene standards/high population density.

If the infectious agent is unknown, transmission ways are unknown and the situation is uncertain or uncontrollable, this practical measure may be followed:

Patient and contacts: strict isolation—negative air pressure isolation

1. Serious illness: isolation of index case and all contacts
2. Less severe disease: isolation of index case and close contacts
  - *Registering*: All exposed persons are registered (name, address, telephone number) and followed up.
  - *Ambulance* personnel use contact and airborne regime for patient pickup and transport. Use respiratory protection (P3 mask), visor and cap in addition to gloves and gown/overall/shoe covers/dedicated shoes, and put a surgical mask on the patient.

### 82.5.11 Other Dangerous Agents/Infections

- *Botulism* is caused by a bacteria-produced toxin (*Clostridium botulinum*) that causes paresis and is common in soil as spores. The disease can be associated with toxin formation in contaminated and poorly canned foods, shrimp fish, bacon, etc. under anaerobic conditions and randomly affects both healthy people and vulnerable groups, such as infants who have had honey infected with the bacterium, which has happened repeatedly [42]. The toxin is the most dangerous we know and is on the list of bioterrorism.
- *Brucella* bacteria (zoonosis) are particularly related to laboratory outbreaks but are easily transferable outside the laboratory and are considered highly infectious. [43]
- *Francisella tularensis* (zoonosis) is defined as a category A bioterrorism agent, highly infectious and increasing in the society, has low infection dose (10–25

- bacteria) and can be inhaled or infected via food and water. Occasionally, such patients are detected in hospitals, even in the operating department [44].
- *MERS—Middle East respiratory syndrome*—newly discovered coronavirus zoonosis (dromedaries, bats, etc.) and acts as SARS, also with a tendency for nosocomial spread in hospitals. In 2015 there were 1100 cases, of which 40% died [45].
  - *Polio-like illnesses*, especially among children, were discovered in August 2014 in different states in the United States. Probably caused by enterovirus D68 [46].
  - *HIV—aggressive variants (CRF19)* have been detected in Cuba in 2015 and earlier in Africa, with a faster course from infection to AIDS development [47].
  - *Prion disease—new Shy-Drager syndrome* is rediscovered in 2015; multiple-system atrophy (MSA) [48].
  - *Ricin* is a plant-derived toxin that is still used for bioterrorism in letters to, among others, President Obama [49].
  - *Fungi and mould*: different types that are especially related to floods, water damage, etc. and to pollution of medical products [50–53]. In Norway, a recent overview of candida in blood cultures showed a stable state for the past 22 years [54].
  - *Zika virus*: newly discovered flavivirus with mild to serious symptoms and teratogenic effect [5].

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