Infection prevention and control of epidemic- and pandemic-prone acute respiratory infections in health care

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Contents

Tables

Figures

Foreword

This document is an update to the World Health Organization (WHO) interim guidelines *Infection prevention and control of epidemic- and pandemic-prone acute respiratory diseases in health care* (2007). These updated guidelines incorporate the emergency guidance given in the WHO publication *Infection prevention and control during health care for confirmed, probable, or suspected cases of pandemic (H1N1) 2009 virus infection and influenza-like illness* (2009). The revision was informed by both evidence that has emerged since the first edition was published and the practical lessons learnt during the influenza pandemic in 2009.

The WHO Guidelines *Infection prevention and control of epidemic- and pandemic-prone acute respiratory infections in health care* provide recommendations, best practices and principles for non-pharmacological aspects of infection prevention and control (IPC) for acute respiratory infections (ARI) in health care, with special emphasis on ARI that can present as epidemics or pandemics. The guidelines are intended to help policy-makers, administrators and health-care workers to prioritize effective IPC measures.

The document also provides guidance on the application of basic IPC precautions, such as Standard Precautions, and on the importance of maintaining appropriate IPC measures in routine circumstances to strengthen a healthcare facility's capacity to put them into practice during outbreaks. These measures should therefore be part of the hospital's permanent IPC strategy, and we hope that the guidelines will help in the implementation of IPC programmes both at national and health-care facility levels.

The development of the guidelines followed the process established in the WHO handbook for guideline development, which involved active participation of the Global Infection Prevention and Control Network (GIPCN). The resulting recommendations were peer reviewed by internal and external experts.

WHO remains committed to providing guidance for the prevention and control of health-care associated infections in all circumstances. We believe these guidelines will contribute to improving health-care practices worldwide.

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Abbreviations and acronyms

ACH	air changes per hour
ARI	acute respiratory infection
ASTM	American Society for Testing and Materials (now ASTM International)
BFE	bacterial filtration efficiency
BiPAP	bilevel positive airway pressure
CDC	Centers for Disease Control and Prevention, Atlanta, US
CoV	Coronavirus
EU	European Union
FDA	Food and Drug Administration (US)
FFP	filtering facepiece
GIPCN	WHO Global Infection Prevention and Control Network
GRADE	Grading of Recommendations Assessment, Development and Evaluation
HEPA	high-efficiency particulate air
IHR	International Health Regulations
ILI	influenza-like illness
IPC	infection prevention and control (in health care)
NIOSH	National Institute for Occupational Safety and Health (US)
L/s	litres per second
m	metre
OR	operating room
PPE	personal protective equipment
ppm	parts per million
RCT	randomized controlled trial
RSV	respiratory syncytial virus
RT-PCR	reverse transcriptase-polymerase chain reaction
SAR	Special Administrative Region (Hong Kong)
SARS	severe acute respiratory syndrome
SARS-CoV	severe acute respiratory syndrome coronavirus
TB	Tuberculosis
UVGI	ultraviolet germicidal irradiation
WHO	World Health Organization

Glossary

Acute respiratory diseases

Acute upper or lower respiratory tract diseases, frequently infectious in etiology, that can result in a spectrum of illnesses, ranging from asymptomatic or mild infection to severe or fatal disease. The severity depends on the causative pathogen, and on environmental and host factors.

Acute respiratory infection

An acute respiratory tract disease that is caused by an infectious agent. Although the spectrum of symptoms of acute respiratory infection (ARI) may vary, the onset of symptoms is typically rapid, ranging from hours to days after infection. Symptoms include fever, cough and, often, sore throat, coryza, shortness of breath, wheezing, or difficulty in breathing. The pathogens that cause this disease include influenza virus, parainfluenza virus, rhinovirus, respiratory syncytial virus (RSV) and severe acute respiratory syndrome coronavirus (SARS-CoV).

Acute respiratory infections of potential concern

Infections in which the pathogens can cause outbreaks on a large scale or with high morbidity and mortality. Examples include SARS-CoV (Section 1.3.1), new influenza viruses causing human infection (Section 1.3.2) and novel ARI pathogens with the potential for a high public health impact (Section 1.3.3).

Adequately ventilated patient room or area

A room or area that has an adequate ventilation rate without controlled direction of airflow. For a naturally ventilated general ward room, adequate ventilation is considered to be 60 litres/second (L/s) per patient (*1*). For a mechanically ventilated single room, adequate ventilation is considered to be at least two outdoor air changes (ACH) per hour and at least six total ACH per hour (*2*).

Aerosol-generating procedures associated with increased risk of pathogen transmission

Medical procedures that have been reported to be aerosol-generating and consistently associated with an increased risk of pathogen transmission (Annex A).

Air changes per hour

See Environmental ventilation rate.

Airborne Precaution room

A room with high ventilation rate and controlled direction of airflow that can be used to contain airborne infections (*1, 3-5*) and ARIs caused by a novel agent with the potential to pose a public health risk (*6, Article 1*). An Airborne Precaution room can be naturally or mechanically ventilated (Annex B):

- In a *naturally ventilated* Airborne Precaution room, the airflow should be directed to areas free of transit, or should permit the rapid dilution of contaminated air into the surrounding areas and the open air; the average ventilation rate should be 160 l/s per patient (*1*).
- In a *mechanically ventilated* Airborne Precaution room, negative pressure is created to control the direction of airflow; the ventilation rate should be at least 12 ACH (*3, 7*).

Such a room is equivalent to the "airborne infection isolation room" described by the CDC (*8*).

Airborne transmission

The spread of an infectious agent caused by the dissemination of droplet nuclei that remain infectious when suspended in air over long distances and time. Airborne transmission can be further categorized into obligate or preferential airborne transmission (*9*).

- *Obligate airborne transmission* refers to pathogens that are transmitted only by deposition of droplet nuclei under natural conditions (e.g. pulmonary tuberculosis).
- *Preferential airborne transmission* refers to pathogens that can initiate infection by multiple routes, but are predominantly transmitted by droplet nuclei (e.g. measles and chickenpox).

Alcohol-based hand rub

An alcohol-containing preparation designed for application to the hands for antisepsis.

Anteroom

A small room leading from a corridor into another room, often an isolation room.

Caregiver

A person who provides support and assistance (formal or informal) to elderly people or to people with disabilities or long-term ill health (*10*).

Cleaning

The removal of dirt from a device or surface, either by physically scrubbing with a surfactant or detergent and water, or through an energy-based process (e.g. ultrasonic cleaner).

Clinical triage

A system by which patients are screened for specific signs, symptoms and epidemiological clues upon initial contact with the health-care system, for the purpose of determining further diagnostic tests, isolation precautions, treatment and reporting.

Clinical waste

Hazardous waste (also known as infectious waste) capable of causing infections in humans. Such waste includes contaminated animal waste, human blood and blood products, waste from isolation areas, pathological waste (e.g. human tissues), and discarded sharps (needles, scalpels or broken medical instruments). The definition of clinical waste may vary depending on local legislation and regulations.

Cohorting

The placement of patients infected or colonized with the same laboratory-confirmed pathogens in the same designated unit, zone or ward (with or without the same staff). This term is also frequently applied to grouped patient placement based on clinical and epidemiological information without laboratory confirmation of the pathogen; however, such an arrangement is referred to as *special measure*s throughout this document (see Special measures).

Contact transmission

The spread of an infectious agent caused by physical contact of a susceptible host with people or objects.

- *Direct contact transmission* involves both a direct body-surface-to-body-surface contact and physical transfer of microorganisms between an infected or colonized person and a susceptible host.
- *Indirect contact transmission* involves contact of a susceptible host with a contaminated intermediate object (e.g. contaminated hands) that carries and transfers the microorganisms (*5*).

Disinfection

A process that eliminates all viable pathogenic microorganisms (other than bacterial spores) from inanimate objects.

Droplet transmission

The spread of an infectious agent caused by the dissemination of droplets. Droplets are primarily generated from an infected (source) person during coughing, sneezing and talking. Transmission occurs when these droplets that contain microorganisms are propelled (usually < 1 m) through the air and deposited on the conjunctivae, mouth, nasal, throat or pharynx mucosa of another person. Most of the volume (> 99%) comprises large droplets that travel short distances (< 1 m) and do not remain suspended in the air. Thus, special air handling and ventilation are not required to prevent droplet transmission (*5*).

Environmental ventilation

There are three types of environmental ventilation:

- *Mechanical environmental ventilation* uses mechanical fans to introduce or exhaust outdoor or properly treated recycled air into or out of a building or a room.
- *Natural environmental ventilation* uses natural forces to introduce and distribute outdoor air into a building (*1*). Such forces include wind pressure or pressure generated by the density difference between indoor and outdoor air.
- *Mixed-mode environmental ventilation* combines mechanical and natural ventilation.

Environmental ventilation rate

The ventilation flow rate can be measured by either an absolute ventilation flow rate in L/s or L/s per cubic metre (L/s/m^3), or by ACH, relative to the volume of the space. In these guidelines, we refer to the ventilation rate as the absolute amount of inflow air per unit time (L/s or L/s/m^3), and the air change rate as the relative amount of inflow air per unit time (ACH) (*1*).

Hand hygiene

A general term that applies to handwashing, antiseptic handwashing, antiseptic hand rubbing or surgical hand antisepsis.

Health-care facility

Any establishment that is engaged in direct care of patients on site (*10*).

Health-care setting

Context where health care is provided (e.g. hospital, outpatient clinic or home).

Health-care worker

One of a variety of professionals (e.g. medical practitioners, nurses, physical and occupational therapists, social workers, pharmacists and spiritual counsellors) involved in providing coordinated and comprehensive health care (*10*).

Health personnel

Anyone employed or contracted to provide health services (*10*).

Infection prevention and control

Infection prevention and control (IPC) is the practical discipline concerned with preventing healthcare-associated infection. IPC is an essential part of the health care infrastructure. Its purpose in health care is as follows:

- to prevent the occurrence of healthcare-associated infections in patients, health-care workers, visitors and other persons associated with health-care settings;
- to prepare health-care facilities for the early detection and management of epidemics and to organize a prompt and effective response;
- to contribute to a coordinated response to control community-acquired infectious diseases, endemic or epidemic, that may be "amplified" via health care;
- to contribute to preventing the emergence of antimicrobial resistance and/or dissemination of resistant strains of microorganisms; and
- to minimize the environmental impact of these infections or their management.

Infectious respiratory aerosols

Respiratory aerosols that contain infectious particles. Aerosol size is determined by the force and pressure involved in the generation of the particles. The final size depends on the nature of the fluid containing the organisms, the force and pressure at emission, the initial size of the aerosol, environmental conditions (e.g. temperature, relative humidity and airflow), the time spent airborne, and the size of the organisms within a droplet. The distance travelled and the length of time particles remain suspended in the air is determined by the types of organism, particle size, settling velocity, relative humidity and airflow. Large particles typically remain suspended in the air for a limited period of time and settle within 1 m (3 feet) of the source. Smaller particles evaporate quickly; the resulting dried residues settle from the air slowly, and remain suspended in the air for variable lengths of time. The definitions and classification of the different types of infectious respiratory aerosols are evolving, and the implications for IPC measures are not yet clear. However, for the purpose of this document, infectious respiratory aerosols are classified into:

- *droplets* – *r*espiratory aerosols > 5 μm in diameter; and
- *droplet nuclei* – the residue of dried respiratory aerosols (≤ 5 μm in diameter) that results from evaporation of droplets coughed or sneezed into the atmosphere or by aerosolization of infective material.

Isolation precautions

Measures designed to minimize the risk of transmission of infections. They are often referred to as IPC precautions. Isolation precautions are typically separated into:

- *Standard Precautions* – these should always be in place for all patient care; and
- *additional precautions* – these are required in particular circumstances and comprise Contact, Droplet and Airborne Precautions.

Litres per second per cubic metre

See Environmental ventilation rate.

Mechanical ventilation

See Environmental ventilation.

Medical mask

Also known as a surgical or procedure mask. As personal protective equipment, a facial mask is intended to protect caregivers and health-care workers against droplet-transmitted pathogens, or to serve as part of facial protection for patient-care activities that are likely to generate splashes or sprays of blood, body fluids, secretions or excretions (Annex A provides details of usage and standards for medical masks). In this document, the term refers to disposable masks only.

Mixed-mode ventilation

See Environmental ventilation.

Natural ventilation

See Environmental ventilation.

Negative pressure room

A room in which the air pressure differential between the room and the adjacent indoor airspace directs the air into the room (i.e. room air is prevented from leaking out of the room and into adjacent areas such as a corridor).

New influenza virus

A new strain of influenza virus found in people that has not previously been circulating in humans. Current animal viruses that may have the potential to begin circulating among people include H5 and H7 strains of avian influenza, most notably A(H5N1). New influenza viruses are often of swine or avian origin.

Obligate airborne transmission

See Airborne transmission.

Pandemic

An epidemic occurring worldwide or over a wide area, crossing boundaries of several countries, and usually affecting a large number of people (*13*).

Particulate respirator

Also known as a filtering facepiece respirator. A type of facial mask that uses a filter as an integral part of the facepiece, or in which the entire facepiece is composed of the filtering medium and a means of sealing to the face.

Preferential airborne transmission

See Airborne transmission.

Procedure mask

See Medical mask.

Respiratory hygiene

The practice of covering the mouth and nose during coughing or sneezing (using a medical mask, cloth mask, tissues, a sleeve or flexed elbow), followed by hand hygiene, to reduce the dispersal of respiratory secretions that may contain infectious particles.

Spatial separation

Physical separation or distancing of at least 1 m between patients or between patients and health-care workers, which may be within a confined space such as a room, or between two separate bays, rooms or wards.

Special measures

The placement of patients with the same suspected diagnosis (similar epidemiological and clinical information) in the same designated unit, zone or ward (with or without the same staff) when the etiological agent has not been laboratory confirmed.

Surgical mask

See Medical mask.

Executive summary

Acute respiratory infections (ARIs) are the leading cause of morbidity and mortality from infectious disease worldwide, particularly affecting the youngest and oldest people in low- and middle-income nations. These infections, typically caused by viruses or mixed viral–bacterial infections, can be contagious and spread rapidly. Although knowledge of transmission modes is ever-evolving, current evidence indicates that the primary mode of transmission of most acute respiratory diseases is through droplets, but transmission through contact (including hand contamination followed by self-inoculation) or infectious respiratory aerosols at short range can also happen for some pathogens in particular circumstances.

In modern medicine, infection prevention and control (IPC) measures in health-care settings are of central importance to the safety of patients, health-care workers and the environment, and to the management of communicable disease threats to the global and local community. Application of basic IPC precautions, such as Standard Precautions, is a cornerstone for providing safe health care. In an era of emerging and re-emerging infectious diseases, IPC in health care is as important now as ever. The management of ARIs is no exception. Because many symptoms of ARIs are common and nonspecific, the application of IPC measures for ARIs in health care can be fraught with difficulty and confusion, especially in outbreaks where resources may be strained. Yet such measures, including early identification, prompt isolation precautions, proper patient placement and adequate ventilation, are essential to contain and mitigate the impact of pathogens that may constitute a major public health threat.

To address the need for clear advice on applying IPC measures for ARIs, these guidelines focus on recommendations for non-pharmacological[1] aspects of IPC for ARIs in health care. The document is intended for IPC professionals and members of IPC teams, health-care managers and policy-makers. The secondary audience is health-care workers, including doctors, nurses, allied health professionals, auxiliary and community health workers, and others involved in provision of health care. Given that etiological diagnosis is often not achievable, these guidelines prioritize a syndromic and epidemiological approach for assessing risks of infection and application of additional IPC measures. Special emphasis is placed on ARIs that can present as epidemics or pandemics. Committed and engaged leadership in health-care facilities is essential to ensure an institutional safety climate and continuous and consistent application of IPC measures, both during outbreak events and at all other times.

These guidelines represent an update to the World Health Organization (WHO) interim guidelines *Infection prevention and control of epidemic- and pandemic-prone acute respiratory diseases in health care*, 2007 (*16*). They also incorporate the emergency guidance given in the WHO publication *Infection prevention and control during health care for confirmed, probable, or suspected cases of pandemic (H1N1) 2009 virus infection and influenza-like illness,* 2009 (*17*). It was considered imperative to review and incorporate

[1] Documents from WHO that specifically address the use of vaccines and antivirals for influenza are the *WHO guidelines for the use of seasonal influenza vaccine in humans*, 2004 (*14*) and the *WHO guidelines for pharmacological management of pandemic (H1N1) 2009 influenza and other influenza viruses, 2010* (*15*). Recommendations in the current guidelines that refer to the use of vaccines and antivirals are based on these documents.

relevant research data that have become available since publication of the interim guidelines in 2007. The revision was a multistage process that included a field evaluation and an extensive literature review, conducted in accordance with the WHO standard for guideline development (*18*), as well as a review of practical experience and lessons learnt from pandemic influenza A (H1N1) 2009.

A WHO Steering Group engaged in defining the scope of the revision, establishing guideline development and external review groups, and ensuring the necessary declarations of conflict of interest. It also formulated specific questions for systematic review in several areas of relevance to these guidelines. Systematic reviews were commissioned and critical reviews of the literature conducted, as needed, to address these questions. The quality of evidence and other important considerations (e.g. balance of benefits versus disadvantages, costs, values and feasibility) were assessed and summarized using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) process (Annex K). Recommendations were formulated on that basis and then submitted for broad internal and external peer review.

There has been no change to most of the recommendations contained in the previous version of these guidelines; however, additional reference information has been added in many areas. The important changes that were made to these guidelines as a result of the revision process relate to the duration of additional isolation precautions, vaccination of health-care workers against influenza, antiviral prophylaxis for health-care workers exposed to ARIs, and environmental ventilation. The guidelines now recommend:

- that additional precautions for patients with all ARIs should be maintained for the duration of symptomatic illness (rather than various durations depending on the pathogen and patient information, as was previously recommended);
- vaccination of health-care workers for those caring for patients at high risk of complicated influenza illness (rather than for all health-care workers, as was previously recommended); and
- that antiviral prophylaxis should not routinely be given to health-care workers exposed to ARIs (providing more clarity to this issue than was given previously).

Information on the technical details of environmental ventilation is no longer in this document, because this information is now available in a separate WHO publication, *Natural ventilation for infection control in health-care settings*, 2009 (*1*). These guidelines retain reference to natural ventilation as an effective method for IPC.

The main document comprises:

- an introduction to the concepts discussed in the guidelines (Chapter 1);
- a detailed description of the IPC recommendations, best practices, and principles (Chapter 2);
- an outline of the main components of preparedness plans for health-care facilities to prevent and control ARI outbreaks that may constitute an international public health concern (Chapter 3);
- a description of the research gaps that were identified in relation to these recommendations (Chapter 4); and
- annexes that provide background information for the recommendations in Chapter 2, including evaluations of the evidence for key recommendations.

This guidance will be reviewed in 2016. A guideline review group will be convened to evaluate the new evidence and revise the recommendation if needed. The Department of Pandemic and Epidemic Diseases at the WHO headquarters in Geneva, along with its internal

partners, will be responsible for coordinating the guideline update, following the *WHO handbook for guideline development* (*18*) procedures. If new evidence that may require changing current recommendations is published, the guideline will be updated before the review date indicated above. In addition and as companions to this document, updated summary guidance document and training materials targeted specifically to health care workers are currently being prepared.

The recommendations are summarized in the box below. The decision tables for these recommendations are provided in Annex K

Recommendations in guidelines

Recommendations	Quality of evidence	Strength of recommendation
Use clinical triage for the early identification of patients with ARIs in order to prevent the transmission of ARI pathogens to health-care workers and other patients.	Very low to low	Strong
Respiratory hygiene (i.e. covering the mouth and nose during coughing or sneezing with a medical mask, tissue, or a sleeve or flexed elbow, followed by hand hygiene) should be practised by people with ARIs to reduce the dispersal of respiratory secretions containing potentially infectious particles.	Very low	Strong
Maintain spatial separation (distance of at least 1 m) between each ARI patient and others, including health-care workers (without the use of personal protective equipment [PPE]), to reduce the transmission of ARI.	Very low to low	Strong
Consider the use of patient cohorting (i.e. the placement of patients infected or colonized with the same laboratory-identified pathogens in the same designated unit, zone or ward). If cohorting is not possible, apply special measures (i.e. the placement of patients with the same suspected diagnosis – similar epidemiological and clinical information – in the same designated unit, zone or ward) to reduce transmission of ARI pathogens to health-care workers and other patients.	Low to moderate	Conditional
Use appropriate PPE as determined by risk assessment (according to the procedure and suspected pathogen). Appropriate PPE when providing care to patients presenting with ARI syndromes may include a combination of: medical mask (surgical or procedure mask); gloves; long-sleeved gowns; and eye protection (goggles or face shields).	Low to moderate	Strong
Use PPE, including gloves, long-sleeved gowns, eye protection (goggles or face shields), and facial mask (surgical or procedure mask, or particulate respirators) during aerosol-generating procedures that have been consistently associated with an increased risk of transmission of ARI pathogens. The available evidence suggests that performing or being exposed to endotracheal intubation either by itself or in combination with other procedures (e.g. cardiopulmonary resuscitation or bronchoscopy) is consistently associated with increased risk of transmission.	Very low to low	Conditional
Use adequately ventilated single rooms when performing aerosol-generating procedures that have been consistently associated with increased risk of ARI transmission.	Very low to low	Conditional
Vaccinate health-care workers caring for patients at high risk of severe or complicated influenza disease, to reduce illness and mortality among these patients.	Very low to low	Strong
Ultraviolet Germicidal Irradiation (UVGI) for disinfection of air – no recommendation possible	-	-
Implement additional IPC precautions at the time of admission and continue for the duration of symptomatic illness, and modify according to the pathogen and patient information. Always use Standard Precautions. There is no evidence to support the routine application of laboratory tests to determine the duration of IPC precautions.	Very low	Conditional

1 Introduction and scope of the guidelines

1.1 Acute respiratory infections in health care

Acute respiratory infections (ARIs) are the leading cause of morbidity and mortality from infectious disease in the world. Almost four million people die from ARIs each year, with 98% of these deaths due to lower respiratory tract infections. Mortality rates are particularly high in infants, children, and the elderly, particularly in low-income and middle-income countries (*19, 20*). ARIs are one of the most frequent causes of consultation or admission to health-care facilities, particularly in paediatric services (*21*).

Bacteria are a major cause of lower respiratory tract infection, with *Streptococcus pneumoniae* being the most common cause of bacterial community-acquired pneumonia in many countries. However, the pathogens that most often cause ARIs are viruses or mixed viral–bacterial infections. ARIs that have epidemic or pandemic potential, and may pose a public-health risk, warrant special precautions and preparedness (*22*).

The incidence of specific ARIs, their distribution and the outcome of disease varies according to several factors, including (*23-25*):

- environmental conditions (e.g. air pollutants, household crowding, humidity, hygiene, season and temperature);
- availability and effectiveness of medical care and infection prevention and control (IPC) measures to contain spread such as vaccines, access to health-care facilities, and isolation capacity;
- host factors such as age, cigarette-smoking, host ability to transmit infection, immune status, nutritional status, prior or concurrent infection with other pathogens, and underlying medical conditions; and
- pathogenic characteristics, including modes of transmission, transmissibility, virulence factors (e.g. genes encoding toxins) and microbial load (inoculum size).

1.2 Scope of the current guidelines

This document provides recommendations and other information relating to IPC measures for ARIs in health-care settings, with specific emphasis on ARIs that have the potential for rapid spread and may cause epidemics or pandemics (or both). Some of the epidemic-prone ARIs may constitute a global public-health emergency. According to the *International Health Regulations* (IHR), 2005 (*6*) the respiratory disease events that may constitute a public-health emergency of international concern include:

- severe acute respiratory syndrome (SARS);
- human influenza caused by a new subtype, including human episodes of avian influenza;
- pneumonic plague; and
- novel ARIs that can cause large-scale outbreaks, or outbreaks with high morbidity and mortality.

Recommendations for prevention and control of pneumonic plague have been addressed in a previous World Health Organization (WHO) publication *Operational guidelines on plague surveillance, diagnosis, prevention and control*, 2009 (*26*), and a summary of IPC precautions is provided in Table 2.1 in these guidelines.

Tuberculosis (TB) seldom presents as an ARI. However, its spread has been associated with health care and is a major global health concern. Recommendations for prevention and control of TB in health-care facilities have been addressed in a previous WHO publication – *WHO policy on TB infection control in health-care facilities, congregate settings and households,* 2009 (*27*) – and a summary of IPC precautions is provided in the Table 2.1.

This document focuses on the most common ARIs, and highlights ARIs of potential concern. In particular, these guidelines address IPC precautions for ARIs that:

- cause acute respiratory tract infection, including pneumonia and acute respiratory distress syndrome;
- cause severe disease in susceptible people with apparently normal immune systems; and
- may constitute a public health emergency of international concern as defined by IHR (*6*), except in the case of pneumonic plague.

1.3 ARIs that may constitute a public health emergency of international concern covered in the current document

1.3.1 Severe acute respiratory syndrome

SARS is caused by the SARS coronavirus (SARS-CoV) (*28*) that can infect animals and humans. The disease was first reported in Asia in February 2003, and spread to people in over 24 countries in Asia, Europe, North America and South America before the outbreak was contained (*29*). SARS is currently not known to be circulating among people, but it could still be circulating in animal hosts and may thus re-emerge in humans (*30*). Human-to-human transmission of SARS occurs mainly through droplets or direct contact, although transmission through infectious respiratory aerosols of various sizes may occur at short range (*31*).

1.3.2 New influenza virus causing human infection

Influenza viruses can infect many species, including humans, birds, pigs, horses and seals. Birds, in particular, are the main reservoir for influenza A viruses. Influenza viruses tend to infect people sporadically or in seasonal epidemics; occasionally, when a new human influenza virus emerges, it can cause a worldwide pandemic. Seasonal epidemics are caused by influenza viruses that are well adapted to the human hosts they circulate in. When an influenza virus with the capacity to infect humans first emerges in another species, it is not yet adapted to humans and may circulate in animal hosts, generating sporadic human infections. Because it may subsequently evolve the ability for sustained human-to-human transmission, any new influenza virus that generates sporadic cases of human infection may present a pandemic risk. Thus, early detection, isolation and warning of sporadic infections are crucial to minimize the risk of serious public health impacts from new influenza viruses (*32*).

Direct transmission of avian influenza viruses – including H5N1, H7N9, H7N2 and H9N2 – to humans has been described on numerous occasions (*33-36*), and often results in a high fatality rate (*37*). The most important avian virus infecting humans in recent years has been

avian influenza A(H5N1), which can be highly pathogenic. Human cases of H5N1 were reported in Hong Kong Special Administrative Region (SAR), China, in 1997, and have been found in other countries since 2003. Because A(H5N1) is believed to be circulating widely among wild birds, more cases in people are expected. Most instances of avian influenza infection in people have resulted from contact with infected poultry (e.g. domesticated chickens, ducks or turkeys) or surfaces contaminated with secretions or excretions from infected birds (*33-40*). So far, however, no efficient or sustained human-to-human transmission of avian influenza A(H5N1) has been demonstrated. In the potential cases of human-to-human transmission, infection was associated with close, extensive unprotected contact, suggesting that the virus might have spread through respiratory droplets or contact (*37, 41*).

Pandemic influenza A (H1N1) 2009 virus resulted from genetic re-assortment of swine, avian and human viruses, and it is efficiently spread through human-to-human transmission (*42*). First recognized in North America in April 2009, A(H1N1)pdm09 subsequently spread around the globe, causing a pandemic between June 2009 until August 2010 (*43, 44*).

1.3.3 Novel acute respiratory infections with potential for a high public health impact

Infectious diseases have spread across populations and regions throughout history, and it is likely that newly emerging infectious diseases will continue to be identified. Many infectious diseases with animal reservoirs can sometimes infect humans. Two examples that occurred after the 2009 influenza pandemic are human cases of influenza A(H7N9) which first occurred in 2013, and of Middle East Respiratory Syndrome (MERS) coronavirus from 2012[1].

The following factors have been associated with the emergence and spread of infectious diseases (*22, 45*):

- changes in human demographics and behaviour;
- impact of new technologies and industries;
- economic development and changes in land use;
- increased international travel and commerce;
- microbial adaptation and change;
- poor implementation of public-health measures; and
- sharing an environment with domestic or wild animals, including birds.

When a new infectious disease is identified, the modes of transmission are not well understood. The epidemiological and microbiological studies needed to determine the modes of transmission and identify possible IPC measures may be protracted. Due to the lack of information on modes of spread, Airborne and Contact Precautions, as well as eye protection, should be added to the routine Standard Precautions whenever possible, to reduce the risk of transmission of a newly emerging agent (Annex B describes Standard and other precautions). These precautions should be implemented until further studies reveal the mode of transmission. Epidemiological and clinical clues can indicate when additional precautions are needed (Section 2.1).

It is essential to maintain close surveillance of health-care workers from the very beginning of an outbreak with a novel pathogen, and during the outbreak, since this could offer

[1] Information on current infectious disease outbreaks can be found at http://www.who.int/csr/disease/en/.

important information about means of transmission, both for community and health-care associated transmission.

1.4 Infection prevention and control guiding principles

The conditions and levels of complexity in health-care facilities vary within and between countries. Policy-makers and health administrators should identify strategies with optimal cost-effectiveness ratios based on the facilities' potential for sustainable and continuous quality improvement.

The principles of IPC for ARI patient care include:

- early and rapid recognition of patients;
- application of routine IPC precautions (Standard Precautions) for all patients;
- additional precautions in selected patients (e.g. based on the presumptive diagnosis);
- establishment of an IPC infrastructure for the health-care facility, to support IPC activities.

IPC strategies in health-care facilities are commonly based on early recognition and source control, administrative controls, environmental and engineering controls, and personal protective equipment (PPE).

1.4.1 Early recognition and source control

Infected patients are the main source of pathogens in health-care settings, and reducing or preventing the dissemination of the infectious agent from the source is critical. These methods of reduction and prevention include promotion of respiratory hygiene (Annex B, Section B.1.3), early recognition and investigation, prompt implementation of IPC precautions, reporting and surveillance, and treatment to make patients non-infectious.

1.4.2 Administrative controls

The health-care facility management team needs to ensure that the necessary resources are available for implementation of IPC measures. These resources include the establishment of sustainable IPC infrastructures and activities; clear policies on early recognition of ARIs of potential concern; access to prompt laboratory testing for identification of the etiologic agent; implementation of appropriate IPC measures (e.g. Standard Precautions for all patients), and appropriate clinical triage and placement of patients; provision of regular supplies; and organization of services. The management team should also undertake staff planning to promote an adequate patient-to-staff ratio, provide staff training, and establish appropriate programmes for staff vaccination and prophylaxis.

1.4.3 Environmental and engineering controls

Environmental and engineering controls aim to reduce the concentration of infectious respiratory aerosols (e.g. droplet nuclei) in the air and to reduce the contamination of surfaces and inanimate objects. Examples of primary engineering controls for infectious respiratory aerosols include adequate environmental ventilation and spatial separation, with a distance of at least 1 m between patients. Adequate environmental ventilation is especially important to reduce the transmission of pathogens that are transmitted through the airborne route (e.g. pulmonary TB, measles and chickenpox). For infectious agents that spread by contact, important environmental control methods include cleaning and disinfection of contaminated surfaces and inanimate objects.

1.4.4 Personal protective equipment

These strategies all serve to reduce, but do not eliminate, the possibility of exposure to respiratory pathogens. The appropriate use of PPE serves to further reduce the risks of transmission of respiratory pathogens to health-care workers and other people interacting with the patients in the health-care facility. The use of PPE should be defined by policies and procedures addressing isolation precautions. Their effectiveness depends on adequate and regular supplies, adequate staff training, proper hand hygiene and, in particular, appropriate human behaviour.

All these controls are connected and should be harmonized to promote an institutional culture of safety.

1.5 Guideline development process

These guidelines were developed according to the *WHO handbook for guideline development,* 2012 (*18*). WHO commissioned systematic reviews and critical reviews of the literature as applicable. Every attempt was made to develop recommendations that focused on priority or controversial areas, using systematic reviews and evidence summaries according to the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach (*18, 46-50*) (Annex K). The GRADE approach provides a structured and transparent assessment of the quality of evidence and its application to the guidelines process. A hierarchical approach was used to review the evidence when formulating the recommendations in these guidelines, with the highest ranking given to systematic reviews of human studies. Quality of evidence was ranked from randomized trials (deemed to be of highest quality), followed by prospective cohort studies, retrospective cohort studies, and finally controlled before-and-after studies (lowest quality). Similarly, priority of studies was ranked from in vivo animal studies relevant to the topic (deemed to be of highest priority) to in vitro laboratory studies relevant to the topic and theoretical considerations (lowest priority). The scientific evidence was also assessed for inconsistency, indirectness, imprecision, reporting bias, and other potential sources of bias. The summaries of each systematic review are provided in the Annex L, and the evidence profiles are available in published systematic reviews and referenced in the decision tables (Annex K) and in the Annex L.

Quality of evidence was considered of major importance in developing the guidelines. In addition, we considered the balance of the benefits or desired effects versus the disadvantages or undesired effects; values and preferences from a global perspective, including those of front-line health-care workers; cost and resource implications; and the feasibility of adopting a recommendation (*18, 46-50*). The recommendations were discussed internally with a Working Group within WHO, and then submitted to members of the Global Infection Prevention and Control Network (GIPCN) for review and feedback. Following the technical consultation meeting with the GIPCN, additional changes were made. The draft of these guidelines was also submitted for broad internal and external review.

2 Infection prevention and control recommendations

2.1 Recommendations for early recognition and source control

Early recognition of ARIs and application of source control, including respiratory hygiene, are administrative control measures aimed at reducing or preventing the dissemination of infectious agents from the source. The early identification, isolation and reporting of ARIs of potential concern are therefore central to effective containment and treatment.

2.1.1 Recommendations for health-care facilities and public health authorities

Health-care facilities

- Use clinical triage for early identification of patients with ARIs to prevent the transmission of ARI pathogens to health-care workers and other patients (Strong recommendation, very low to low quality of evidence) (*27, 51*) (Annex K, Table K.1). Regularly monitor and evaluate the clinical triage system to ensure effectiveness (*52-55*).
- Place ARI patients in an area separate from other patients, and evaluate clinical and epidemiological aspects of the case as soon as possible (*51, 52, 56*). Complement investigation with laboratory evaluation if applicable (*57, 58*).
- In people with ARIs, encourage the use of respiratory hygiene (i.e. covering the mouth and nose during coughing or sneezing with a medical mask [surgical or procedure mask], cloth mask, tissue, sleeve or flexed elbow), followed by hand hygiene, to reduce the dispersal of respiratory secretions containing potentially infectious particles (Strong recommendation, very low quality of evidence) (*27, 51, 59-63*) (Annex K, Table K.2).
- Implement additional IPC precautions promptly according to the suspected pathogen (Table 2.1) (*64*).
- Report all available essential information regarding episodes of ARIs of potential concern to public health authorities via the local surveillance system. This is in line with the requirements of the IHR (2005) (*6*), which have been in force since June 2007. The IHR (2005) require the international notification to WHO by States Parties of events that may constitute a public health emergency of international concern.

Public health authorities

- Establish channels to inform health-care facilities and the community about ongoing epidemic ARIs, so that the facilities will be aware of the extent and types of problems likely to be encountered.

Early recognition of ARIs of potential public health concern may be difficult, given the large number of etiological agents, and the similarities of presentation of patients with acute respiratory disease. Although the case definition may vary according to the specific disease, there are some general epidemiological and clinical clues to prompt suspicion, as outlined below:

- *Epidemiological clues* – A patient's history of travel to areas where there are patients known to be infected with an ARI of potential concern within the known or suspected

incubation period; possible occupational exposure to pathogens or novel agents causing ARIs of potential concern; unprotected contact with patients with ARIs of potential concern within the known or suspected incubation period; or being part of a rapidly spreading cluster of patients with ARI of unknown cause (*52, 65-69*), including exposure to household members with ARIs. Family members who live with patients with ARIs of potential concern can be assumed to have been exposed to the same ARI, and could be evaluated for both epidemiological clues and active infection (*52, 53, 69-75*). For novel agents, the epidemiological clues may change as additional information becomes available.

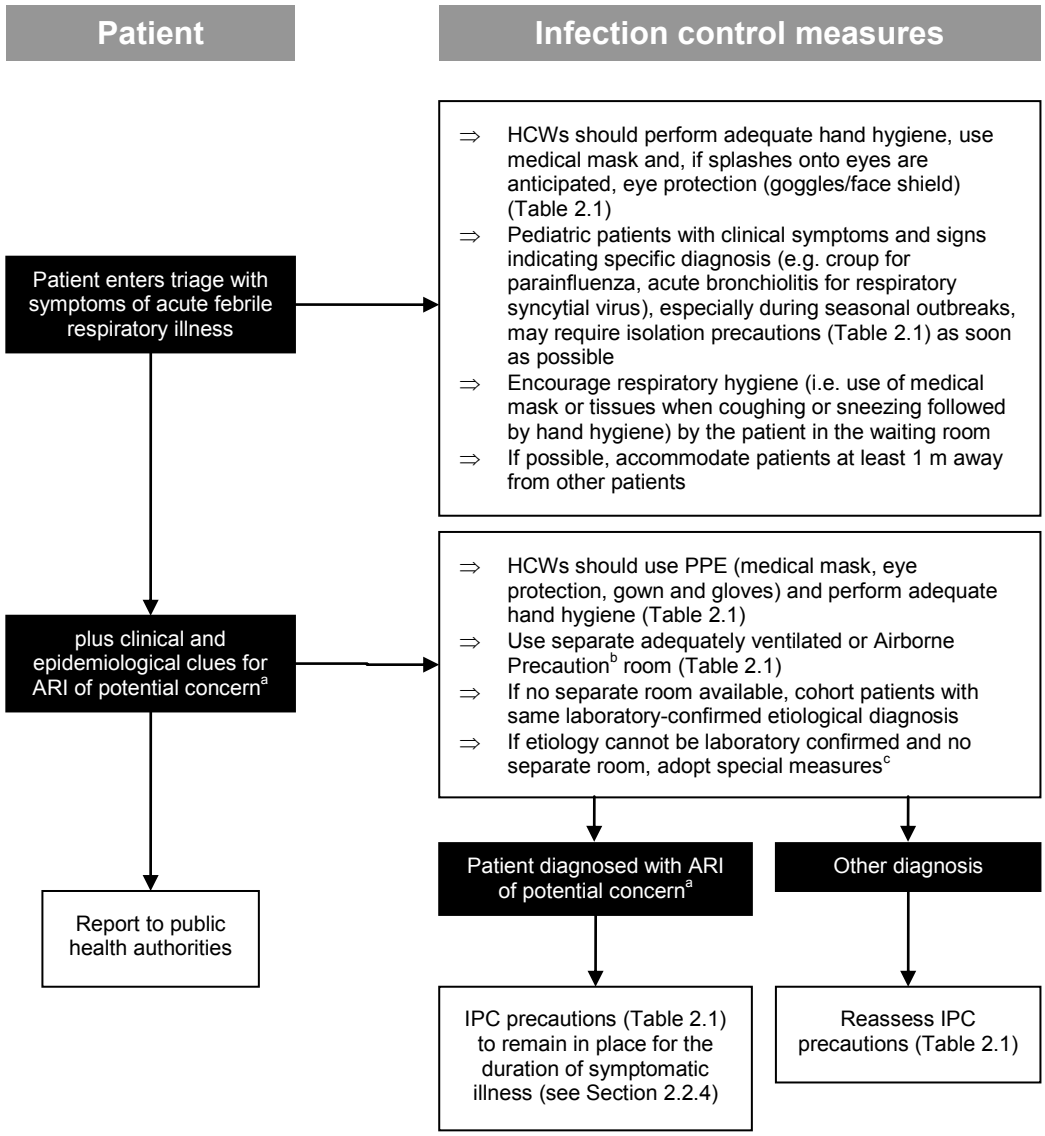
- *Clinical clues* – All patients who present with, or who have died of, unexplained severe acute febrile respiratory illness (e.g. fever > 38 °C, cough or shortness of breath) in the presence or absence of other severe unexplained illness (e.g. encephalopathy or diarrhoea) (*52, 53, 69-73*), with an exposure history consistent with the ARI of potential concern mentioned above, within the known or suspected incubation period.

Rationale

Prompt identification of ARI patients will enable the immediate implementation of IPC measures, reduce transmission to others in the health-care facility, and thus prevent outbreaks of epidemic-prone infections.

Since patients with severe ARIs tend to seek care at health-care facilities, such facilities are critical in identifying early signals of emerging ARIs that could constitute a public health emergency, either locally or internationally. Early identification and reporting offers an opportunity for successful containment. Prompt identification and management of patients, health-care workers or visitors who may be infected with an ARI of potential concern with pandemic and epidemic potential are key administrative control measures. Thus, they are critical to minimize the risk of health-care associated transmission and to enable an efficient public health response. The response includes implementation of adequate IPC measures, patient treatment and immediate reporting. The recognition of possible episodes depends on the case definition, which may evolve as additional epidemiological and clinical information becomes available.

Figure 2.1 Decision-tree for infection prevention and control measures for patients known or suspected to have an acute respiratory infection



[a]For the purpose of this document, ARIs of potential concern include SARS, new influenza virus causing human infection (e.g. human cases of avian influenza), and novel organism-causing ARIs that can cause outbreaks with high morbidity and mortality. Clinical and epidemiological clues (Section 2.1) include severe disease in a previously healthy host, exposure to household member or close contact with severe ARI, cluster of cases, travel, exposure to ill animals or laboratory.

[b]Airborne Precaution rooms include both mechanically and naturally ventilated rooms with ≥ 12 ACH and controlled direction of airflow (see Glossary).

[c]The term "special measures" means allowing patients with epidemiological and clinical information suggestive of a similar diagnosis to share a room, but with a spatial separation of at least 1 m.

Table 2.1 Infection prevention and control precautions for health-care workers and caregivers providing care for patients with acute respiratory infection and tuberculosis

Precaution		No pathogen identified, no risk factor for TB or ARI of potential concern (e.g. influenza-like illness without risk factor for ARI of potential concern)	Pathogen						
			Bacterial ARI[a], including plague	TB	Other ARI viruses (e.g. parainfluenza RSV, adenovirus)	Influenza virus with sustained human-to-human transmission (e.g. seasonal influenza, pandemic influenza)	New influenza virus with no sustained human-to-human transmission (e.g. avian influenza)	SARS	Novel ARI[b]
Hand hygiene[c]		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Gloves		Risk assessment[d]	Risk assessment[d]	Risk assessment[d]	Yes	Risk assessment[d]	Yes	Yes	Yes
Gown[e]		Risk assessment[d]	Risk assessment[d]	Risk assessment[d]	Yes	Risk assessment[d]	Yes	Yes	Yes
Eye protection		Risk assessment[f]	Risk assessment[f]	Risk assessment[f]	Risk assessment[f]	Risk assessment[f]	Yes	Yes	Yes
Medical mask for health-care workers and caregivers		Yes	Risk assessment[f]	No	Risk assessment[f] /Yes[g]	Yes	Yes[h]	Yes[i]	Not routinely[b]
Particulate respirator for Health-care workers and caregivers	for room entry	No	No	Yes	No	No	Not routinely[h]	Not routinely[i]	Yes
	within 1 m of patient	No	No	Yes	No	No	Not routinely[h]	Not routinely[i]	Yes
	for aerosol-generating procedures[j]	Yes[k]	Yes[k]	Yes	Yes[k]	Yes[k]	Yes[k]	Yes	Yes[b,k]
Medical mask for patient when outside isolation areas[l]		Yes	Yes	Yes	Yes[m]	Yes	Yes	Yes	Yes
Adequately ventilated separate room		Yes, if available[n]	No	No	Yes, if available[n]	Yes, if available[n]	Yes	Yes	Not routinely[b]

Precaution	No pathogen identified, no risk factor for TB or ARI of potential concern (e.g. influenza-like illness without risk factor for ARI of potential concern)	Pathogen						
		Bacterial ARI[a], including plague	TB	Other ARI viruses (e.g. parainfluenza RSV, adenovirus)	Influenza virus with sustained human-to-human transmission (e.g. seasonal influenza, pandemic influenza)	New influenza virus with no sustained human-to-human transmission (e.g. avian influenza)	SARS	Novel ARI[b]
Airborne Precaution room[o]	No	No	Yes[p]	No	No	Not routinely[p]	Not routinely[p]	Yes[p]
Summary of isolation precautions for routine patient care, excluding aerosol-generating procedures[j] (Annex B)	Standard	Standard	Standard	Standard	Standard	Standard	Standard	Standard
	Droplet	--	--	Droplet	Droplet	Droplet	Droplet	--
	--	--	--	Contact	--	Contact	Contact	Contact
	--	--	Airborne	--	--	--	--	Airborne

ARI, acute respiratory infection; IPC, infection prevention and control; RSV, respiratory syncytial virus; SARS, severe acute respiratory syndrome; TB, tuberculosis

a Bacterial ARI refers to common bacterial respiratory infections caused by organisms such as *Streptococcus pneumoniae*, *Haemophilus influenzae*, *Chlamydophila* spp. and *Mycoplasma pneumoniae*.

b When a novel ARI is newly identified, the mode of transmission is usually unknown. Implement the highest available level of IPC precautions, until the situation and mode of transmission is clarified.

c Perform hand hygiene in accordance with Standard Precautions (Annex B).

d Gloves and gowns should be worn in accordance with Standard Precautions (Annex B). If glove demand is likely to exceed supply, glove use should always be prioritized for contact with blood and body fluids (nonsterile gloves), and contact with sterile sites (sterile gloves).

e If splashing with blood or other body fluids is anticipated and gowns are not fluid resistant, a waterproof apron should be worn over the gown.

f Facial protection, i.e. a medical mask and eye protection (eye visor, goggles) or a face shield, should be used in accordance with Standard Precautions by health-care workers if activities are likely to generate splashes or sprays of blood, body fluids, secretions and excretions onto mucosa of eyes, nose or mouth; or if in close contact with a patient with respiratory symptoms (e.g. coughing/sneezing) and sprays of secretions may reach the mucosa of eyes, nose or mouth.

g Adenovirus ARI may require use of medical mask

h As of the publication of this document, no sustained efficient human-to-human transmission of avian influenza A(H5N1) is known to have occurred, and the available evidence does not suggest airborne transmission from humans to humans. Therefore a medical mask is adequate for routine care.

i The current evidence suggests that SARS transmission in health-care settings occurs mainly by droplet and contact routes; therefore, a medical mask is adequate for routine care

j See Table K4, Annex K.

k Some aerosol-generating procedures have been associated with increased risk of transmission of SARS (Annex A; Annex L, Table L.1). The available evidence suggests performing or being exposed to endotracheal intubation either by itself or combined with other procedures (e.g. cardiopulmonary resuscitation, bronchoscopy) was consistently associated with increased risk of transmission of SARS. The risk of transmission of other ARI when performing the aerosol-generating procedures is currently unknown.

l If medical masks are not available, use other methods for respiratory hygiene (e.g. covering the mouth and nose with tissues or flexed elbow followed by hand hygiene).

m These are common pathogens in children, who may not be able to comply with this recommendation.

n Cohort patients with the same diagnosis. If this is not possible, place patient beds at least 1 m (3 feet) apart.

o Airborne Precaution rooms can be naturally or mechanically ventilated, with adequate ventilation rate of 160 l/s/patient or at least 12 air changes per hour and controlled direction of airflow.

p Airborne Precaution rooms, if available, should be prioritized for patients with airborne infections (e.g. pulmonary TB, chickenpox and measles) and for those with novel organisms causing ARI.

2.2 Recommendations for administrative control strategies for health-care facilities

Effective IPC programmes can reduce the frequency and financial burden of health-care associated infections (*76-78*). The 10-year long SENIC (Study on the Efficacy of Nosocomial Infection Control) study in the United States of America showed that organized IPC programmes are both effective and cost effective (*77*). Currently, IPC programmes are considered an integral part of the delivery of patient care[1] (*79, 80*). In addition to the recommendations for early recognition and source control described in Section 2.1, the following administrative control strategies for IPC programmes in health-care facilities outlined below are recommended.

For all ARIs

- Strengthen or establish an IPC committee and IPC programmes with trained personnel to keep policies current (*52, 53, 69-75, 79, 81, 82*).
- Monitor and increase compliance with IPC precautions using evidence-based methods, including multimodal strategies (e.g. change in infrastructure, education, posters, reminders, senior management engagement and performance feedback) (*83-85*).
- Educate health-care workers about ARIs, including the IPC precautions to be used for patients who present with a febrile ARI (*55, 86, 87*).
- Ensure that adequate IPC supplies are provided (*55, 87-89*), for example:
  - hand-hygiene facilities (e.g. soap and clean running water, alcohol-based hand rub, and paper or single-use towels);
  - PPE for patient care (e.g. masks, respirators, gowns, gloves and eye protection);
  - PPE for heavy duties (e.g. closed protective footwear, waterproof aprons and rubber gloves); and
  - an adequate supply of appropriate materials for cleaning and disinfection.

For ARIs of potential concern

- Reinforce the health-care facility's system that triggers patients and visitors to immediately alert health-care workers to symptoms of severe febrile ARI (e.g. signposting all entrances and clinical evaluation areas, such as emergency departments), in areas with reported ARIs of potential concern (*90*).
- Increase surveillance to detect evidence of transmission to other patients and health-care workers when a patient with a confirmed ARI of potential concern has been admitted to the facility (*91-93*).

Rationale

Hospital administrators and governments play a key role in preventing the spread of health-care associated pathogens by creating the necessary conditions at an institutional level. Targets for improvement include written guidelines, availability of necessary resources (staff and supplies), promotion of a culture or tradition of adherence to IPC practices, and administrative leadership or support. Important opportunities for improvement include

[1] For more details consult the WHO document *Core components for infection prevention and control programmes* (*79*).

enhancing individual and institutional attitudes to the feasibility of making changes, obtaining active participation, and promoting a safety climate.

In the SARS outbreak, important factors associated with compliance were the perception of health-care workers that their facilities had clear policies and protocols, the perceived attitudes and actions of management about the importance of occupational health and safety, adequate training in IPC procedures, and fast access to specialists. Education, regular supplies, adequate staffing, institutional climate and leadership are the cornerstones for promotion of good IPC practices (*88*). It is essential that health-care facilities develop preparedness plans addressing these elements (Chapter 4).

2.2.1 Isolation precautions

IPC precautions are measures designed to minimize the risk of transmission of infections. Such precautions are typically separated into Standard Precautions and additional precautions, such as Contact, Droplet and Airborne Precautions. Annex B summarizes the application and principles of Standard and additional precautions in health care.

Additional precautions may be needed depending on:

- the suspected or confirmed causative agents of the ARIs (*53, 65, 67-69, 94*);
- the presence of epidemiological and clinical clues suggesting that patients have ARIs of potential concern; and
- the types of contact and procedures that are undertaken with patients with ARIs.

IPC precautions to be applied when a patient with a suspected acute respiratory infection presents to a health-care facility

- Apply Standard Precautions routinely to ALL patients in ALL health-care settings (*95*) (Annex B).
- Apply Standard and Droplet Precautions (Annex B) at the initial evaluation of a patient with a suspected ARI. Modify isolation precautions according to the specific diagnosis, as it becomes available (Table 2.1).
- Apply Standard, Contact and Droplet Precautions (Annex B) at initial evaluation of a paediatric patient presenting with a suspected ARI during the peak season of certain viruses (e.g. croup and parainfluenza, acute bronchiolitis, and respiratory syncytial virus). Modify isolation precautions according to the specific diagnosis (Table 2.1).
- Evaluate the risk to determine whether additional protective measures may be necessary; for example, when providing care for patients infected with some specific pathogens (Table 2.1). If the patient has indications suggestive of a novel ARI with epidemic or pandemic potential (Section 1.3.3) and the route of transmission has not been established, add Airborne and Contact Precautions, plus eye protection, to Standard Precautions (Annex B).

Rationale

Because droplets are the major mode of transmission for most ARIs, Droplet Precautions should be applied in addition to Standard Precautions when an ARI is suspected. This is of particular importance in clinical areas that receive new patients who do not yet have a diagnosis (e.g. outpatient department and emergency room). The prompt application of

appropriate isolation precautions in these clinical areas, in particular, can help to mitigate spread of infections within the facility. However, since other modes of transmission are sometimes involved in ARI transmission, the type of precautions used should be reviewed once diagnosis has been confirmed (Table 2.1). In addition, enhanced isolation precautions are warranted for medical procedures with consistently documented increased risk of infection transmission (Annex A, Section A.1; Annex L, Table L.1).

Details of different types of isolation precautions are described in Annex B.

2.2.2 Cohorting and special measures

For all ARIs

- Consider the use of patient cohorting – that is, place patients infected or colonized with the same laboratory-confirmed pathogens in the same designated unit, zone or ward (with or without the same staff) – to reduce transmission of ARI pathogens to health-care workers and other patients (Conditional recommendation, low to moderate quality of evidence) (*51*) (Annex K, Table K.4).

- When there is no laboratory confirmation, apply special measures – that is, place patients with the same suspected diagnosis (similar epidemiological and clinical information) in the same designated unit, zone or ward (with or without the same staff) – to reduce transmission of ARI pathogens to health-care workers and other patients (Conditional recommendation, low to moderate quality of evidence) (*51*) (Annex K, Table K.4).

- Avoid sharing of equipment. If sharing is unavoidable, ensure that reusable equipment is appropriately disinfected between patients (*95*).

For ARIs of potential concern

- If single rooms used for the isolation of ARIs of potential concern are insufficient for the number of individuals, apply either cohorting of patients or special measures.

- For patient-care units that house patients with ARIs of potential concern, wherever possible, assign health-care workers who are experienced with IPC for ARIs and outbreak settings. Also, if possible, these workers should not "float" or be assigned to other patient-care areas.

- Limit the number of people entering the assigned unit or area for isolation, cohorting or special measures, to the minimum number required for patient care and support (*86, 96*).

2.2.3 Transport of patients inside and outside health-care facilities

Patient transport within health-care facilities

For all ARIs

- Encourage the use of medical masks by patients with ARI during transport or when care is necessary outside of the isolation room or area (*51, 95*) (Annex K, Table K.2). If medical masks are not available or not tolerated by the patient, other methods to reduce the dispersal of respiratory secretions, including covering the mouth and nose with a tissue or flexed elbow during coughing or sneezing (*90*), can be used, and should be followed by hand hygiene (*97, 98*). For more information on respiratory hygiene, see Annex B.

For ARIs of potential concern

Implement the measures described above for all ARIs, plus the following measures:

- Avoid the movement and transport of patients out of the isolation room or area unless medically necessary (*95*). The use of designated portable X-ray equipment and other important diagnostic equipment may make this easier. If transport is necessary, use routes of transport that minimize the exposures of staff, other patients and visitors to potential infection.

- As soon as possible, notify the receiving area of the patient's diagnosis and precautions that will be required before the patient's arrival.

- Clean and disinfect surfaces that the patient comes into contact with (e.g. bed) after use (99).

- Ensure that health-care workers who are transporting patients with an ARI of potential concern wear appropriate PPE and perform hand hygiene afterwards (*51*).

Pre-hospital care and transport outside health-care facilities

For all ARIs

- Screen patients with severe acute febrile respiratory illness for risk factors associated with ARIs of potential concern (*52, 66, 100*).

- After pre-hospital care or transport has been provided, follow recommended procedures for waste disposal, and for cleaning and disinfecting emergency vehicles and reusable patient-care equipment, as described for Standard Precautions (Annex B) (*95*).

- Avoid crowding of patients during examination and in outpatient treatment areas (*51*).

For ARIs of potential concern

Implement the measures described above for all ARIs, plus the following measures:

- Avoid aerosol-generating procedures associated with risk of pathogen transmission (e.g. intubation) during pre-hospital care and transport, unless required for life-support (*101, 102*). (Annex A, Section A.1)

- Ensure that transport vehicles have as high a volume of air exchange as possible (e.g. by opening the windows) (*1*). Separate the driver's and patients' compartments whenever possible.

- Notify the receiving facility as soon as possible before arrival that a patient with a suspected ARI of potential concern is due to arrive, and indicate whether additional precautions are required.

2.2.4 Duration of infection prevention and control precautions and patient discharge

Duration of IPC precautions

For all ARIs

Always implement Standard Precautions. Implement additional IPC precautions (Section 2.2.1) at the time of admission, and continue for the duration of symptomatic illness, modifying according to the pathogen and patient information (Table 2.1 and Table K.10).[1] Do not routinely use laboratory tests to determine the duration of IPC precautions, as there is no evidence that this is effective (*103, 104*).

For ARIs of potential concern

Avian and human influenza

The latest evidence indicates that at least 80% of pandemic H1N1 influenza transmission events occur within 2 days of symptom-onset (*104*). Although earlier research had suggested that influenza virus shedding may be protracted in infants (*105*) and young children (*106*), evidence from household settings now suggests that this shedding may not translate into an increased risk of influenza transmission (*104*). Therefore, the recommended duration of additional IPC precautions for influenza is the same as for ARIs in general (see above).

Severe acute respiratory syndrome

The duration of infectivity for SARS is not well defined. Although it has been reported that conversion to a negative reverse transcriptase-polymerase chain reaction (RT-PCR) may take a long time (median 30 days, longest 81 days), the clinical and epidemiological significance of this conversion is not known. In studies in Hong Kong SAR, China, no SARS-CoV could be cultured from clinical samples once the infected patients became asymptomatic (*107*).

Newly emerging ARIs

Implement additional IPC precautions at the time of admission, and continue for the duration of symptomatic illness, modifying according to the pathogen and patient information. Base the precautions used and their duration on information about transmission risk as it becomes available, and on local health authority recommendations. It may be prudent to implement the highest level of IPC precautions possible, including the use of particulate respirators, until the mode of transmission is clarified.

Discharge of patients infected with an ARI of potential concern

These are the recommendations suggested for discharging patients who are still symptomatic:

- Determine whether or not to discharge the patient on the basis of their clinical condition. If a patient with an ARI of potential concern no longer requires hospital care, assess the infection risk before discharge by assessing the patient's home environment. A sample checklist is provided in Annex C. To reduce the risk of transmission in the home setting, avoid discharging patients if IPC measures cannot be implemented, (*74, 75*).

[1] Patient information (e.g. age, immune status and medication) should be considered in situations where there is concern that a patient may be infectious for a prolonged period.

- Educate patients and their family members about personal hygiene and basic IPC measures (e.g. respiratory hygiene, hand hygiene, use of PPE if necessary, and adequate ventilation of rooms) (*51, 108, 109*).
- Enquire about household members who may be at higher risk of ARIs or their complications. Such people include those who are immunocompromised, pregnant women, people with chronic illness (e.g. heart, lung or kidney disease, and sickle cell disease), young children (< 2 years of age), and the elderly (> 65 years of age). These individuals should not have contact with the patient until the patient is asymptomatic. If this is not possible, alternative housing during the patient's isolation period could be considered (*110, 111*).
- Provide the patient or caregiver with instructions for follow-up clinic visits and a means to contact a health-care provider, if necessary (*112, 113*).

2.2.5 Family member and visitors

For all ARIs

- Advise visitors about the possible risk of ARI transmission, and ask them about whether they have any symptoms before they enter the facility or ward (*96, 114-116*).
- In the case of a paediatric patient, encourage and support parents, relatives or legal guardians to accompany the child throughout the hospitalization (*117, 118*). Parents, relatives or legal guardians could also assist in providing care to ARI patients in some situations (e.g. where there is a lack of resources), provided that it is possible to ensure hand hygiene and an adequate supply of PPE (with training and supervision of PPE use) (*117, 119*).

For ARIs of potential concern

Implement the recommendations given above for all ARIs, plus the following measures:

- Instruct visitors about the appropriate use of PPE and hand-hygiene before entry into an isolation room or area (*115, 120*).
- Evaluate family members and visitors with respiratory symptoms as possible cases of ARI of potential concern (*74, 96, 115, 116, 121*).

Rationale

Care of a patient in isolation can become a challenge when:

- resources are inadequate;
- the patient has poor hygiene habits or cannot assist in maintaining IPC precautions;
- the patient receives visitors;
- family members are frequently involved in the care of the patient.

Nevertheless, it is essential that the patient's right to receive visits and the child's right to be accompanied by a parent, relative or legal guardian is guaranteed. Therefore, the risk of ARI transmission should be mitigated by providing IPC instructions to visitors and accompanying guardians.

2.2.6 Specimen collection, transport and handling within health-care facilities

For all ARIs

- Ensure that health-care workers who collect specimens from patients with ARIs wear appropriate PPE (Table 2.1).
- Place specimens for transport in leak-proof specimen bags that have a separate sealable pocket for the specimen (i.e. a plastic biohazard specimen bag), with the patient's label on the specimen container, and a clearly written request form (*122*).
- Ensure that personnel who transport specimens are trained in safe handling practices and spill decontamination procedures (*123*).
- Ensure that laboratories in health-care facilities adhere to best biosafety practices according to the type of organism being handled (*124*).

For ARIs of potential concern

Implement the recommendations given above for all ARIs, plus the following measures:

- Deliver all specimens by hand whenever possible. Do not use pneumatic-tube systems to transport specimens (*125*).
- State the name of the suspected ARI of potential concern clearly on the accompanying request form. Notify the laboratory as soon as possible that the specimen is being transported.

Rationale

All specimens should be regarded as potentially infectious, and health-care workers who collect or transport clinical specimens should adhere rigorously to Standard Precautions, to minimize the possibility of exposure to pathogens. For further information on specimen handling and collection guidelines, see:

- *WHO laboratory biosafety guidelines for handling specimens suspected of containing avian influenza A virus*, 2005 (*126*);
- *WHO guidelines for the collection of human specimens for laboratory diagnosis of avian influenza infection*, 2005 (*127*).

For further information on laboratory biosafety guidelines, see the WHO *laboratory biosafety manual*, 2004 (*128*).

2.2.7 Health-care worker vaccination and occupational health

Health-care facility administrators

- Vaccinate health-care workers caring for patients who are at higher risk of severe or complicated influenza disease, to reduce illness and mortality among these patients (Strong recommendation, very low to low quality of evidence) (*129-131*) (Annex K, Table K.8).[1]
- Inform health-care workers who are at high risk of severe or complicated illness from influenza and ARIs of potential concern about the medical risks of providing care to ARI patients and offer alternative work assignments (*111, 132, 133*).
- Develop a surveillance system for health-care workers for influenza-like illness (ILI).

[1] Refer to the WHO *Guidelines for the use of seasonal influenza vaccine in humans at risk of H5N1 infection*, 2004 (*14*).

- Exclude health-care workers with ILI from units, zones or wards that house patient populations that are at high risk of severe disease from ARIs (e.g. neonatal intensive care unit, and haematopoietic stem cell transplantation unit) (*134-137*).

Special recommendations for health-care facilities managing patients with ARIs of potential concern are as follows:

- Keep a register of health-care workers who have provided care for patients with ARIs of potential concern, for contact tracing (*138*).
- Develop a system to monitor health-care workers' health, especially that of workers providing care for patients with ARIs of potential concern, that uses self-reporting by symptomatic workers (Annex D) (*139, 140*). Provide prompt access to diagnosis, counselling and treatment if these are available.
- Antiviral prophylaxis is not routinely recommended. If local policy recommends antiviral prophylaxis, health-care facility administrators should contact public health officials for assistance in obtaining adequate supplies for prophylaxis of health-care workers providing care for patients with ARIs of potential concern, in line with local guidance. Details of appropriate use of antiviral prophylaxis for influenza are provided in *WHO guidelines for pharmacological management of pandemic (H1N1) 2009 influenza and other influenza viruses*, 2010 (*15*).
- Consider developing methods to provide additional support to health-care workers taking care of patients with ARIs of potential concern (e.g. emotional and family support), as necessary (*141, 142*).

Health-care workers who provide care for patients known or suspected to be infected with an ARI of potential concern

- Organize health-care workers into groups designated for caring for patients. Check temperature regularly (e.g. before each work shift), and monitor for symptoms of ILI (cough, sore throat and difficulty in breathing) for 7–10 days after last possible exposure to a patient with an ARI of potential concern (Annex D) (*93, 143*).
- Advise workers to take the following actions if they develop a fever > 38 °C or symptoms of ILI (*93, 144*):
  - stop work immediately or do not report to work;
  - limit interactions with others;
  - exclude themselves from public areas; and
  - notify management or the team dealing with IPC and occupational health that they are symptomatic and have had contact with patients with an ARI of potential concern.

Rationale

During ARI outbreaks, health-care workers can become infected either through exposure in the community or in the health-care facility (i.e. not necessarily as a result of patient exposure) (*145*). Once infected, these workers can serve as sources of transmission to other staff and to their patients, who may be at higher risk of severe or complicated illness from ARIs. Therefore, influenza vaccination of workers caring for patients at high risk for severe disease could reduce the risk of infection among these patients. (For more information on the evaluation of vaccination of health-care workers, see Annex K.) While seasonal influenza vaccine does not provide protection against new influenza viruses, such as avian influenza, it

will help to prevent concurrent infection with seasonal human influenza (*146*), and thus reduce confusion in diagnosis and unnecessary work furlough in areas with frequent reported cases of avian influenza. Antibody responses are usually developed within 2 weeks of influenza vaccination in adults. Vaccination should not preclude the full application of IPC precautions.

2.3 Recommendations for engineering and environmental control for acute respiratory infection

2.3.1 Placement of patients and spatial separation

For all ARIs

- Place patients infected with ARIs in adequately ventilated rooms.
- Maintain spatial separation (distance of at least 1 m) between each ARI patient and other individuals not wearing PPE, to reduce the transmission of ARI pathogens (Strong recommendation, very low to low quality of evidence) (*12, 51, 143, 147*) (Annex K, Table K.3).

ARIs of potential concern

- Place patients infected with an ARI of potential concern in adequately ventilated single rooms or Airborne Precaution rooms (*51*).
- If possible, situate rooms used for isolation of ARIs of potential concern (i.e. single rooms) in an area that is clearly segregated from other patient-care areas (*31, 51, 86, 99, 148*).

Rationale

Patient placement should be planned according to:

- the presence of epidemiological and clinical clues of ARIs of potential concern;
- the precautions undertaken, in addition to Standard Precautions, for the suspected or confirmed causative agents; and
- the availability of facilities.

Airborne Precaution rooms should be prioritized for patients with obligate (pulmonary TB) or preferential airborne infections (e.g., measles and chickenpox) and for patients infected with novel agents causing ARIs of potential concern for which there is no information on possible routes of transmission.

Transmission of ARIs through droplet nuclei at short range can occur during aerosol-generating procedures associated with increased risk of pathogen transmission (Annex A) under special situations (e.g. inadequate use of PPE or poor environmental ventilation). Rooms should be kept adequately ventilated.

Section 2.2.2 discusses cohorting and special measures; Annex B gives details of isolation precautions; and Annex E gives details of isolation rooms.

2.3.2 Design of triage and waiting areas

- Ensure that triage and waiting areas are adequately ventilated (*1-3*).
- Organize the space and the processes to allow for spatial separation (at least 1 m) between patients waiting to be seen (*51*), and undertake rapid triage of patients with

acute febrile respiratory diseases. Screen patients for risk factors associated with ARIs of potential concern (*52, 54, 86*).

2.3.3 Environmental controls for aerosol-generating procedures

- Use adequately ventilated single rooms when performing aerosol-generating procedures that have been consistently associated with increased risk of ARI transmission (Conditional recommendation, very low to low quality of evidence) (*1, 149*) (Annex K, Table K.7; Annex A).

2.3.4 Corridors

- Maintain a ventilation rate of 2.5 L/s/m3 in corridors and other transient spaces. When patient care is regularly undertaken in corridors during emergency or other situations, apply the same ventilation rate requirements as for regular patient-care areas (60 l/s/patient) (*1*).

2.3.5 Ultraviolet germicidal irradiation in health-care settings

At this time, it is not possible to make a recommendation about the use of ultraviolet germicidal irradiation (UVGI) to reduce the risk of transmission of ARI pathogens in health-care facilities (Annex K.2, Table K.9).

Rationale

There is very limited evidence to suggest that the transmission of ARI pathogens from patients to health-care workers or other patients can be prevented by the use of UVGI in health-care settings (*150*). Additional research is needed to understand whether the use of UVGI for disinfection of air reduces transmission of specific ARI pathogens from patients to health-care workers during care delivery in health-care settings, with or without the use of other precautions. In addition, more research is required to assess the potential harms and cost effectiveness of using UVGI in these settings. Therefore, no recommendation about the use of UVGI to reduce the risk of transmission of ARI pathogens in health-care facilities is possible at this time.

2.4 Recommendations for use of personal protective equipment

- Use PPE in the context of other prevention and control strategies (*151*), and in accordance with IPC recommendations (e.g. Standard, Contact, Droplet or Airborne Precautions) (*95*).
- Use appropriate PPE as determined by risk assessment (according to the procedure and suspected pathogen, see Table 2.1). Appropriate PPE that may be required when providing care to patients presenting with ARI syndromes includes one or more of the following: medical mask (surgical or procedure mask), gloves, long-sleeved gowns and eye protection (goggles or face shields) (Strong recommendation, low to moderate quality of evidence) (*51*) (Annex K, Table K.5).
- Use PPE – including gloves, long-sleeved gowns, eye protection (goggles or face shields) and facial mask (surgical or procedure mask, or particulate respirators)[1] – during aerosol-generating procedures that have been consistently associated with an increased

[1] There is no evidence to suggest a difference in the effectiveness of particulate respirators over medical masks as a component in the use of PPE for routine care. However, it is not known whether there is any difference in the setting of care involving aerosol-generating procedures. When performing such procedures associated with an increased risk of transmission of ARI pathogens, it may be preferable to use particulate respirators (Annex A).

risk of transmission of ARI pathogens (*27, 51*).[1] The evidence suggests that performing or being exposed to endotracheal intubation, either by itself or combined with other procedures (e.g. cardiopulmonary resuscitation or bronchoscopy), is consistently associated with increased risk of transmission (Conditional recommendation, very low to low quality of evidence) (*149*) (Annex K, Table K.6).

- Monitor health-care workers' compliance with proper use of PPE. This is particularly important when caring for patients with ARIs of potential concern.
- Ensure that staff receive appropriate training on the use of PPE (*87, 151-155*).

Annex E gives details of preparation of an isolation room or area, and of wearing and removing PPE.

2.4.1 Rational use of personal protective equipment

- Ensure sufficient supplies of appropriate PPE (*87, 152, 154, 155*). If resources are limited and disposable PPE items are not available, use reusable items (e.g. disinfectable cotton gowns) and disinfect properly after each use (*99*). To avoid wastage, critically evaluate situations in which PPE is indicated (using Table 2.1), and maximize the provision of clinical care during each entry to the patient's room (*95*).
- Avoid reuse of disposable PPE items. It is not known whether reusing disposable PPE is as safe and effective as using new PPE, and reuse may increase the risk of infection for health-care workers (*156 , 157*).

Respiratory protection

- Ensure that users receive training on how to put on a particulate respirator, and that they understand the need to perform the seal check every time the respirator is worn, to avoid contamination during use, and to remove and dispose of the respirator (*158*). If patients with known or suspected airborne infections (e.g. pulmonary TB) are cohorted in a common area or in several rooms on a nursing unit, and if multiple patients will be visited sequentially, it may be practical for a health-care worker to wear a single particulate respirator for the duration of the activity. This type of use requires that the respirator not be removed at any time during the activity, and that the user does not touch the respirator. If the respirator gets wet or dirty with secretions, it must be changed immediately.
- If supplies are limited, prioritize the use of particulate respirators for workers who provide care to patients with obligate and preferentially airborne-transmitted diseases, and who are performing aerosol-generating procedures that have been consistently associated with increased risk of pathogen transmission (Annex A, Section A.1). If a particulate respirator is not available, whenever possible, avoid performance of aerosol-generating procedures associated with an increased risk of pathogen transmission in patients with ARIs of potential concern (*101, 102, 116, 159, 160*).

Medical masks

- Wear medical masks fitted tightly to the face, and discard immediately after use (*161, 162*). If the mask gets wet or dirty with secretions, it must be changed immediately.

[1] When a novel ARI is identified and the mode of transmission is unknown, it may be prudent to implement the highest level of IPC precautions whenever possible (including the use of particulate respirators), until the mode of transmission has been clarified.

Gloves

- If supplies of gloves are limited, reserve gloves for situations where there is a likelihood of contact with blood, respiratory secretions, or body fluids, including during aerosol-generating procedures that have been consistently associated with increased risk of pathogen transmission (Annex A) (*155, 163, 164*). Apply standard IPC practices for glove use (e.g. changing gloves between patients). The use of gloves does not eliminate the need to perform hand hygiene (Annex B).

Gowns

- If supplies of gowns for health-care workers are limited, prioritize the use of gowns for aerosol-generating procedures that have been consistently associated with increased risk of pathogen transmission (Annex A, Section A.1) and for activities that involve close contact with the patient (e.g. in paediatric settings) (*155, 163*). Gowns may also be worn during the care of more than one patient in a single cohort area only, provided that the gown does not come into direct contact with any patient.

Eye protection

- Reusable eye protective equipment can be used (e.g. goggles or face shield), but may pose a risk of cross-infection if not cleaned and decontaminated properly according to the manufacturer's instructions after each use (*87*). Ensure that equipment is thoroughly cleaned before disinfection (*165-170*). Perform hand hygiene after disposal or cleaning of eye protection equipment that may be contaminated with splash or spray (*97, 98*).
- Do not use conventional eye glasses as eye protection, because they are not designed to protect against splashes to the eye mucosa.

Rationale

PPE is meant to provide additional protection for the user but should not result in increased risk for other individuals or the environment. PPE supplies may be limited, and reuse of PPE items unavoidable; however, items should be reused under safe conditions. Avoid use of unnecessary PPE.

2.5 Recommendations for care of the deceased

2.5.1 Removal of the body from the isolation room or area

- Ensure proper use of PPE, according to Standard Precautions, to avoid direct contact with body fluids (*51, 95*).
- Apply principles of cultural sensitivity. If the family of the patient wishes to view the body after removal from the isolation room or area, they may be allowed to do so with the application of Standard Precautions (*95*). Annex F provides details of recommended PPE and procedures for body packing and transport for ARI of potential concern.

2.5.2 Mortuary care

- Ensure that mortuary staff and the burial team apply Standard Precautions (i.e. perform proper hand hygiene and use appropriate PPE, including long sleeved gown, gloves and facial protection if there is a risk of splashes from the patient's body fluids or secretions onto the body or face of the staff member) (*51, 95, 97, 98, 171, 172*).
- Apply Standard Precautions if hygienic preparation of the deceased (e.g. cleaning of body, tidying of hair, trimming of nails and shaving) is desired (*95*).

Rationale

Transmission of lethal infectious diseases associated with mortuary care has been reported (*173*), however, the cultural context of the local community should also be respected (*174*). Assess the risk during the mortuary care process, and provide adequate explanation to the family. If indicated, provide PPE to the family, with instruction in its use. Manage each situation on a case-by-case basis, balancing the rights of the family with the risks of exposure to infection.

2.5.3 Postmortem examination

- Ensure that safety measures are in place when performing postmortem examinations and collection of samples for microbiologic analyses (Annex F).
- Apply appropriate safety measures to protect those performing the examination (*175-177*) (Annex F).
- Engage a minimum number of staff in the procedure, and perform only if (*178, 179*):
  - an adequately ventilated room suitable for the procedure is available; and
  - appropriate PPE is available; for details of PPE suggested, and how to put on and take off PPE, refer to Annex F.

2.5.4 Engineering and environmental controls for autopsy

- Perform autopsies in an adequately ventilated room (*180*).
- Minimize aerosols in the autopsy room (e.g. during lung excision) by:
  - avoiding the use of power saws whenever possible (*181, 182*);
  - avoiding splashes when removing, handling or washing organs, especially lung tissue and the intestines (*181, 182*); and
  - using exhaust ventilation to contain aerosols and reduce the volume of aerosols released into the ambient air environment; exhaust systems around the autopsy table should direct air and aerosols away from health-care workers performing the procedure (e.g. exhaust downward) (*182-184*).

For details of how to reduce aerosol generation during autopsy, refer to Annex F.

- Clean surfaces that have become contaminated with tissues or body fluids and decontaminate by (*179*):
  - removing most of the tissue or body substance with absorbent materials;
  - cleaning surfaces with water and detergent;
  - applying the disinfectant standardized by the health-care facility – if sodium hypochlorite solution is used (Annex G, Table G.1), wet the surface with the solution and allow at least 10 minutes contact time;
  - rinsing thoroughly.

Rationale

Safety procedures for deceased individuals infected with an ARI should be consistent with those used for any autopsy procedure. In general, the known hazards of work in the autopsy room seem to arise from contact with infectious materials and, particularly, with splashes onto body surfaces of health-care workers rather than from inhalation of infectious material. However, if a patient with an ARI of potential concern died during the infectious period, the

lungs and other organs may still contain live virus, and additional respiratory protection is needed during procedures that generate small-particle aerosols (e.g. use of power saws and washing of intestines). Therefore, postmortem examinations of patients with ARIs of potential concern deserve special caution.

3 Health-care facility preparedness planning for acute respiratory infection epidemics

The SARS outbreak of the early 2000s, and the influenza pandemic (H1N1) 2009, highlighted the importance of preparedness to reduce the spread of potentially epidemic or pandemic ARIs. Health-care facilities should prepare for communicable disease emergencies by (*185-188*):

- organizing permanent IPC activities, surveillance and training of dedicated personnel and clinical staff;
- creating a multidisciplinary group within the health-care facility to develop a preparedness plan;
- developing a preparedness plan in the health-care facility;
- performing a plan evaluation and monitoring exercise, and updating the plan as necessary; and
- strengthening liaison with other levels of the health-care system and public health authorities.

Rationale

Most of the population will have no immunity against a new respiratory virus that could potentially cause an epidemic or pandemic. Thus, if the initial containment fails, a substantial proportion of the population, including health-care workers, may fall ill and require health-care services. There may be a need to manage large numbers of ill patients requiring various levels of health care, and to contain the spread of ARIs of potential concern associated with heath care. Preparedness of health-care facilities is considered an essential part of general emergency preparedness plans (*189, 190*). The main goals are to:

- identify, isolate and report early cases of a putative epidemic or pandemic ARI virus;
- keep the health-care system functioning for pandemic and non-pandemic patients; and
- reduce the risk of pandemic ARI transmission associated with health care.

The capacity of the health-care facility to respond efficiently to epidemic or pandemic threats at any given moment is highly dependent on existing standards of practice. The implementation of additional measures during an outbreak is challenging, and the lack of good baseline standards may hamper efforts to respond to the epidemic or pandemic. Thus, ARI epidemic or pandemic preparedness requires continuous strengthening of early detection systems and safe care practices in the health-care facility. Promotion of routine Standard Precautions in health care is the cornerstone of reducing the spread of pathogens. Such promotion should be increased worldwide, to support the preparedness of health-care facilities for epidemics and a potential pandemic.

3.1 Components of health-care facility pandemic acute respiratory infection preparedness plans

These plans should take into account the geographical location of the facility and the progress of the ongoing pandemic, if any. The strategy should include actions to be taken

before, during, and after the epidemic or pandemic event and be part of the overall Emergency Response Plan, based on the health-care facility's risk assessment. They should address the issues outlined below: surveillance, triage, surge capacity, access, risk communication, IPC, occupational health, patient flow and discharge planning, mortuary and promotion of outpatient care.

3.1.1 Surveillance

- As a priority, establish within the health-care facility processes for the early recognition and investigation of possible pandemic ARI patients (*57, 58*).
- Connect the hospital and public-health infectious diseases surveillance systems, and immediately report any essential information about possible pandemic ARI cases to public health authorities. The reporting should occur through the local surveillance system, as per Annex 1 of the IHR (2005) (*6*).
- Public-health authorities should keep health-care facilities informed about ongoing epidemics.
- In the case of pandemic influenza:
  - enhance ILI surveillance (Annex D) (*185, 191*);
  - define criteria that would shift surveillance of episodes of influenza of potential concern (e.g. human cases of avian influenza) from passive to active (*185, 188, 192*).

3.1.2 Triage

- Define IPC measures for triage, flow, and placement of patients, and early reporting and treatment.
- Organize front-line services (e.g. emergency department) for triage of patients with respiratory symptoms (*52, 192*).
- Promptly initiate IPC precautions when a possible epidemic or pandemic ARI episode is suspected (*64, 189, 193*).

3.1.3 Surge capacity

- Plan for surge capacity according to the estimated impact of a potential pandemic on health care (*194-198*). (Annex H provides information on how to do this.)
- Identify the supplies and infrastructures needed to implement IPC measures.
- Outline the limits of the health-care facility's surge capacity to provide care, and suggest thresholds at which alternative sites for provision of health care (i.e. off-site care facilities) should be implemented (*194-198*).

Outline surge capacity in relation to (*194-198*):

- supplies (e.g. pharmaceuticals and PPE);
- ventilators and supplemental oxygen;
- staff – develop plans to maintain sufficient personnel to carry out activities (e.g. by planning alternative shifts or staffing assignments, and having a supplemental staffing plan);
- infrastructure;
- space;

- laboratory and diagnostic capacity; and
- security policies to handle an unexpected increase in demand for services.

3.1.4 Access

Establish policies for access to the health-care facility for (*114*):

- the public;
- visitors (those who are allowed to enter should be educated on respiratory hygiene and risk of disease transmission, and screened or surveyed for ARIs);
- health-care workers (i.e. flow of workers through the facility); and
- patients (i.e. patient flow).

3.1.5 Risk communication policy

Develop a risk communication policy to cover communication (*199*):

- within the health-care facility;
- with other health-care facilities;
- with other public health bodies, government agencies and ministries;
- with other societal bodies (e.g. media, professional societies and nongovernmental organizations).

3.1.6 Infection prevention and control

Undertake IPC measures, as follows:

- Engage health-care workers in prioritization of resources and training (e.g. use of PPE).
- Engage health-care workers in the process of implementing the IPC measures to decrease the infection risk.
- For all staff members involved in IPC prepare Job Action Sheets describing their roles and tasks in an emergency situation; ensure they participate in regular exercises in order to enhance their ability to fulfil their roles.
- Reinforce Standard Precautions (Annex B), to promote a culture of safe practices (*154*).
- Educate health-care workers about pandemic ARIs, with information about the main pathogens, epidemiology, morbidity, routes of transmission, breaking the chain of transmission and PPE use (e.g. risk assessment, proper ways to put on and take off, and safe disposal) (*55, 86, 144, 158*).
- Plan which areas in health-care facilities will be used for pandemic ARI patients.
- Apply IPC precautions according to the pandemic pathogen (Table 2.1) (*95, 200*).
- For specimen collection, transport and handling within the health-care facility (*201*):
  - when collecting specimens, use IPC precautions according to the pandemic pathogen (Table 2.1);
  - when transporting specimens to the laboratory, use Standard Precautions;
  - when handling specimens, follow appropriate biosafety practices.
- Define procedures for safe transport of patients both within the health-care facility and between facilities.

- Establish environmental and engineering controls, such as ensuring effective environmental ventilation and cleaning.

3.1.7 Occupational health programme

- Monitor and support the health of health-care workers.
- Consider appropriate vaccination (e.g. seasonal influenza vaccine) (*190, 202, 203*).
- Consider vaccination against a new ARI of potential concern, if a vaccine is available.
- Emphasize ILI surveillance among health-care workers; this may help to provide early signals of human-to-human transmission of a new ARI agent (*202*).
- Treat and follow up health-care workers infected with epidemic or pandemic ARI (*15, 204*).
- Plan staff reassignment according to risk assessment (*111, 132, 133, 205*).
- Provide psychosocial support.

3.1.8 Patient flow and discharge planning

- Heighten awareness of the clinical presentation of the ARI during an outbreak period, to increase early recognition of possible cases (*52*).
- Plan a safe flow of patients, to help prevent transmission of ARI-causing pathogens (*52*). For example, provide health services targeting uninfected populations (e.g. prenatal care, injury care, well-child visits and treatment of non-infectious diseases), particularly those who are at high risk of a complicated ARI (e.g. the immunocompromised and the elderly), in an area separate from patients known or suspected to have the ARI.
- Plan the discharge of a patient based on the patient's clinical conditions, assessment of the patient's home conditions and the capability of home caregivers to comply with instructions. (See Section 2.2.4 for details.)

3.1.9 Mortuary

- Plan strategies to cope with mass fatalities, including how to conduct burials for a large number of people.
- Take cultural and religious aspects into consideration (*174*).

3.1.10 Promotion of outpatient care of ARI patients in the event of pandemic

- Liaise with other stakeholders within the health-care system (e.g. community health centres) to help support outpatient care when the patient needs higher levels of care than usual. For example, acute-care health-care facilities may refer patients to ambulatory-care facilities for diagnosis, treatment and follow-up, according to the patient's clinical status (*188*). For additional information about IPC across the continuum of health care, see Annex J.
- Apply strategies to limit unnecessary office visits by ill patients; for example, divert patients to designated pandemic influenza triage and evaluation sites, and use triage before arrival at the health-care facility to determine which patients need on-site medical evaluation.

4 Research gaps

The recommendations in this document are based on the scientific evidence available at the time of publication. However, there are research gaps in many areas pertinent to IPC practices for ARIs. For example, there is a lack of high-quality research on (*206, 207*):

- several facets of the transmission of ARIs, and the effectiveness of interventions to reduce transmission of ARIs, particularly with respect to epidemiologically relevant outcomes; and
- the cost and resource implications of interventions to reduce transmission of ARIs, and the social and cultural factors that might compromise compliance with the application of interventions.

The identification of these research gaps will be useful in planning and conducting future studies in areas relevant to ARIs and in using IPC approaches to reduce the transmission of ARI pathogens.

4.1 Aerosol-generating procedures

There is a significant research gap regarding the epidemiology of ARI transmission from patients to health-care workers during aerosol-generating procedures, particularly with respect to pathogens other than SARS-CoV. This gap is compounded by a lack of precision in the literature with regard to the definition for aerosol-generating procedures. In addition, little information exists on the minimum ventilation requirements to reduce pathogen transmission during such procedures. There is no evidence to suggest a difference in the effectiveness of particulate respirators over medical masks as a component of PPE for routine care; however, research is needed to determine whether there is a difference between the effectiveness of particulate respirators and medical masks in the context of aerosol-generating procedures that have been consistently associated with increased risk of pathogen transmission.

4.2 Epidemiology of transmission

Additional research is required to fully elucidate the epidemiology of transmission of specific ARIs from patients to health-care workers, and to other patients, during care delivery in health-care settings:

- with and without the use of specific precautions;
- with the use of triage and early identification alone versus its use in combination of other selected precautions; and
- with the use of spatial separation alone versus spatial separation with the use of other selected precautions. In relation to spatial separation, high-quality epidemiological studies are needed to examine the effect of discrete parameters (e.g. 1 m, 2 m) of spatial separation on the reduction of transmission and infection by ARIs.

4.3 Duration of IPC precautions

The specific duration of infectious period for ARI pathogens is unknown. In particular, research is needed to undertand whether extending the duration of additional IPC precautions after the resolution of symptoms for patients with ARIs in health-care settings

reduces the risk of transmission to other patients and to health-care workers. There is also a need for research into:

- using routine laboratory tests as a guide to define the duration of IPC precautions for individuals with ARI in health-care settings; and
- the harms and cost implications of using laboratory tests to define the duration of IPC precautions.

4.4 Cohorting and special measures

In relation to cohorting (placement of patients infected with the same known pathogen in a common designated unit, zone or ward) and special measures (placement of patients with the same suspected but not laboratory-confirmed diagnosis in a common designated unit, zone or ward), additional research is required to:

- fully validate the equivalence of special measures and cohorting with respect to the reduction of transmission of ARI pathogens;
- fully elucidate the epidemiology of ARI transmission from patients to health-care workers with the use of cohorting alone compared to cohorting with other selected precautions, such as PPE; and
- study the cost and resource implications for cohorting in different settings around the world.

4.5 Other interventions

The effectiveness of respiratory hygiene in people with ARI as a means to reduce droplet dispersion and clinical illness among contacts needs to be determined.

Research is also needed:

- into whether the use of UVGI for disinfection of air in health-care settings further reduces the risk of transmission of and infection with specific ARI pathogens in such settings, with and without the use of other precautions; and
- to assess the potential harms and cost effectiveness of the use of UVGI in health-care settings.

Studies suggest that influenza vaccination of health-care workers provides a protective effect to patients in long-term residential care facilities (where patient turn-over is very low compared to standard health-care settings and where most patients are at high risk of complications from influenza infection); however, the relevance of these findings to acute health-care facilities requires further study. The benefits of other vaccinations, as well as the safety and cost effectiveness of implementing a vaccination programme for workers are yet to be determined.

Annex A Respiratory protection

A.1 High-risk aerosol-generating procedures

Aerosols are produced when an air current moves across the surface of a film of liquid, generating small particles at the air–liquid interface. The particle size is inversely related to the velocity of air. Therefore, if a procedure causes air to travel at high speed over the respiratory mucosa and epithelium, the production of aerosols containing infectious agents is a potential risk. An aerosol-generating procedure is defined as any medical procedure that can induce the production of aerosols of various sizes, including droplet nuclei. Previously, the association between medical procedures that are known to produce aerosols and an increased risk of pathogen transmission had not been rigorously evaluated. However, a systematic review on aerosol-generating procedures and the risk of ARI transmission has now made it easier to determine which procedures are associated with a high risk of transmission and provides a basis for recommendations (*149*). The review also highlighted the following research gaps:

- a lack of information about the risk of ARI transmission from patients to health-care workers during aerosol-generating procedures, particularly with respect to pathogens other than SARS-CoV;
- a lack of precision in the definition of aerosol-generating procedures;
- the need to determine the minimum environmental ventilation requirements in terms of variable ventilation rate;
- the need for control of airflow direction for aerosol-generating procedures.

Our understanding of the aerobiology of aerosol-generating procedures will continue to evolve. Annex L (Table L.1 and Figs L.2A & B) describes the results of studies evaluating the infection risk associated with aerosol-generating procedures. All included studies were found to be very low quality by the GRADE evaluation framework (*149*).

The evidence, the best of which comes from studies of SARS-CoV, suggests a consistent association between pathogen transmission and tracheal intubation (*149*). In addition, a few studies reported an increased risk of SARS-CoV infection associated with tracheotomy, non-invasive ventilation, and manual ventilation before intubation. However, because these findings were identified from only a few studies of very low quality, interpretation and practical application is difficult. No other procedures were found to be significantly associated with any increased risk of ARI transmission.

Recommendations for environmental controls and PPE use for health-care workers performing aerosol-generating procedures on ARI patients have been addressed in Chapter 2 (Sections 2.3.3 and 2.4).

A.2 Selection of respiratory protection equipment

A.2.1 Particulate respirators

Considerations for health-care workers:

- If caring for patients with an airborne infection (e.g. pulmonary TB), or undertaking aerosol-generating procedures associated with an increased risk of transmission of ARI

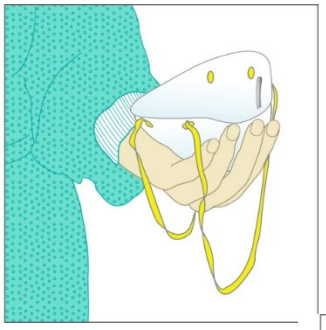
pathogens, select the highest level of respiratory protection equipment available, preferably a particulate respirator.

- When putting on a disposable particulate respirator, always check the seal (Fig. A.1, below).

Considerations for health-care facilities:

- The fit and seal of disposable particulate respirators are important for effective function. If the fit and seal are poor, airborne particles may be inhaled from leaks, and the particulate respirator may not be effective. Consider undertaking respirator fit-testing with users, to determine which model or models will achieve an acceptable fit, before procuring large stocks of respirators.
- Train those who may need to wear a particulate respirator in how to use the device (e.g. putting on of respirator, avoiding self-contamination during use and on removal, and achieving the best seal) (*158*). The inclusion of fit-testing in respirator user-training has not been shown to be an effective means to improve compliance with proper use of respirators (*158*). Follow local regulations regarding the regular performance of the fit test.

Figure A.1 Sequence of steps in a particulate respirator seal check



1 Cup the respirator in your hand with the nosepiece at your fingertips allowing the headbands to hang freely below your hand.

2 Position the respirator under your chin with the nosepiece up.

3 Pull the top strap over your head resting it high at the back of your head. Pull the bottom strap over your head and position it around the neck below the ears.

4 Place fingertips of both hands at the top of the metal nosepiece. Mould the nosepiece (USING TWO FINGERS OF EACH HAND) to the shape of your nose. Pinching the nosepiece using one hand may result in less effective respirator performance.

5 Cover the front of the respirator with both hands, being careful not to disturb the position of the respirator.

5A Positive seal check
- Exhale sharply. A positive pressure inside the respirator = no leakage. If leakage, adjust position and/or tension straps. Retest the seal.
- Repeat the steps until respirator is sealed properly.

5B Negative seal check
- Inhale deeply. If no leakage, negative pressure will make respirator cling to your face.
- Leakage will result in loss of negative pressure in the respirator due to air entering through gaps in the seal.

- Facial hair impedes good fit, and a seal may not be achieved, decreasing the efficiency of the particulate respirator. Health-care workers with facial structure abnormalities also may be unable to obtain a good seal and need alternative approaches for respiratory protection.
- Examples of acceptable disposable particulate respirators in use in various parts of the world include[1]:
  - Australia/New Zealand: P2 (94%), P3 (99.95%)
  - China: II (95%), I (99%)
  - European Union: Conformité Européenne-certified filtering facepiece class 2 (FFP2) (95%), or class 3 (FFP3) (99.7%)
  - Japan: 2nd class (95%), 3rd class (99.9%)
  - Republic of Korea: 1st class (94%), special (99.95%)
  - US: National Institute for Occupational Safety and Health (NIOSH)-certified N95 (95%), N99 (99%), N100 (99.7%).
- Some factors to consider when choosing particulate respirators in health-care settings are affordability, availability, impact on mobility, impact on patient care, potential for exposure to high levels of aerosolized respiratory secretions, and potential for transmission via contact with contaminated respiratory surfaces.
- Particulate respirators should be changed after each use or if they become wet or dirty (Annex H).

A.2.2 Medical masks

- Medical masks[2] are surgical or procedure masks that are flat or pleated (some are like cups); they are affixed to the head with straps. Such masks should be used when caring for patients infected by droplet-transmitted pathogens or as part of facial protection during patient-care activities that are likely to generate splashes or sprays of blood, body fluids, secretions or excretions.
- However, medical masks may not offer adequate respiratory protection against small-particle aerosols (droplet nuclei). Therefore, particulate respirators are preferable when caring for patients with diseases caused by airborne pathogens (e.g. TB) or a novel ARI pathogen for which the route of transmission is not known (*208-210*). Medical masks are not designed to provide a face seal, and thus do not prevent leakage around the edge of the mask when the user inhales; this is a potential major limitation for protection against droplet nuclei (*211*).
- Medical masks should be changed after each use or if they become wet or dirty (Annex H). Medical masks are considered clinical waste and should be placed in an appropriate clinical waste container.

[1] The percentages in parentheses refer to respirator filter efficiency

[2] In this document, the term "medical mask" refers to **disposable** surgical or procedure masks. Although some alternative barriers to standard medical masks are used in certain settings (e.g. cloth masks, paper masks, etc.), there is insufficient information available on their effectiveness.

A.2.3 Medical mask standards

Medical masks protect the wearer's nose and mouth from inadvertent exposures (e.g. through splashes) to blood and other body fluids. However, there are no minimum standards or standardized testing methods for mask filter efficiency, and available masks vary widely in the efficiency of their filters. As an example of standards, the Association of Perioperative Registered Nurses recommends that surgical masks filter particles of at least 0.3 μm for regular use and 0.1 μm for laser use (i.e. to protect the wearer against laser smoke), or have 90–95% bacterial filtration efficiency. Furthermore, surgical masks are classified as medical devices in Europe and the US and are regulated appropriately. For example, the US Food and Drug Administration (FDA) standards for surgical masks are as follows: [1]

- Fluid resistance:
  - American Society for Testing and Materials (ASTM) F 1862–00a: standard test method for resistance of surgical mask to penetration by synthetic blood.
- Filtration efficiency:
  - particulate filtration efficiency (PFE) – 0.1 μ polystyrene latex sphere;
  - bacterial filtration efficiency (BFE) – ASTM F 2101–01: standard test method for evaluating the BFE of surgical masks using a biological aerosol of *Staphylococcus aureus*.
- Air exchange (differential pressure, delta-P):
  - measure of breathability and comfort of surgical masks.
- Flammability:
  - Class 1 and Class 2 flammability rating material for use in the operating room (OR);
  - Class 4 flammability rating is not appropriate for use in the OR (would be labelled as “not for OR use”).
- Biocompatibility.

[1] For more information, see http://www.fda.gov/cdrh/ode/guidance/094.html

Annex B Isolation precautions

B.1 Standard Precautions

Standard Precautions (*95*) are routine IPC precautions that should apply to ALL patients, in ALL health-care settings. The precautions, described in detail below in Sections B.1.1 to B.1.7, are:

- hand hygiene;
- use of PPE;
- respiratory hygiene;
- environmental controls (cleaning and disinfection);
- waste management;
- packing and transporting of patient-care equipment, linen and laundry, and waste from isolation areas;
- prevention of needle-stick or sharps injuries.

Rationale

Standard Precautions are the basic IPC precautions in health care. They are intended to minimize spread of infection associated with health care, and to avoid direct contact with patients' blood, body fluids, secretions and, non-intact skin. The SARS outbreak illustrated the critical importance of basic IPC precautions in health-care facilities. Transmission of SARS within health-care facilities was often associated with lack of compliance with Standard Precautions. The threat of emerging respiratory infectious diseases makes the promotion of Standard Precautions more important than ever and it should be a priority in all health-care facilities.

For additional information on Standard Precautions, see:

- *Practical guidelines for infection control in health care facilities*, 2004 (*212*);
- *Prevention of hospital-acquired infections: A practical guide*, 2002 (*213*);
- *Aide-memoire: Infection control Standard Precautions in health care*, 2006 (*214*).

B.1.1 Hand hygiene

Hand hygiene is one of the most important measures to prevent and control spread of disease in health-care facilities, and is a major component of Standard Precautions (*215*). Although hand hygiene is a simple procedure, numerous studies have shown that compliance is low. Its implementation is complex, requiring continued reinforcement and multidisciplinary team coordination. The use of alcohol-based hand rubs in health-care facilities has been implemented in recent years, in an attempt to increase compliance with hand hygiene. The main points are as follows:

- If hands are not visibly soiled, hand hygiene should be done using an alcohol-based hand rub, or by washing hands with soap and water, and drying them using a single-use towel.
- If hands are visibly dirty or soiled with blood or other body fluids, or if broken skin might have been exposed to potentially infectious material, hands should be washed thoroughly with soap and water.

Perform hand hygiene:

- before and after any direct contact with patients;
- immediately after removal of gloves;
- before handling an invasive device not requiring a surgical procedure, including central intravascular catheters, urinary catheters or peripheral vascular catheters;
- after touching blood, body fluids, secretions, excretions, non-intact skin or contaminated items, even if gloves are worn;
- when moving from a contaminated to a clean body site on the same patient;
- after contact with inanimate objects in the immediate vicinity of the patient; and
- after using the lavatory.

For additional information on hand hygiene, see:

- *WHO guidelines on hand hygiene in health care*, 2009 (*215*).

B.1.2 Selection of personal protective equipment based on risk assessment

- Routinely assess the risk of exposure to body substances or contaminated surfaces before any anticipated health-care activity.
- Select PPE based on the assessment of risk.
- Ensure that appropriate PPE is available at all times, so that it can be used in the event of an unexpected emergency.

Gloves

- Wear gloves whenever contact with blood, body fluids, secretions, excretions, mucous membranes or non-intact skin is anticipated.
- Change gloves between tasks and procedures on the same patient after contact with potentially infectious material.
- Remove gloves after use, before touching non-contaminated items and surfaces, and before going to another patient.
- Perform hand hygiene immediately after removing gloves.

Facial protection

Wear facial protection, including a medical mask and eye protection (face shield or goggles), to protect the conjunctivae and the mucous membranes of the nose, eyes and mouth during activities that are likely to generate splashes or sprays of blood, body fluids, secretions or excretions. When providing care in close contact with a patient with respiratory symptoms (e.g. coughing or sneezing), use eye protection, because sprays of secretions may occur.

Gowns

- Wear gowns to protect skin and prevent soiling of clothing during activities that are likely to generate splashes or sprays of blood, body fluids, secretions or excretions.
- Select a gown that is appropriate for the activity and the amount of fluid likely to be encountered. If the gown in use is not fluid-resistant, wear a waterproof apron over the gown if splashing or spraying of potentially infectious material is anticipated.
- Remove a soiled gown as soon as possible, place it in a waste or laundry receptacle (as appropriate), and perform hand hygiene.

B.1.3 Respiratory hygiene

Controlling the spread of pathogens from infected patients (source control) is key to avoiding transmission to unprotected contacts. For diseases transmitted through large droplets or droplet nuclei, respiratory hygiene should be applied by all individuals with respiratory symptoms (*90*). Respiratory hygiene refers to covering the mouth and nose during coughing or sneezing using medical masks (Annex A, Section A.2.2), cloth masks, tissues or flexed elbow, followed by hand hygiene to reduce the dispersal of respiratory secretions containing potentially infectious particles.

Health-care facility management should promote respiratory hygiene as follows:

- Promote the use of respiratory hygiene by all health-care workers, patients and family members with ARIs.
- Educate health-care workers, patients, family members and visitors on the importance of containing respiratory aerosols and secretions to help prevent the transmission of ARI pathogens.
- Consider providing resources for hand hygiene (e.g. dispensers of alcohol-based hand rubs and handwashing supplies) and respiratory hygiene (e.g. tissues); prioritize areas of gathering, such as waiting rooms.

B.1.4 Environmental controls: cleaning and disinfection

The viruses and bacteria that cause ARIs can survive in the environment for variable periods of time (hours to days). The bioburden of such microorganisms can be reduced by cleaning, and infectious agents can be inactivated by the use of standard hospital disinfectants. Environmental cleaning and disinfection is intended to remove pathogens or significantly reduce their numbers on contaminated surfaces and items, thus breaking the chain of transmission. Disinfection is a physical or chemical means of killing microorganisms (but not spores), and should be used for non-critical medical equipment used or shared by patients.

- No disinfection is required for surfaces and equipment that do not come into direct contact with patients. These surfaces or equipment should be thoroughly cleaned between patients.

- Clean equipment or surfaces in a way that avoids possible generation of aerosols; this process alone significantly reduces the bioburden of microorganisms.
- When disinfection is required, ensure that cleaning is done before disinfection. Items and surfaces cannot be disinfected if they are not first cleaned of organic matter (e.g. patient excretions, secretions, dirt and soil).
- Follow the manufacturer's recommendations for use or dilution, contact time and handling of disinfectants.
- The viruses and bacteria that cause ARIs are inactivated by a range of disinfectants (*99, 216-220*). However, in some countries, regulatory agencies will control the types of disinfectant available for hospital use. Common hospital disinfectants include:
  - sodium hypochlorite (household bleach);
  - alcohol;
  - phenolic compounds;
  - quaternary ammonium compounds; and
  - peroxygen compounds.
- Sodium hypochlorite and alcohol are available in most countries. The use of these two disinfectants is detailed in Annex G.

Cleaning the patient-care environment

- Clean horizontal surfaces in isolation rooms or areas – focusing particularly on surfaces where the patient has been lying or has frequently touched, and immediately around the patient's bed – regularly and on discharge (*221*).
- To avoid the possible generation of aerosols of ARI pathogens, use damp cleaning (moistened cloth) rather than dry dusting or sweeping.
- During wet cleaning, cleaning solutions and equipment soon become contaminated; change cleaning solutions, cleaning cloths and mop heads frequently, according to health-care facility's policies.
- Ensure that equipment used for cleaning and disinfection is cleaned and dried after each use.
- Launder mop heads daily and dry them thoroughly before storage or reuse (*222*).
- To facilitate daily cleaning, keep areas around the patient free of unnecessary supplies and equipment.
- Use disinfectant to wipe down surfaces used by patients who are known or suspected to be infected with an ARI of potential concern (*52*).
- Do not spray (i.e. fog) occupied or unoccupied rooms with disinfectant; this is a potentially dangerous practice that has no proven disease-control benefit (*223*).
- To facilitate cleaning, and to reduce the potential for generation of aerosols caused by use of a vacuum cleaner, accommodate patients in uncarpeted rooms or areas where possible. If vacuuming is necessary, use a vacuum cleaner that is equipped with a high-efficiency particulate air (HEPA) filter, if available.

Patient-care equipment

- If equipment is reused, follow general protocols for disinfection and sterilization (*224, 225*).
- If not visibly soiled, wipe external surfaces of large portable equipment (e.g. X-ray machines and ultrasound machines) that has been used in the isolation room or area with an approved hospital disinfectant upon removal from the patient's room or area.
- Proper cleaning and disinfection of reusable respiratory equipment is essential in ARI patient care (*226-230*). See Annex G for further details on use of disinfectants.

Dishes and eating utensils

- When possible, wash reusable items in a dishwasher (*231, 232*). If no dishwasher is available, wash the items by hand with detergents. Use nonsterile rubber gloves if washing items by hand.
- Wash dishes and eating utensils for the patient after each meal or use.
- Discard disposable items as waste, classified as directed by the relevant state, territory or national legislation and regulations (*8*).

Linen and laundry

- Remove large amounts of solid material (e.g. faeces) from heavily soiled linen (while wearing appropriate PPE), and dispose of the solid waste in a toilet before placing the linen in the laundry bag (*233-235*).
- Avoid sorting linen in patient-care areas. Place contaminated linen directly into a laundry bag in the isolation room or area with minimal manipulation or agitation, to avoid contamination of air, surfaces and people (*8*).
- Wash and dry linen according to routine standards and procedures of the health-care facility. For hot-water laundry cycles, wash with detergent or disinfectant in water at 70 °C (160 °F) for at least 25 minutes. If low-temperature (i.e. < 70 °C; < 160 °F) laundry cycles are used, choose a chemical that is suitable for low-temperature washing when used at the proper concentration (*236-238*).

B.1.5 Waste management

Waste disposal should be safe for those handling the waste and for the environment. Definitions of clinical (infectious) waste may differ according to local regulations and legislation.

- Classify waste as directed by relevant state, territory or national legislation and regulations. If waste from ARI-infected patients is classified as infectious, then consider all waste from the patient-care area as clinical waste, and treat and dispose of it according to the health-care facility's policy, and in accordance with national regulations pertaining to such waste (*8*).
- Handle faeces with caution to avoid possible generation of aerosols (e.g. during removal of faeces from bedpan, commode or clothing, or when spraying reusable incontinence pads with water) (*233*).
- Flush liquid waste (e.g. urine) or solid faecal waste into the sewerage system, if there is an adequate system in place (*239, 240*).
- Ensure that health-care workers use appropriate PPE whenever there is risk of splash or spray during handling of waste (*95*).

B.1.6 Packing and transporting patient-care equipment, linen and laundry, and waste from isolation areas

- Place used equipment and soiled linen and waste directly into containers or bags in the isolation room or area.
- Contain the used equipment and soiled linen and waste in a manner that prevents the containers or bags from opening or bursting during transport.
- One layer of packing is adequate, provided that the used equipment and soiled linen and waste can be placed in the bag without contaminating the outside of the bag. Double-bagging is unnecessary.
- Ensure that all personnel handling the used equipment and soiled linen and waste use Standard Precautions, and perform hand hygiene after removing PPE. Heavy-duty tasks (e.g. cleaning of the environment) require more resistant PPE (e.g. rubber gloves and apron, and resistant closed shoes).

B.1.7 Prevention of needle-stick or sharps injuries

Although it may not be crucial for prevention and control of ARIs, prevention of needle-stick or sharp injuries is a component of Standard Precautions. It targets the reduction and elimination of transmission of bloodborne pathogens to health-care workers, other patients and people with any possible contact with the related waste.[1]

- Take care to prevent injuries when using needles, scalpels and other sharp instruments or devices when handling sharp instruments after procedures, when cleaning used instruments and when disposing of used needles.
- Never recap used needles.
- Never direct the point of a needle towards any part of the body except before injection.
- Do not remove used needles from disposable syringes by hand, and do not bend, break or otherwise manipulate used needles by hand.
- Dispose of syringes, needles, scalpel blades and other sharp items in appropriate puncture-resistant containers. Such containers should be located as close as practicable to the area in which the items were used.
- Avoid the use of reusable syringes.

B.2 Droplet Precautions

Respiratory pathogens that are transmitted through large droplets include adenovirus, avian influenza A(H5N1), human influenza and SARS-CoV. Adenovirus infections are more common among children, and influenza and SARS-CoV can affect both adults and children. During an influenza pandemic, the circulating human virus is expected to be transmitted in the same manner as seasonal influenza viruses; hence, Droplet Precautions should be applied in addition to Standard Precautions.

[1] Detailed recommendations from the Safe Injection Global Network (SIGN) Alliance (*241*).

Droplet Precautions include (*95*):

- *PPE* – Use a medical mask if working within 1 m of the patient (*154, 242-244*). For practical purposes, it is advisable to use a medical mask when entering the patient's room.
- *Patient placement* – Place patients in single rooms, or cohort those with the same etiological diagnosis. If an etiological diagnosis is not possible, group patients with similar clinical diagnosis and based on epidemiological risk factors, with a spatial separation of at least 1 m.
- *Patient transport* – Limit patient movement and ensure that patients wear medical masks when outside their rooms.

B.3 Contact Precautions

In addition to transmission by large droplets, some common respiratory pathogens (e.g. parainfluenza and respiratory syncytial virus) can be transmitted through contact – particularly by hand contamination and self-inoculation into conjunctival or nasal mucosa. Contact transmission may also play a role in avian influenza A(H5N1) and SARS infections. Contact Precautions include PPE, use of equipment and environment, and patient placement and transport, as outlined below (*95*).

PPE

Put on PPE when entering the room and remove it when leaving. PPE includes:

- *Gloves* – wear clean, nonsterile latex gloves, disposing of the gloves after each patient contact;
- *Gowns*:
  - use either a disposable gown made of synthetic fibre, or a washable cloth gown; ensure that the gown is the appropriate size to fully cover the areas to be protected;
  - if possible, wear a gown once only, then place it in a waste or laundry receptacle, as appropriate, and perform hand hygiene; and
  - if the gown is permeable, wear an apron to reduce fluid penetration (do not use an apron alone to prevent contact contamination).

Equipment and environment

- If possible, use either disposable equipment or dedicated equipment (e.g. stethoscopes, blood pressure cuffs and thermometers) when dealing with patients under Contact Precautions. If equipment needs to be shared among patients, clean and disinfect it between each patient use.
- Ensure that health-care workers refrain from touching their eyes, nose or mouth with potentially contaminated gloved or ungloved hands (*245*).
- Avoid contaminating environmental surfaces that are not directly related to patient care (e.g. door handles and light switches).

Patient placement

Use single rooms, or cohort patients with the same etiological diagnosis, to facilitate the application of IPC measures.

Patient transport

Limit patient movement and minimize patient contact with those who are not infected.

B.4 Airborne Precautions

Airborne pathogens are transmitted through inhalation of droplet nuclei that remain infectious over a long distance (e.g. > 1 m), and require special air handling (*4, 5*). Their transmission is further classified as obligate or preferential (*9*):

- obligate airborne transmission applies to agents naturally transmitted exclusively through droplet nuclei deposited in the distal part of the lung (e.g. *Mycobacterium tuberculosis* causing pulmonary TB); and
- preferential airborne transmission applies to pathogens (e.g. measles) that are transmitted by droplet nuclei deposited in the airways but can also be transmitted by other routes.

Transmission of droplet nuclei at short range may also occur with SARS-CoV, human influenza, and perhaps with other viral respiratory infections, during special circumstances; for example:

- performance of aerosol-generating procedures associated with pathogen transmission (Annex A, Section A.1), in rooms that are inadequately ventilated; and
- lack of adequate use of PPE (e.g. as happened with SARS).

This type of transmission has been referred to as opportunistic airborne transmission (*9*), and does not involve transmission over long distances as obligate and preferential airborne transmission do (*4*).

B.4.1 Infection prevention and control precautions for airborne diseases

For airborne pathogens (*4, 5, 7, 246*), supplement Standard Precautions with additional precautions, as outlined below.

Personal protective equipment

When entering the isolation room or area, or when providing care to a patient with an obligate or preferential airborne infectious disease in other settings, use a particulate respirator that is at least as protective as a NIOSH-certified N95 or equivalent (Annex A).

Patient placement

- Place the patient in an Airborne Precaution room (*3*).
- If a ventilated isolation room is not available, place patients in separate well-ventilated rooms.
- If single rooms are not available, cohort patients according to the same etiological diagnosis in well-ventilated places.
- To perform any aerosol-generating procedures associated with pathogen transmission, use appropriate PPE in an Airborne Precaution room.

Patient transport

- Limit patient movement and ensure that patients wear medical masks when outside their room or area.

B.4.2 Infection prevention and control precautions for diseases that can be opportunistically transmitted through droplet nuclei

For most diseases that can be opportunistically transmitted through droplet nuclei, Droplet Precautions should be added to Standard Precautions during routine patient care. Take additional measures during aerosol-generating procedures associated with increased risk of pathogen transmission.

Personal protective equipment

- At a minimum, use a medical mask (surgical or procedure mask) if working at a distance of less than 1 m from the patient (*247-249*).
- When performing aerosol-generating procedures associated with pathogen transmission, use a particulate respirator that is at least as protective as a NIOSH-certified N95, EU FFP2 or equivalent, and wear gloves, gowns and eye protection (e.g. goggles) (*86, 120, 250*).

Patient placement

- Use adequately ventilated rooms. Group patients according to the laboratory-confirmed etiological diagnosis (cohorting) or suspected diagnosis (special measures) (*31, 148*). If more than one patient is housed in a room, place patients so that they are at least 1 m apart.
- Airborne Precaution rooms are not obligatory. If they are available, prioritize them for patients with airborne-transmitted diseases (*31, 148*).
- To perform aerosol-generating procedures associated with increased risk of pathogen transmission, use adequately ventilated single rooms (*101, 102, 153, 251*).

Patient transport

- Limit the movement of patients and ensure that they wear medical masks when outside their room or area.

Annex C Sample checklist assessment of environmental conditions for home care of patients with ARIs of potential concern

The sample checklists below can be used to assess environmental conditions for home care of patients with ARIs of potential concern. Circle "Y" (yes) or "N" (no) for each option.

Infrastructure

Functioning telephone	Y	N
Any other means to rapidly communicate with the health system	Y	N
Potable water	Y	N
Sewerage system	Y	N
Cooking source (and fuel)	Y	N
Operable electricity	Y	N
Operable heat source when required	Y	N
Adequate environmental ventilation	Y	N

Accommodation

Separate room or bedroom for the patient	Y	N
Accessible bathroom	Y	N

Resources

Food	Y	N
Necessary medications	Y	N
Medical masks[a] (patient)	Y	N
Medical masks[a] (care providers, household contacts)	Y	N
Gloves[a]	Y	N
Hand-hygiene items (soap, alcohol-based hand rub)	Y	N
Household cleaning products	Y	N

a Check feasibility of training patient and household contacts on use of PPE

Primary care and support

Person to provide care and support	Y	N
Access to medical advice and care	Y	N
Any at-risk people at home (e.g. children < 2 years of age, elderly > 65 years of age, immunocompromised people)	Y	N

Annex D Sample health-care worker influenza-like illness monitoring form for workers exposed to patients with ARIs of potential concern

The sample form given below can be used to monitor ILI in workers exposed to patients with ARIs of potential concern.

Name: _____
Home telephone number: _____
Job title: _____
Work location:_____
Date/s of exposure (list all, use back of page if necessary): ____/____/_____ ____/____/_____
Type of contact with patient with ARI of potential concern, with patient's environment, or with virus:
_____
Was the following personal protective equipment (PPE) used:

	Yes	No	Don't know
Gown	☐	☐	☐
Gloves	☐	☐	☐
Particulate respirator	☐	☐	☐
Medical mask	☐	☐	☐
Eye protection	☐	☐	☐
Other (Please specify)	☐	☐	☐

List any non-occupational exposures (e.g. exposure to anyone with severe acute febrile respiratory illness):
_____
Please check your temperature twice a day, in the morning (AM) and evening (PM), for 10 days after providing care for a patient infected with an acute respiratory disease of potential concern (including 10 days after your last exposure), and also monitor yourself for any of the following influenza-like illness (ILI) symptoms including:

- fever > 38 °C
- cough
- acute onset of respiratory illness
- sore throat
- arthralgia
- myalgia or prostration
- gastrointestinal symptoms (e.g. diarrhoea, vomiting, abdominal pain)

If any symptoms of ILI occur, **immediately** limit your interactions with others, exclude yourself from public areas, and notify _____at _____

Sample health-care worker influenza-like illness monitoring form for workers exposed to patients with ARIs of potential concern

Day 1	**Day 2**	**Day 3**	**Day 4**	**Day 5**
Date ____/____/_____	Date ____/____/_____	Date ____/____/_____	Date ____/____/_____	Date ____/____/_____
AM temperature: _____	AM temperature: _____	AM temperature: _____	AM temperature: _____	AM temperature: _____
PM temperature: _____	PM temperature: _____	PM temperature: _____	PM temperature: _____	PM temperature: _____
ILI symptoms: No ____ Yes ___	ILI symptoms: No ___ Yes ___	ILI symptoms: No ___ Yes ____	ILI symptoms: No ___ Yes ____	ILI symptoms: No ___ Yes ____

Day 6	**Day 7**	**Day 8**	**Day 9**	**Day 10**
Date ____/____/_____	Date ____/____/_____	Date ____/____/_____	Date ____/____/_____	Date ____/____/_____
AM temperature: _____	AM temperature: _____	AM temperature: _____	AM temperature: _____	AM temperature: _____
PM temperature: _____	PM temperature: _____	PM temperature: _____	PM temperature: _____	PM temperature: _____
ILI symptoms: No ___ Yes ___	ILI symptoms: No ___ Yes ____	ILI symptoms: No ___ Yes ____	ILI symptoms: No ___ Yes ____	ILI symptoms: No ___ Yes ____

Annex E Isolation rooms or areas

E.1 Preparation of the isolation room or area

- Ensure that appropriate handwashing facilities and hand-hygiene supplies are available.
- Stock the sink area with suitable supplies for handwashing, and with alcohol-based hand rub, near the point of care and the room door.
- Ensure adequate room ventilation.
- Post signs on the door indicating that the space is an isolation area.
- Ensure that visitors consult the health-care worker in charge (who is also responsible for keeping a visitor record) before being allowed into the isolation areas. Keep a roster of all staff working in the isolation areas, for possible outbreak investigation and contact tracing.
- Remove all non-essential furniture and ensure that the remaining furniture is easy to clean, and does not conceal or retain dirt or moisture within or around it.
- Stock the PPE supply and linen outside the isolation room or area (e.g. in the change room). Set up a trolley outside the door to hold PPE. A checklist may be useful to ensure that all equipment is available (see sample checklist in Section E.3, below).
- Place appropriate waste bags in a bin. If possible, use a touch-free bin. Ensure that used (i.e. dirty) bins remain inside the isolation rooms.
- Place a puncture-proof container for sharps disposal inside the isolation room or area.
- Keep the patient's personal belongings to a minimum. Keep water pitchers and cups, tissue wipes, and all items necessary for attending to personal hygiene, within the patient's reach.
- Dedicate non-critical patient-care equipment (e.g. stethoscope, thermometer, blood pressure cuff and sphygmomanometer) to the patient, if possible. Thoroughly clean and disinfect patient-care equipment that is required for use by other patients before use.
- Place an appropriate container with a lid outside the door for equipment that requires disinfection or sterilization.
- Keep adequate equipment required for cleaning or disinfection inside the isolation room or area, and ensure scrupulous daily cleaning of the isolation room or area.
- Set up a telephone or other method of communication in the isolation room or area to enable patients, family members or visitors to communicate with health-care workers. This may reduce the number of times the workers need to don PPE to enter the room or area.

E.2 Wearing and removing personal protective equipment

Before entering the isolation room or area:

- collect all equipment needed;
- perform hand hygiene with an alcohol-based hand rub (preferably when hands are not visibly soiled) or soap and water;

- put on PPE in the order that ensures adequate placement of PPE items and prevents self-contamination and self-inoculation while using and taking off PPE; an example of the order in which to don PPE when all PPE items are needed is hand hygiene, gown, mask or respirator, eye protection and gloves, as illustrated in Fig. E.1A, below.

E.2.1 Leaving the isolation room or area

- Either remove PPE in the anteroom or, if there is no anteroom, make sure that the PPE will not contaminate either the environment outside the isolation room or area, or other people.
- Remove PPE in a manner that prevents self-contamination or self-inoculation with contaminated PPE or hands. General principles are:
  - remove the most contaminated PPE items first;
  - perform hand hygiene immediately after removing gloves;
  - remove the mask or particulate respirator last (by grasping the ties and discarding in a rubbish bin);
  - discard disposable items in a closed rubbish bin;
  - put reusable items in a dry (e.g. without any disinfectant solution) closed container; an example of the order in which to take off PPE when all PPE items are needed is gloves (if the gown is disposable, gloves can be peeled off together with gown upon removal), hand hygiene, gown, eye protection, mask or respirator, and hand hygiene (Fig. E.1B, below).

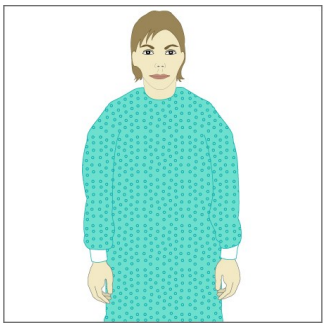
Perform hand hygiene with an alcohol-based hand rub (preferably) or soap and water whenever ungloved hands touch contaminated PPE items.

Figure E.1 Putting on and removing personal protective equipment

A. Putting on PPE (when all PPE items are needed)

1

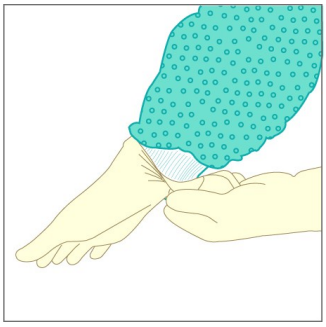
- Identify hazards and manage risk.
- Gather the necessary PPE.
- Plan where to put on and take off PPE.
- Do you have a buddy? Mirror?
- Do you know how you will deal with waste?



2 Put on a gown.

3 Put on particulate respirator or medical mask; perform user seal check if using a respirator.

4 Put on eye protection, e.g. face shield/goggles (consider anti-fog drops or fog-resistant goggles). Caps are optional: if worn, put on after eye protection.



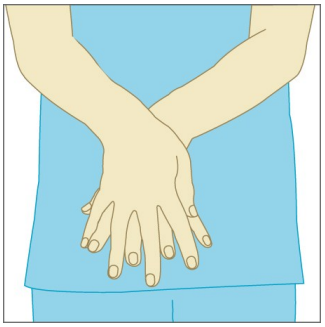
5 Put on gloves (over cuff).

B. Taking off PPE

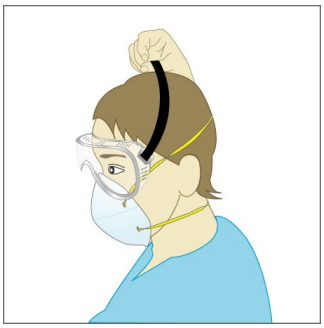
1

- Avoid contamination of self, others and the environment.
- Remove the most heavily contaminated items first.

Remove gloves and gown:
- peel off gown and gloves and roll inside, out;
- dispose of gloves and gown safely.



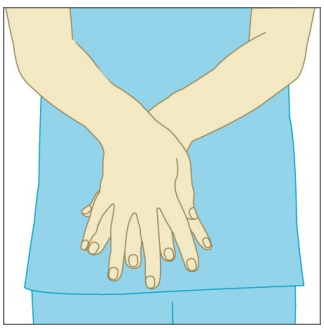
2 Perform hand hygiene.



3

- Remove cap (if worn).
- Remove goggles from behind.
- Put goggles in a separate container for reprocessing.

4 Remove respirator from behind.



5 Perform hand hygiene.

E.3 Checklist for isolation room or area trolley or table

The following items should be kept on the trolley at all times so that PPE is always available for health-care workers.

Equipment	Stock present
Eye protection (visor or goggles)	
Face shield (provides eye, nose and mouth protection)	
Gloves • reusable vinyl or rubber gloves for environmental cleaning • latex single-use gloves for clinical care	
Hair covers (optional)	
Particulate respirators (N95, FFP2, or equivalent)	
Medical (surgical or procedure) masks	
Gowns and aprons • single-use long-sleeved fluid-resistant or reusable non-fluid-resistant gowns • plastic aprons (for use over non-fluid-resistant gowns if splashing is anticipated and if fluid-resistant gowns are not available)	
Alcohol-based hand rub	
Plain soap (liquid if possible, for washing hands in clean water)	
Clean single-use towels (e.g. paper towels)	
Sharps containers	
Appropriate detergent for environmental cleaning and disinfectant for disinfection of surfaces, instruments or equipment	
Large plastic bags	
Appropriate clinical waste bags	
Linen bags	
Collection container for used equipment	

For more information on isolation precautions, see:

- *Practical guidelines for infection control in health care facilities*, 2004 (*212*)
- *Prevention of hospital-acquired infections: A practical guide*, 2002 (*213*).

For additional information on hand hygiene, see:

- *WHO guidelines on hand hygiene in health care*, 2009 (*215*).

Annex F Mortuary care and postmortem examination

F.1 Packing and transport of the dead body of patients with ARI of potential concern, to a mortuary, crematorium or burial

- Ensure that the body is fully sealed in an impermeable body bag before being removed from the isolation room or area, and before being transferred to the pathology department or the mortuary, to avoid leakage of body fluid.
- Transfer the body to the mortuary as soon as possible after death.
- When properly packed in the body bag, the body can be safely removed for storage in the mortuary, sent to the crematorium, or placed in a coffin for burial.
- If an autopsy is being considered, the body may be kept in refrigeration in the mortuary and the autopsy conducted only when a safe environment can be provided (Section 2.5).

F.2 Personal protective equipment for handling dead bodies

- Wear a disposable, long-sleeved, cuffed gown; if the outside of the body is visibly contaminated with body fluids, excretions, or secretions, ensure that this gown is waterproof. If no waterproof gown is available, wear a waterproof apron in addition to the gown.
- Wear nonsterile gloves (single layer) that cover the cuffs of the gown.
- If splashing of body fluids is anticipated, use facial protection: preferably a face shield, or if not, goggles and a medical mask.
- Perform hand hygiene after taking off the PPE.
- Use PPE for heavy-duty tasks (e.g. rubber gloves, rubber apron and resistant closed shoes) in addition to regular PPE.

F.3 Personal protective equipment during autopsy

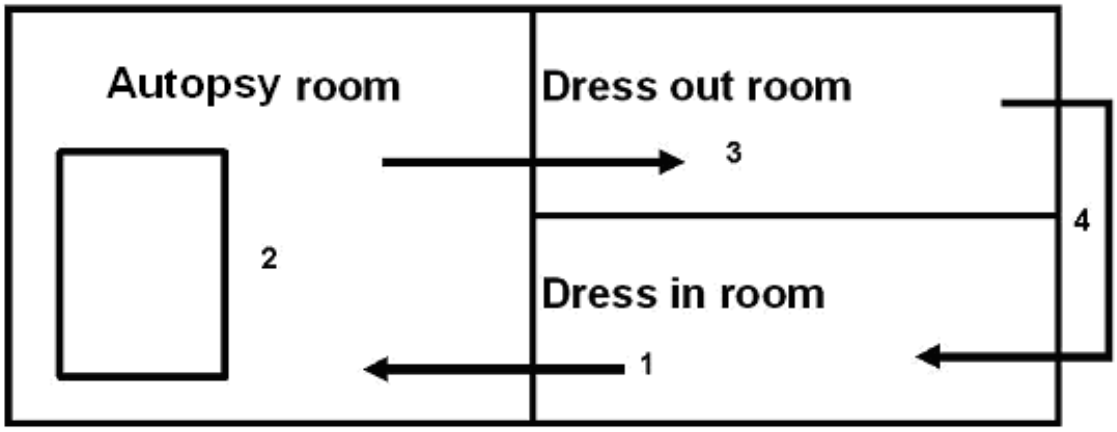
PPE to be provided during autopsy includes:

- scrub suit – tops and trousers, or equivalent garments;
- single-use, fluid-resistant, long-sleeved gown;
- surgical mask or, if small-particle aerosols might be generated during autopsy procedures, a particulate respirator at least as protective as a NIOSH-certified N95, EU FFP2 or equivalent;
- face shield (preferably) or goggles;
- either autopsy gloves (cut-proof synthetic mesh gloves) or two pairs of nonsterile gloves;
- knee-high boots.

Placement of PPE:

- put on PPE in the dress in room (Fig. F.1) before entering the autopsy room where the body is located;
- in the dress in room, replace outer street clothes and shoes with scrub suits, or equivalent coverall garments, plus boots;
- proceed to the autopsy room where the body is located.

Figure F.1 Suggested movement of the autopsy team undertaking a postmortem examination in a health-care facility



To remove PPE:

- exit the autopsy room to the dress out room as suggested in Fig. F.1;
- remove PPE in the designated dress out room, dispose of the PPE in accordance with recommendations, and perform hand hygiene.

F.4 Suggested methods to reduce aerosol generation during autopsy

To reduce aerosol generation during autopsy:

- use containment devices whenever possible (e.g. biosafety cabinets for the handling and examination of smaller specimens);
- use vacuum shrouds for oscillating saws;
- do not use high-pressure water sprays;
- if opening intestines, do so under water.

Annex G Use of disinfectants: alcohol and bleach

Different countries have different disinfection protocols. Health-care facilities with limited resources may not have access to a variety of hospital disinfectants, however, alcohol and bleach are acceptable chemical disinfectants if used appropriately. As with any other disinfectants, soiled surfaces need to be cleaned with water and detergent first.

G.1 Alcohol

Alcohol is effective against influenza virus (*252*). Ethyl alcohol (70%) is a powerful broad-spectrum germicide and is considered generally superior to isopropyl alcohol. Alcohol is often used to disinfect small surfaces (e.g. rubber stoppers of multiple-dose medication vials, and thermometers) and occasionally external surfaces of equipment (e.g. stethoscopes and ventilators). Since alcohol is flammable, limit its use as a surface disinfectant to small surface-areas and use it in well-ventilated spaces only. Prolonged and repeated use of alcohol as a disinfectant can also cause discoloration, swelling, hardening and cracking of rubber and certain plastics.

G.2 Bleach

Bleach is a strong and effective disinfectant – its active ingredient sodium hypochlorite is effective in killing bacteria, fungi and viruses, including influenza virus – but it is easily inactivated by organic material. Diluted household bleach disinfects within 10–60 minutes contact time (see Table G.1 below for concentrations and contact times), is widely available at a low cost, and is recommended for surface disinfection in health-care facilities. However, bleach irritates mucous membranes, the skin and the airways; decomposes under heat and light; and reacts easily with other chemicals. Therefore, bleach should be used with caution; ventilation should be adequate and consistent with relevant occupational health and safety guidance. Improper use of bleach, including deviation from recommended dilutions (either stronger or weaker), may reduce its effectiveness for disinfection and can injure health-care workers.

Procedures for preparing and using diluted bleach

To prepare and use diluted bleach:

- use a mask, rubber gloves and waterproof apron; goggles also are recommended to protect the eyes from splashes;
- mix and use bleach solutions in well-ventilated areas;
- mix bleach with cold water (hot water decomposes the sodium hypochlorite and renders it ineffective);
- if using bleach containing 5% sodium hypochlorite, dilute it to 0.05%, as shown in Table G.1 below.

Table G.1 Sodium hypochlorite: concentration and use

Starting solution Most household bleach solutions contain 5% sodium hypochlorite (50 000 ppm available chlorine).
Recommended dilution 1:100 dilution of 5% sodium hypochlorite is the usual recommendation. Use 1 part bleach to 99 parts cold tap water (1:100 dilution) for disinfection of surfaces. *Adjust ratio of bleach to water as needed to achieve appropriate concentration of sodium hypochlorite. For example, for bleach preparations containing 2.5% sodium hypochlorite, use twice as much bleach (i.e. 2 parts bleach to 98 parts water).*
Available chlorine after dilution For bleach preparations containing 5% sodium hypochlorite, a 1:100 dilution will yield 0.05% or 500 ppm available chlorine. *Bleach solutions containing other concentrations of sodium hypochlorite will contain different amounts of available chlorine when diluted.*
Contact times for different uses Disinfection by wiping of nonporous surfaces: a contact time of ≥ 10 minutes is recommended. Disinfection by immersion of items: a contact time of 30 minutes is recommended. *N.B. Surfaces must be cleaned of organic materials, such as secretions, mucus, vomit, faeces, blood or other body fluids before disinfection or immersion.*

ppm: parts per million

Precautions for the use of bleach

- Bleach can corrode metals and damage painted surfaces.
- Avoid touching the eyes. If bleach gets into the eyes, immediately rinse with water for at least 15 minutes, and consult a physician.
- Do not use bleach together with other household detergents, because this reduces its effectiveness and can cause dangerous chemical reactions. For example, a toxic gas is produced when bleach is mixed with acidic detergents, such as those used for toilet cleaning, and this gas can cause death or injury. If necessary, use detergents first, and rinse thoroughly with water before using bleach for disinfection.
- Undiluted bleach emits a toxic gas when exposed to sunlight; thus, store bleach in a cool, shaded place, out of the reach of children.
- Sodium hypochlorite decomposes with time. To ensure its effectiveness, purchase recently produced bleach, and avoid over-stocking.
- If using diluted bleach, prepare the diluted solution fresh daily. Label and date it, and discard unused mixtures 24 hours after preparation.
- Organic materials inactivate bleach; clean surfaces so that they are clear of organic materials before disinfection with bleach.
- Keep diluted bleach covered and protected from sunlight, and if possible in a dark container, and out of the reach of children.

Annex H Surge capacity: personal protective equipment needs of health-care facilities during epidemics or pandemics

It is difficult to provide guidance for hospitals wishing to stockpile PPE for epidemic or pandemic ARIs. This annex is intended to provide a step-by-step approach for estimating additional PPE needs for health-care facilities. Some key steps include:

- defining assumptions;
- producing estimates; and
- defining a purchasing strategy to meet the planned needs, replenishment and monitoring of stock expiration and use.

A recent systematic review explored resource use as well as the economic implications (e.g. total cost and cost–effectiveness ratios) associated with physical barriers (e.g. masks, gowns and gloves) to interrupt or reduce the spread of respiratory viruses (*207*). The researchers concluded that, while the use of physical interventions to interrupt or reduce the spread of respiratory viruses increases during epidemics and pandemics, PPEs appear to be an economically attractive option in reducing the burden of illness associated with respiratory viruses, due to the relatively low costs of these interventions. The economic benefits rise when transmission rates and fatality rates are high. However, few studies were available for review, and the overall quality of data was low.

Each health-care facility should follow the national assumptions, and adapt to its local policies and rationale.

Assumptions to be taken into consideration include those concerning the use of PPE, expected impact of an epidemic (e.g. proportion of the population diseased, seeking care or being hospitalized), organization of health services (e.g. frequency of encounters between health-care workers and patients), recommended IPC precautions and duration of the epidemic. The rest of this annex discusses considerations that health-care facilities can use in making assumptions about supplies of PPE for surge capacity.

Medical masks

Medical masks should be changed between uses, and also whenever they become wet, damaged or visibly soiled. In conditions of increased air temperature and humidity, assume that masks will become wet with perspiration more quickly (surgical mask standards are described in Annex A). Wearing additional PPE, such as gowns and gloves will also increase perspiration.

Respirators

There are no data on how long particulate respirators remain effective. Respirators are disposable, but can be reused repeatedly by the same heath-care worker when working with TB patients, because TB has not been documented to spread by contact, and contamination of the respirator is not a concern in TB transmission. Humidity, dirt, and crushing, reduce the efficiency of the respirator; thus, respirators should be stored in a clean, dry location. When

used in the care of TB patients, respirators can be reused until they are wet, soiled, damaged or difficult to breathe through (i.e. when the filter becomes "clogged" with trapped particles). Filtration efficiency actually increases as more particles are trapped in the filter. However, because many ARI pathogens (e.g. SARS, and avian or pandemic influenza) can be spread by contact as well as by respiratory aerosols, contaminated respirators could contribute to disease transmission. The concern about the reuse of respirators and other equipment relates to surface contamination and the possible risks of self-contamination and self-inoculation that may result when heath-care workers handle potentially contaminated equipment. It is essential to educate workers on how to safely remove, store, handle and re-apply potentially contaminated equipment.

At this time, there are no recommendations on the reuse of respirators when caring for patients with ARIs, and medical masks and respirators should be discarded after each use in these circumstances.

Entry of health-care workers into the isolation room or area

Other issues that must be considered when making assumptions about PPE are:

- the number of times that health-care workers are expected to enter the isolation room or area;
- whether any PPE will be reused by the same worker during a shift; and
- how many different workers will enter the isolation room or area.

These factors directly influence how much PPE will be used. The number of different health-care workers entering the isolation room or area, and the number of times that each worker goes in an out of the room, should be limited to the minimum necessary. Ways to minimize the number of different workers who enter the isolation area include:

- ensuring that tasks are carried out by as few workers as possible, without hampering the quality of health-care;
- having a means of communication (such as a telephone) between the patient or family in the room and health-care workers outside the room.

Cohorting patients could decrease the need for masks or respirators and eye protection, since several patients could be attended in one visit to the room or area, without the health-care worker needing to change these items of PPE. Other PPE – including gloves and gowns – must be changed between patients, even when providing care in a cohort or isolation room or area. Health-care workers providing care to patients with ARIs of potential concern will also need "PPE breaks”, because wearing PPE is hot and tiring, and these factors may contribute to inadvertent IPC breaches.

Assumptions about factors such as these must be built into any mathematical model used for estimating the amounts of PPE needed, such as:

- number of epidemic or pandemic ARI patients per day for an average of X number of days;
- number of times that a health-care worker enters the isolation room or area per shift, and length of shifts;
- number of different workers who have direct contact with epidemic or pandemic patients per day;
- IPC precautions recommended;

- duration of the epidemic or pandemic wave;
- estimated numbers of cohorted patients (e.g. X patients per cohort unit versus X patients in single rooms);
- number of times items can be reused (e.g. cloth gowns, goggles and face shields); fewer masks may be needed in patient cohort units because the same respiratory protection equipment could be worn during the care of multiple patients (as mentioned above);
- whether medical masks would be provided for patients and visitors.

Several countries have developed planning assumptions. (Examples of national pandemic preparedness plans are available at http://www.euro.who.int/en/what-we-do/health-topics/communicable-diseases/influenza/country-work/national-plans)

Annex I Cleaning and disinfection of respiratory equipment

Equipment used for respiratory therapy (e.g. items that come into contact with mucous membranes) is considered semicritical[1]; such items should be cleaned and then receive at least high-level disinfection between patients (*225*). High-level disinfection of respiratory equipment takes place after cleaning, and is typically accomplished by chemical germicides or physical methods, as outlined below (*253*).

Chemical germicides

Chemical germicides used for high-level disinfection include (*225*):

- glutaraldehyde-based formulations (2%);
- stabilized hydrogen peroxide (6%);
- peracetic acid (variable concentrations, but ≤ 1% is sporicidal);
- sodium hypochlorite (5.25%, diluted to 1000 ppm available chlorine – 1:50 dilution).

The most appropriate chemical germicide for a particular situation should be selected on the basis of the object to be disinfected, its composition and intended use; the level of disinfection needed; and the scope of the services, physical facilities, resources and personnel available.

Physical methods

Physical methods for high-level disinfection include hot-water disinfection (pasteurization) or steam (e.g. autoclaving at lower temperature). Pasteurization is a non-toxic, cost-effective alternative to high-level disinfection with chemical germicides. Equipment should be submerged for at least 30 minutes in water at a temperature of about 70 °C (less than the temperature that typically damages plastic). Pasteurization can be accomplished using a commercial washer or pasteurizer (*254*). After pasteurization, wet equipment is typically dried in a hot-air drying cabinet before storage. Steam sterilization is an inexpensive and effective method for sterilization or high-level disinfection. Steam sterilization is, however, unsuitable for processing plastics with low melting points, powders or anhydrous oils. Bacterial spores may survive after high-level disinfection. Microbiological sampling can verify that high-level disinfection has resulted in the destruction of vegetative bacteria; however, such sampling is not routinely recommended.

I.1 Steps for cleaning and disinfection of plastic pieces of respiratory equipment

PPE is required when cleaning or processing equipment and instruments, to protect against splashing, spraying or aerosols.

1. Wash the equipment with soap (e.g. liquid dish soap) and clean water.
2. Rinse the equipment completely with clean water.
3. Disinfect the equipment to inactivate any remaining pathogens.

[1] According to Spaulding's classification (*224*), semicritical items are devices that come into contact with mucous membranes or nonintact skin

There are several ways to disinfect equipment, and the products available at the health-care facility should be used. Safe methods of disinfection include:

- heat for heat-resistant equipment that can withstand high temperature (e.g. 80 °C); such equipment can be disinfected using a washer–disinfector;
- if a washer or pasteurizer is not available, use a high-end or commercial dishwasher with a "sanitize" feature that can reach 70 °C ;
- for plastic equipment that may not tolerate 80 °C and for equipment that may be damaged by boiling, or in the absence of the equipment described above, use chemical disinfection (e.g. soak in 1:100 sodium hypochlorite solution for 30 minutes, as described in Annex G).

4. If using chemical disinfection, rinse with sterile or clean water (i.e. water boiled for 5 minutes and cooled). Sterile water is preferred for rinsing off residual liquid chemical disinfectant from a respiratory device that has been chemically disinfected for reuse, because tap or distilled water may harbour microorganisms that can cause pneumonia. However, when rinsing with sterile water is not feasible, instead, rinse with tap water or filtered water (i.e. water passed through a 0.2 µ filter), followed by an alcohol rinse and forced-air drying.

5. Dry equipment.

- Physical equipment (e.g. a washer, pasteurizer or autoclave) often has a drying feature within the machine.
- For chemical methods, let equipment parts air dry on a clean towel or cloth.

6. Store equipment dry in closed packages.

Summary: Wash with soap and clean water, rinse, disinfect, rinse (if chemical method), dry and store.

I.2 Cleaning and disinfection of mechanical ventilators

To clean and disinfect a mechanical ventilator, wipe down the controls and entire outside of the equipment with a compatible disinfectant (e.g. sodium hypochlorite solution of 0.05% or 500 ppm for non-metal surfaces).

Disinfect tubing using sodium hypochlorite solution of 0.1% or 1000 ppm, ensuring that the entire lumen of the tubing is flushed (Section I.1, above).

It is not necessary to routinely clean respiratory and pressure lines within a ventilator between patients, because the lines are not exposed to the patient or the patient's respiratory secretions.

Usually, the entire expiratory side tubing is removable (the expiratory end has a valve to control the escape of gas from the circuit and may also have a flow measurement device or a water trap, or both). This tubing should be disassembled and cleaned first with a detergent, rinsed clean, and then subjected to either high-level disinfection or sterilization. High-level disinfection is the minimum required procedure for these items, but due to the practicability of some sterilization methods and health-care facility protocols (e.g. steam), these items can, if suitably designed, be submitted to sterilization.

When mechanical ventilators are used in the care of a patient with an ARI of potential concern, bacterial and viral filters are recommended on exhalation valves.

Annex J Infection prevention and control across the continuum of health care

The principles of IPC are the same across the continuum of health care. Areas that require particular attention such as emergency and outpatient care, paediatric acute care and home care for ARI patients, are discussed in this section.

J.1 Emergency and outpatient care

Measures for countries with no reported ARIs of potential concern

In countries with no reported ARIs of potential concern, implement the following measures:

- Post signage that alerts people with severe acute febrile respiratory illness to notify staff immediately, and to use respiratory hygiene (*255*).
- Assess patients with acute febrile respiratory illness as promptly as possible.
- Consider designating separate areas for patients with acute febrile respiratory illness, and whenever possible keep a distance of 1 m between each patient in the waiting area.
- Provide tissues in the waiting area so that patients can contain respiratory secretions when coughing or sneezing whenever possible. Provide receptacles for disposal of used tissues (if possible, these should be no-touch receptacles).
- Give people with acute febrile respiratory illness medical masks on entry, if possible.
- Encourage hand hygiene after contact with respiratory secretions, and provide hand-hygiene facilities (e.g. sinks equipped with water, soap and single-use towel, alcohol-based hand rub) in waiting areas whenever possible.
- Clean environmental surfaces in waiting and patient-care areas at least daily and when visibly soiled.
- Ensure that patient-care equipment is appropriately cleaned and disinfected between patients.
- Use Standard and Droplet Precautions when providing close contact care to patients with acute febrile respiratory illness.
- Undertake any aerosol-generating procedures associated with an increased risk of ARI transmission in a well-ventilated separate room, and ensure that health-care workers use appropriate PPE (Chapter 2, Section 2.4).
- If a patient known or suspected to be infected with an ARI of potential concern is referred to another facility, notify receiving staff of the necessary IPC precautions.

Additional measures for countries with reported ARIs of potential concern

In countries with reported ARIs of potential concern, implement the following additional measures:

- During pandemics, apply strategies to limit unnecessary office visits by ill patients; for example, divert patients to designated pandemic influenza triage and evaluation sites, and use pre-facility triage to determine which patients need on-site medical evaluation.

- Educate the public about the clues (i.e. signs or symptoms) of ARIs of potential concern, and ask them to seek medical care promptly for assessment and admission.
- Establish triage criteria to promptly identify people at risk of infection with an ARI of potential concern.
- If an ARI of potential concern is suspected, ensure that health-care workers use appropriate PPE (Chapter 2, Table 2.1), as available.
- After a patient known or suspected to be infected with an ARI of potential concern has left the ambulatory-care setting, clean surfaces in the examination room or other areas where the patient was located, and clean and disinfect any patient-care equipment used for the patient.

J.2 Acute paediatric care

Implementing IPC measures for paediatric patients requires special consideration:

- Family members are essential for the emotional support of children admitted to hospital (*56, 256*). The child's right to be accompanied by a parent, relative or legal guardian at all times should be guaranteed (*257*).
- Family members can be critical in assisting in the care of hospitalized children, particularly if there is a shortage of health-care workers (*117*).
- Children are likely to be infectious with ARIs for longer than adults; this may affect the duration of IPC precautions (*105*).
- Paediatric patients may not be able to comply with respiratory hygiene.
- Some pathogens are more prevalent among children and require additional precautions; for example, Contact Precautions for respiratory syncytial virus or parainfluenza virus; and Contact plus Droplet Precautions for adenovirus or metapneumovirus (*244*).
- Contamination of the environment may be more prominent with children than with adult or continent patients.
- Clean and disinfect toys between different children, and take precautions when gathering patients in the playroom (follow the same principles as for cohorting) (*258-261*).

J.3 Home care for patients with acute respiratory infection

During a public-health emergency, such as a pandemic, it may not be possible to provide acute or ambulatory-care services for all who might need them. Also, ambulatory-care facilities may be unable to meet the demand for health-care services, and may only be able to provide care for the most severely ill patients (*262*). In this situation, patients infected with ARIs of potential concern may require care at home, and they may still be infectious to household contacts (*263, 264*).

Infection prevention and control for the home setting

ARIs can spread easily within a household. Anyone who has not already been infected is at risk of infection if they come into contact with an ARI patient. Thus, household members should observe the following recommendations:

- If a household member develops symptoms of ARI, including fever, cough, sore throat and difficulty breathing, they should follow public-health recommendations.

- Limit contact with the ill person as much as possible. Stay in a different room or, if that is not possible, stay as far away from the ill person as possible (e.g. sleep in a separate bed).
- Ensure that shared spaces (e.g. restrooms, kitchen and bathroom) are well ventilated (e.g. keep windows open).
- If close contact care must be provided to the ill person, ensure that the ill person covers his or her mouth or nose with hands or other materials (e.g. tissues, handkerchiefs or, if available, a mask);
- Discard materials used to cover the mouth or nose, or clean them appropriately.
- Avoid direct contact with body fluids. If contact occurs, perform hand hygiene immediately afterwards.
- Perform hand hygiene, either by washing with soap and water or using an alcohol-based hand rub. Address safety concerns (e.g. accidental ingestion and fire hazards) before recommending alcohol-based hand rubs for household use.
- Ensure that anyone who is at increased risk of severe disease does not care for the ill person or come into close contact with the ill person. For seasonal influenza, people at increased risk include those with heart, lung or kidney disease; diabetes; immunosuppression; blood disease (e.g. sickle cell anaemia); pregnancy; and aged over 65 years or under 2 years.
- Avoid other types of possible exposure to the ill person or contaminated items; for example, avoid sharing toothbrushes, cigarettes, eating utensils, drinks, towels, washcloths or bed linen.
  - Ensure that people caring for a family member suffering from an ARI of potential concern limit their contact with each other, and follow national or local policies regarding home quarantine recommendations. where possible, the caregiver also wears a medical mask or the best available protection against respiratory droplets when in close contact with the ill person, and performs hand hygiene (*265*).

Actions to take if a contact of a patient with an ARI of potential concern becomes ill

- Notify the health-care provider of the diagnosis and receive instructions on where to seek care, when and where to enter the health-care facility, and the IPC precautions that are to be followed.
- Avoid public transportation if possible; call an ambulance or transport the ill person with own vehicle and open the windows of the vehicle.
- Always perform respiratory hygiene.
- Stand or sit as far away from others as possible (at least 1 m), when in transit and when in the health-care facility.
- Use hand hygiene whenever appropriate.

Annex K Strength of infection prevention and control recommendations based on GRADE

These guidelines were updated in accordance with the *WHO handbook for guideline development*, 2012 (*18*). The process comprised multiple steps, including setting up a guideline development group, scoping the revision of the document, and setting up an external expert review group to guide the systematic reviews using the PICOT framework (which clearly defined the IPC intervention in terms of question, population, comparator and outcome), and the conduct of the systematic reviews, including evidence retrieval and synthesis. Where systematic reviews could not be undertaken, evidence-based reviews or critical appraisals of the literature were done instead. Evidence was synthesized and recommendations formulated using the GRADE framework (*18, 46-50*).

Major systematic reviews of relevance to these guidelines are summarized in Annex L, and the evidence profiles of individual studies are available in the published papers (51, 130, 149, 207).

The tables that make up the remainder of this annex summarize the assessment of evidence and other important factors that support the content and strength of key recommendations according to the GRADE framework (*18, 46-50*). These tables were drafted after careful review of existing evidence, and were extensively reviewed by expert members of the Global Infection Prevention and Control Network. The topics covered by the tables are:

- Table K.1 – Clinical triage and early identification;
- Table K.2 – Respiratory hygiene;
- Table K.3 – Spatial separation;
- Table K.4 – Cohorting and special measures;
- Table K.5 – Personal protective equipment;
- Table K.6 – Personal protective equipment for aerosol-generating procedures;
- Table K.7 – Environmental ventilation for aerosol-generating procedures;
- Table K.8 – Vaccination of health-care workers;
- Table K.9 – Ultraviolet germicidal irradiation;
- Table K.10 – Duration of additional infection prevention and control precautions.

Where consensus was reached that benefits clearly outweighed harms, there was no major variability of values and preferences, and the feasibility of recommendations was high, the factors were labelled as favourable, providing rationale for making a strong recommendation. The same label was assigned where the recommendations were considered not too resource-intensive. Where there was uncertainty about the balance of benefits versus harms, values and preferences, resource implications, and feasibility, the factors were labelled as conditional.

Recommendations were considered strong when the guideline development group was confident that the desirable effects of adherence outweigh the undesirable effects. Recommendations were labelled as conditional when the desirable effects of adherence were deemed to probably outweigh any undesirable effects, but the group was not confident about the trade-off.

Table K.1 Considerations for clinical triage and early identification

Recommendation: Use clinical triage for the early identification of patients with ARIs in order to prevent the transmission of ARI pathogens to health-care workers and other patients. (Chapter 2, Section 2.1)		
Population: People with ARI in health-care settings		
Intervention: Clinical triage and early identification		
Factor	**Assessment**	**Explanation**
Quality of evidence	Very low to low (*27, 51*) (Annex L.2)	There is limited evidence available to suggest that the spread of respiratory virus, particularly RSV, can be prevented by the use of triage and early identification, when combined with other hygienic measures, especially for younger children (*51*). In addition, a systematic review of the use of triage of individuals with symptoms suggestive of TB with and without separation of infectious cases supports the use of triage as an administrative process (*27*).
Balance of benefits or desired effects versus disadvantages or undesired effects	Favourable	Early identification will benefit proper management of patients. Reduction of ARI exposure and infection of health-care workers and other patients by respiratory pathogens during care delivery to patients with ARI in health-care settings. Triage may also help in early identification of events or pathogens of potential public health concern as per the IHR, 2005 (*6*).
Values and preferences	Favourable	Reduction of ARI exposure and infection of health-care workers and other patients by respiratory pathogens while delivering care to patients with ARI in health-care settings.
Costs	Conditional	There is a cost implication for health-care facilities for the use of triage and early identification.
Feasibility	Conditional	The use of triage and early identification during care delivery for patients with ARIs depends on reorganization of services with possible resource implications.
Overall ranking	**STRONG RECOMMENDATION** Although the quality of evidence was considered very low to low, there was consensus that the advantages of early identification of patients with ARIs and an assessment of values and preferences provided sufficient basis for the strong recommendation.	
Research gap	Additional research is required to fully elucidate the epidemiology of the risk of transmission of specific pathogens causing acute respiratory diseases from infected patients to health-care workers and other patients with the use of triage and early identification alone versus its use in combination with other selected precautions.	

ARI, acute respiratory infection; IHR, International Health Regulations; RSV, respiratory syncytial virus; TB, tuberculosis

Table K.2 Considerations for respiratory hygiene

Recommendation: Encourage the use of respiratory hygiene (i.e. covering the mouth and nose during coughing or sneezing with a medical mask, tissue, or a sleeve or flexed elbow, followed by hand hygiene), in all people with ARIs to reduce the dispersal of respiratory secretions containing potentially infectious particles. (Chapter 2, Section 2.1)

Population: People with ARI in health-care settings

Intervention: Respiratory hygiene

Factor	Assessment	Explanation
Quality of evidence	Very low (*51*) (Annex L.2)	The evidence suggests that: • behavioural changes that probably included the principles of respiratory hygiene, when applied within households, were associated with a reduced frequency of influenza illness during an outbreak of influenza (*59*); • coughing and sneezing in those with symptomatic ARIs are associated with the production of droplets and aerosols that contain viable viral particles (*60*); • maximal symptoms for influenza correlate with the peak viral shedding demonstrated by both viral culture and RT-PCR assay (*61*); • the use of medical masks in those with ARI serves as a barrier against RT-PCR detectable influenza virus (*62*); • the use of medical masks in patients with active smear-positive TB with cough is associated with a significant reduction in transmission of TB in an in vivo animal model setting (*63*); and • respiratory virus spread and infection can be reduced by hygienic measures, including hand hygiene and PPE use (*51*).
Balance of benefits or desired effects versus disadvantages or undesired effects	Favourable	Potential reduction of the exposure of non-infected individuals to respiratory pathogens in health-care settings. Use of medical or cloth masks by those with ARI symptoms may be uncomfortable and not well-tolerated, and thus few infected patients may actually adhere to wearing a face mask.
Values and preferences	Favourable	Potential reduction of the exposure of individuals to respiratory pathogens in health-care settings. A similar approach was used for reduction in exposure and infection for TB (*27*).
Costs	Conditional	The reduction of dispersal of respiratory secretions may reduce the exposure to ARI pathogens and thus reduce new cases of ARI and related costs. There is a cost implication for the health-care facility in the use of medical masks, tissues and hand-hygiene supplies.
Feasibility	Conditional	Infants and young children may not be capable of adequate respiratory hygiene. While adults may be capable of following respiratory hygiene, ensuring compliance can be complex since it is affected by the availability of supplies but also by other factors (e.g. attitude, knowledge, peer pressure, motivation and organizational climate), which may widely vary according to the setting.
Overall ranking	**STRONG RECOMMENDATION** Although the quality of evidence was considered very low, there was consensus that the advantages of the use of respiratory hygiene and an assessment of values and preferences provided sufficient basis for the strong recommendation.	
Research gap	A significant research gap exists regarding the maximal effectiveness of respiratory hygiene in those with ARI as a means to reduce droplet dispersion and clinical illness among contacts.	

ARI, acute respiratory infection; PPE, personal protective equipment; RT-PCR, reverse transcriptase-polymerase chain reaction; TB, tuberculosis

Table K.3 Considerations for spatial separation

Recommendation: Maintain spatial separation (distance of at least 1 m) between each ARI patient and others, including health-care workers (without the use of PPE), to reduce the transmission of ARI. (Chapter 2, Section 2.3.1)		
Population: People with ARI in health-care settings		
Intervention: Spatial separation		
Factor	**Assessment**	**Explanation**
Quality of evidence	Very low to low (*51*) (Annex L.2)	Limited evidence suggests that: • spread of respiratory virus, particularly RSV and SARS, can be reduced by the use of spatial separation or distancing between those infected and those not infected, when combined with other hygienic measures (*12, 51*); and • a distance of less than 1 m is associated with increase in risk of ARI pathogen transmission (*143, 147*).
Balance of benefits or desired effects versus disadvantages or undesired effects	Favourable	Reduction of ARI exposure and infection of health-care workers and patients by respiratory pathogens during delivery of care to patients with ARI in health-care settings. There are cost and resource implications for health-care facilities for the use of spatial separation combined with other measures.
Values and preferences	Favourable	Reduction of ARI exposure and infection to health-care workers and other patients by respiratory pathogens during delivery of care to patients with ARI in health-care settings.
Costs	Conditional	There are cost and resource implications to health-care facilities for the use of spatial separation.
Feasibility	Conditional	The use of spatial separation for patients with ARIs depends on availability of space and surge capacity (beds), and may not be readily implementable in all health-care settings.
Overall ranking	**STRONG RECOMMENDATION**	Although the quality of evidence was considered very low to low, there was consensus that the advantages of the spatial separation between each ARI patient and others and an assessment of values and preferences provided sufficient basis for the strong recommendation.
Research gap	Additional research is required to fully elucidate the epidemiology of the risk of transmission of specific pathogens causing acute respiratory diseases from infected patients to health-care workers and other patients with the use of spatial separation alone compared to spatial separation with the use of other selected precautions. A significant research gap exists for studies that examine discrete parameters (e.g. 1 m, 2 m) of spatial separation with respect to the impact on the reduction of transmission and infection by ARIs.	

ARI, acute respiratory infection; PPE, personal protective equipment; RSV, respiratory syncytial virus; SARS, severe acute respiratory syndrome

Table K.4 Considerations for cohorting and special measures

Recommendation: Consider the use of patient cohorting (i.e. the placement of patients infected or colonized with the same laboratory-identified pathogens in the same designated unit, zone or ward). If cohorting is not possible apply special measures (i.e. the placement of patients with the same suspected diagnosis – similar epidemiological and clinical information – in the same designated unit, zone or ward) to reduce transmission of ARI pathogens to health-care workers and other patients. (Chapter 2, Section 2.2.2)		
Population: People with ARI in health-care settings		
Intervention: Cohorting		
Factor	**Assessment**	**Explanation**
Quality of evidence	Low to moderate – cohorting combined with other measures (*51*) (Annex L.2)	Evidence suggests that nosocomial respiratory virus spread and infection, particularly RSV, can be reduced by the use of cohorting when combined with other hygienic measures, especially for younger children (*51*).
Balance of benefits or desired effects versus disadvantages or undesired effects	Conditional	Reduction of ARI exposure and infection of health-care workers and other patients during delivery of care to patients with ARI in health-care settings. The benefits clearly outweigh the disadvantages for ARIs associated with high morbidity or mortality (e.g. SARS), but are less clear for ARIs associated with lesser morbidity or mortality. There are cost and human resource implications for health-care facilities for the use of cohorting.
Values and preferences	Favourable	Reduction of ARI exposure and infection of health-care workers and other patients during care delivery to patients with ARIs in health-care settings.
Costs	Conditional	There are cost implications for health-care facilities for the use of cohorting.
Feasibility	Conditional	The use of cohorting for patients with ARIs depends on the availability of beds and staff that can be allocated for cohorting.
Overall ranking	**CONDITIONAL RECOMMENDATION**	
Research gap	Additional research is required to: • elucidate the epidemiology of the risk of transmission of specific pathogens causing acute respiratory diseases from patients to health-care workers with the use of cohorting alone versus cohorting with the use of other selected precautions; • elucidate the cost and resource implications for cohorting in different settings around the world; • validate that the use of special measures, when the pathogen is suspected but not known, is equivalent to the use of cohorting with respect to the reduction of transmission and infection of ARI pathogens.	

ARI, acute respiratory infection; RSV, respiratory syncytial virus; SARS, severe acute respiratory syndrome

Table K.5 Considerations for personal protective equipment

Recommendation: Use appropriate PPE as determined by risk assessment (according to the procedure and suspected pathogen). Appropriate PPE when providing care to patients presenting with ARI syndromes may include a combination of the following: medical mask (surgical or procedure mask), gloves, long-sleeved gowns and eye protection (goggles or face shields).[1] (Chapter 2, Section 2.4)		
Population: People with ARI in health-care settings		
Intervention: PPE		
Factor	**Assessment**	**Explanation**
Quality of evidence	Low to moderate – PPE measures combined with hand hygiene (*51*) (Annex L.2)	Evidence suggests that respiratory virus spread and infection can be reduced by hygienic measures, including hand hygiene and PPE use (*51*). Most of this evidence comes from studies on RSV, SARS and influenza virus. Case–control studies that focused on SARS suggest that barriers to transmission (e.g. isolation and PPE) are effective at containing epidemic spread of this virus (*51*). The use of masks (medical or N95 particulate respirators) was the measure with the most consistent and comprehensive supportive evidence across all studies. There is moderate evidence that medical masks are non-inferior to particulate respirators (e.g. N95, facial filtering protection 2), and that the latter are more expensive and uncomfortable, and cause skin irritation.
Balance of benefits or desired effects versus disadvantages or undesired effects	Favourable	Reduction of ARI exposure and infection of health-care workers and patients by respiratory pathogens associated with delivery of care to patients with ARI in health-care settings. The benefits clearly outweigh the disadvantages for ARIs associated with high morbidity or mortality (e.g. SARS), but are less clear for ARIs associated with lesser morbidity or mortality. There are unintended effects (e.g. skin reactions) related to the use of PPE in health-care facilities. Use of PPE may be uncomfortable and may create difficulties in interacting with patients.
Values and preferences	Conditional	Although the use of PPE based on risk assessment appears to reduce ARI infection of health-care workers and other patients by respiratory pathogens during care delivery to patients with ARI in health-care settings, PPE may be uncomfortable and may limit interactions with the patient.
Costs	Conditional	There are cost implications for the use of PPE in health-care faciilties, depending on the jurisdiction; other health priorities may hamper acquisition of PPE.
Feasibility	Conditional	The use of PPE during care delivery for patients with ARIs depends on availability of supplies and compliance with recommendations. In turn, compliance is complex and affected by many factors (e.g. attitude, knowledge, peer pressure, motivation and organizational climate), which may widely vary across facilities.
Overall ranking	**STRONG RECOMMENDATION** Although the quality of evidence was considered low to moderate, there was consensus that the advantages of the use of appropriate PPE provided sufficient basis for the strong recommendation.	
Research gap	Additional research is required to elucidate the epidemiology of transmission of specific ARI pathogens from patients to health-care workers and other patients during care delivery in health-care settings, with and without the use of specific precautions.	

ARI, acute respiratory infection; PPE, personal protective equipment; RSV, respiratory syncytial virus; SARS, severe acute respiratory syndrome

[1] When a novel ARI is identified and the mode of transmission is unknown, it may be prudent to implement the highest level of IPC precautions whenever possible, including the use of particulate respirators, until the mode of transmission is clarified.

Table K.6 Considerations for personal protective equipment for aerosol-generating procedures

Recommendation: Use PPE, including gloves, long-sleeved gowns, eye protection (goggles or face shields) and facial mask (surgical or procedure mask, or particulate respirators) during aerosol-generating procedures that have been consistently associated with an increased risk of transmission of ARI pathogens.[1] The available evidence suggests that performing or being exposed to endotracheal intubation either by itself or combined with other procedures (e.g. cardiopulmonary resuscitation or bronchoscopy) is consistently associated with increased risk of transmission. (Chapter 2, Section 2.4)

Population: People with ARI in health-care settings

Intervention: PPE

Factor	Assessment	Explanation
Quality of evidence	Very low to low (*51, 149*) (Annexes L.1-L.2)	Evidence suggests that: • some procedures potentially capable of generating aerosols are associated with increased risk of SARS transmission to health-care workers, with the most consistent association across multiple studies being identified with tracheal intubation (*149*); • an increased risk of SARS infection is associated with tracheotomy, non-invasive ventilation and manual ventilation before intubation, but these findings were identified from a limited number of very low quality studies, which makes the interpretation difficult;[1] no other procedures were found to be significantly associated with any increased risk of transmission; these studies also assessed whether health-care workers had proper IPC training;
	Low to moderate	• respiratory virus spread can be prevented by hygienic measures, including hand hygiene and the use of PPE with gloves, gowns, eye protection (goggles or face shields) and facial mask (medical masks or particulate respirators) (*51*), with medical masks or particulate respirators being the most consistent and comprehensive protective measures.
Balance of benefits or desired effects versus disadvantages or undesired effects	Favourable	Reducing the exposure of health-care workers to respiratory pathogens during aerosol-generating procedures associated with increased risk of infection transmission. Use of PPE may be uncomfortable and may create difficulties for the interaction with patients.
Values and preferences	Favourable	Reducing the exposure of health-care workers to respiratory pathogens during aerosol-generating procedures that are associated with increased risk of infection transmission. A similar approach for this factor was used for reduction in exposure and infection for TB (*27*).
Costs	Conditional	The use of PPE carries cost and resource implications for health-care faciliies.
Feasibility	Conditional	The use of barrier precautions during aerosol-generating procedures associated with increased risk of infection transmission may be feasible but compliance is complex and affected by many factors (e.g. attitude, knowledge, peer pressure, motivation and organizational climate), which may vary according to the setting.
Overall ranking	**STRONG RECOMMENDATION** Although the quality of evidence was considered very low to moderate, there was consensus that the advantages of the use of appropriate personal protective equipment for aerosol-generating procedures and an assessment of values and preferences provided sufficient basis for the strong recommendation.	

[1] When a novel ARI is identified and the mode of transmission is unknown, it may be prudent to implement the highest level of IPC precautions whenever possible, including the use of particulate respirators, until the mode of transmission is clarified.

Research gap	A significant research gap exists regarding the epidemiology of ARI transmission from patients to health-care workers during aerosol-generating procedures. This gap is compounded by a lack of precision in the literature with regard to the definition for aerosol-generating procedures. There is a need to determine the minimum ventilation requirements to reduce pathogen transmission during these procedures. While there is no evidence to suggest a difference in the effectiveness of particulate respirators over medical masks as a component in the use of PPE for routine care, it is not known whether a difference exists in the context of aerosol-generating procedures that have been consistently associated with increased risk of pathogen transmission.

ARI, acute respiratory infection; IPC, infection prevention and control; PPE, personal protective equipment; SARS, severe acute respiratory syndrome; TB, tuberculosis

Table K.7 Considerations for environmental ventilation for aerosol-generating procedures

Recommendation: Use adequately ventilated single rooms when performing aerosol-generating procedures that have been consistently associated with increased risk of ARI transmission. (Chapter 2, Section 2.3.3)		
Population: People with ARI in health-care settings		
Intervention: Environmental ventilation		
Factor	**Assessment**	**Explanation**
Quality of evidence	Very low to low (*149*) (Annex L.1)	Evidence suggests that some procedures potentially capable of generating aerosols are associated with increased risk of SARS transmission to health-care workers, with the most consistent association across multiple studies identified with tracheal intubation.(*149*) An increased risk of SARS infection was associated with tracheotomy, non-invasive ventilation and manual ventilation before intubation, but these findings were identified from a limited number of very low quality studies, which makes the interpretation difficult (*149*). No other procedures were found to be significantly associated with any increased risk of transmission. Some of these studies also assessed whether health-care workers had proper IPC training. A mathematical modelling study suggests that the environmental ventilation rate could be associated with a decrease in risk (*1*).
Balance of benefits or desired effects versus disadvantages or undesired effects	Favourable	Reduction of infection with respiratory pathogens to health-care workers during the performance of aerosol-generating procedures that are conducted on patients with ARI in health-care settings.
Values and preferences	Favourable	Reduction of infection with respiratory pathogens to health-care workers during the performance of aerosol-generating procedures that are conducted on patients with ARI in health-care settings. Good ventilation provides a comfortable sensation.
Costs	No strength	There are cost, space and timing implications for health-care facilities for the use of environmental controls during the performance of aerosol-generating procedures. Low cost is possible if simple natural ventilation is used and is properly designed according to local climate. Higher costs are likely if full mechanical or hybrid ventilation or high-tech natural ventilation is used (*1*).
Feasibility	Conditional	The use of environmental controls during the performance of aerosol-generating procedures is not always feasible and depends on the setting. Natural ventilation is less feasible in extreme climates.
Overall ranking	**CONDITIONAL RECOMMENDATION**	
Research gap	There are significant research gaps: • in the epidemiology of the risk of transmission of acute respiratory diseases from patients undergoing aerosol-generating procedures to health-care workers, and a lack of precision in the definition for aerosol-generating procedures; • regarding the effectiveness of measures to reduce the risk of infection associated with the procedure; and • regarding the minimum ventilation requirements for natural ventilation in terms of variable ventilation rate and airflow direction control for aerosol-generating procedures.	

ARI, acute respiratory infection; IPC, infection prevention and control; SARS, severe acute respiratory syndrome

Table K.8 Considerations for vaccination of health-care workers

Recommendation: Vaccinate health-care workers caring for patients at high risk of severe or complicated influenza disease, to reduce illness and mortality among these patients. (Chapter 2, Section 2.2.7)		
Population: Health-care workers caring for patients with ARI in health-care settings		
Intervention: Vaccination		
Factor	**Assessment**	**Explanation**
Quality of evidence	Very low to low (*130*) (Annex L.4)	Evidence suggests a reduction in ILI, all-cause mortality and, to some extent, laboratory-confirmed influenza among patients at high risk of severe or complicated illness from influenza using a strategy of influenza vaccination of health-care workers providing care for these patients. The protective effects were predominantly demonstrated in residents of long-term residential care facilities (*130*).
Balance of benefits or desired effects versus disadvantages or undesired effects	Favourable	Reduction of illness and mortality among patients at high risk of severe or complicated illness from influenza. There are cost and resource implications to health-care facilities for the use and implementation of influenza vaccination among health-care workers; these will vary among different settings. Influenza vaccination may be associated with side effects.
Values and preferences	Favourable	Reduction of illness and mortality among patients at high risk of severe or complicated illness from influenza.
Costs	Conditional	Influenza vaccination for health-care workers carries cost and resource implications for health-care facilities.
Feasibility	Conditional	The use of an influenza vaccination programme for health-care workers depends on availability of vaccine, administrative capacity and willingness to receive vaccine, and it may not be readily implementable in all settings.
Overall ranking	**STRONG RECOMMENDATION** Although the quality of evidence was considered very low to low, there was consensus that the advantages of the vaccination of health-care workers and an assessment of values and preferences provided sufficient basis for the strong recommendation.	
Research gap	Additional research is required to elucidate the protective effect of influenza vaccination in populations beyond residents of long-term residential care facilities, the benefits of other vaccinations, and the safety and the cost effectiveness of the implementation of a vaccination programme for health-care workers.	

ARI, acute respiratory infection; ILI, influenza-like illness

Table K.9 Considerations for ultraviolet germicidal irradiation

Recommendation: No recommendation possible. (Chapter 2, Section 2.3.5)		
Population: People with ARI in health-care settings		
Intervention: UVGI		
Factor	**Assessment**	**Explanation**
Quality of evidence	Very low	There is very limited evidence available to suggest that respiratory pathogen spread from patients to health-care workers or other patients can be prevented by the use of UVGI for disinfection of air in health-care settings (*150*).
Balance of benefits or desired effects versus disadvantages or undesired effects	No strength	Reduction of the exposure to and infection of health-care workers by respiratory pathogens during care delivery to patients with ARI in health-care settings. Use of UVGI is associated with cost and resource implications for health-care facilities and harms to health-care workers due to excessive exposure. Effective use of UVGI requires expertise in design, installation and testing, maintenance and cleaning, electricity and air mixing (*27*). Direct exposure or overexposure to UVGI results in temporary adverse effects (photokeratitis and erythema).
Values and preferences	No strength	Reduction of exposure and infection to health-care workers by respiratory pathogens during care delivery to patients with ARI in health-care settings.
Costs	No strength	The use and maintenance of UVGI carries cost and resource implications for health-care facilities.
Feasibility	Conditional	The use of UVGI during care delivery for patients with ARIs depends on appropriate safeguards and expertise to install and maintain them.
Overall ranking	**No recommendation possible**	
Research gap	Additional research is required to elucidate whether the use of UVGI for disinfection of air in health-care settings reduces the risk of transmission and infection of specific pathogens causing ARIs from patients to health-care workers during the delivery of care, with and without the use of other precautions. Additional research is also required to assess the potential harms and cost effectiveness of the use of UVGI in these settings.	

ARI, acute respiratory infection; UVGI, ultraviolet germicidal irradiation

Table K.10 Considerations for duration of additional infection prevention and control (IPC) precautions

Recommendation: Implement additional IPC precautions at the time of admission and continue for the duration of symptomatic illness, and modify according to the pathogen and patient information.[1] Always use Standard Precautions. There is no evidence to support the routine application of laboratory tests to determine the duration of IPC precautions. (Chapter 2, Section 2.2.4)

Population: People with ARI in health-care settings

Intervention: Duration of additional IPC precautions

Factor	Assessment	Explanation
Quality of evidence	Very low	The scant evidence on the precise duration of additional precautions for patients with ARI is based on the duration of symptomatic illness and virological and epidemiological data on the infectivity period (*103, 104*). There is no evidence available to suggest that respiratory pathogen spread from patients to health-care workers or other patients is reduced by the use of additional IPC precautions for a longer duration.
Balance of benefits or desired effects versus disadvantages or undesired effects	Favourable	Reduction of exposure and infection to health-care workers and other patients by respiratory pathogens during care delivery to patients with ARI in health-care settings. Avoidance of unnecessary costs and better use of resources. Laboratory tests, using molecular techniques, are a highly sensitive diagnostic measure and may detect traces of viral nucleic acids. A positive result does not necessarily indicate ongoing virus replication and infectious risk.
Values and preferences	Favourable	Reduction of exposure and infection of health-care workers and other patients by respiratory pathogens during care delivery to patients with ARI in health-care settings.
Costs	No strength	The use of IPC precautions for a longer duration, or the use of laboratory tests, carry implications of cost and the use of beds in health-care facilities
Feasibility	Conditional	Increasing the duration of IPC precautions may be feasible in some settings, but it depends on availability of space and surge capacity (beds) and may not be easily implementable in all health-care settings.
Overall ranking	**CONDITIONAL**	
Research gap	Additional research is required: • to fully elucidate whether a longer (e.g. beyond resolution of symptoms) duration of additional IPC precautions for patients with ARIs in health-care settings reduces the risk of transmission and infection of specific pathogens causing ARIs from patients to health-care workers and other patients; • regarding the application of routine laboratory tests as a guide to define the duration of IPC precautions needed to reduce the spread of infection from infected patients to health-care workers or other patients; • to assess the harms and cost implications of using laboratory tests to define the duration of IPC precautions for individuals with ARI in health-care settings.	

ARI, acute respiratory infection; IPC, infection prevention and control

[1] Patient information (e.g. age, immune status and medication) should be considered in situations where there is concern that a patient may be infectious for a prolonged period.

Annex L Summaries of relevant systematic reviews of the literature

L.1 Summary of *Aerosol-generating procedures and risk of transmission of acute respiratory diseases: A systematic review*

Systematic review objective

The 2011 review *Aerosol-generating procedures and risk of transmission of acute respiratory diseases: A systematic review* (*149*) assessed the clinical evidence on the risk of transmission of ARIs to health-care workers exposed to aerosol-generating clinical procedures compared with the risk to workers not exposed to the same procedures.

Methods

The authors used a predefined strategy to search electronic health-care databases including PubMed, MEDLINE, EMBASE, CINAHL, The Cochrane Library (Issue 10, 2010), University of York Centre for Reviews and Dissemination databases, EuroScan, LILACS, Indian Medlars, Index Medicus for South East Asia and international health technology agencies; they also conducted a focused Internet search. Information sources were limited to health technology assessments, systematic reviews, meta-analyses, randomized controlled trials (RCTs), non-randomized controlled studies and guidelines published between 1 January 1990 and 22 October 2010. The search strategy contained no language limitation. Studies included in the review were those that examined the relevant study population (health-care workers caring for patients with ARIs), intervention (provision of care for patients undergoing aerosol-generating procedures), comparator (provision of care for patients not undergoing aerosol-generating procedures) and outcome (transmission of ARI from patient to health-care worker).

Of the 1862 abstracts identified by electronic search and screened against inclusion criteria, 86 citations were retrieved. Of these, 10 relevant non-randomized studies (5 case–control and 5 retrospective cohort studies) met the criteria for inclusion in the systematic review (Fig. L.1). The quality of evidence was rated using the GRADE framework (*47*).

Results and conclusions

All studies included in the review assessed the transmission of SARS-CoV to health-care workers associated with the performance of potentially aerosol-generating procedures while caring for ill patients in hospital or intensive care unit settings during the SARS outbreaks of 2002–2003.

The most consistent statistically significant association of an increased risk of SARS transmission to workers was found in tracheal intubation (eight studies) (Table L.1 and Fig. L.2). Increased risk of SARS transmission was also reported in non-invasive ventilation (two studies), tracheotomy (one study), and manual ventilation before intubation (one study); however, these findings were identified from a limited number of very low quality studies, which makes interpretation difficult. There was no significant difference in the risk of SARS transmission between exposed and unexposed health-care

workers for all other procedures evaluated – suction before intubation, suction after intubation, manual ventilation after intubation, bronchoscopy, nebulizer treatment, manipulation of oxygen mask, manipulation of bilevel positive airway pressure (BiPAP) mask, defibrillation, chest compressions, insertion of nasogastric tube, collection of sputum sample, high-frequency oscillatory ventilation, high-flow oxygen, endotracheal aspiration, suction of body fluid, administration of oxygen, chest physiotherapy and mechanical ventilation (Table L.1). All studies were rated very low quality according to GRADE criteria (*47*).

The findings suggest that some procedures potentially capable of generating aerosols are associated with increased risk of SARS transmission to health-care workers, with the most consistent association being across multiple studies identified with tracheal intubation. Other associations included non-invasive ventilation from two studies, and manual ventilation before intubation and tracheotomy, each from single studies. The authors note that these results must be interpreted in the context of the very low quality of the studies. A significant research gap was identified in this area: studies of higher methodological quality are required to provide more precise information about the risk of aerosol generation and the risk of transmission of microbes causing specific acute respiratory diseases, including influenza, from patients undergoing aerosol-generating procedures to health-care workers.

Figure L.1 Selection of publications for *Aerosol-generating procedures and risk of transmission of acute respiratory diseases: A systematic review*

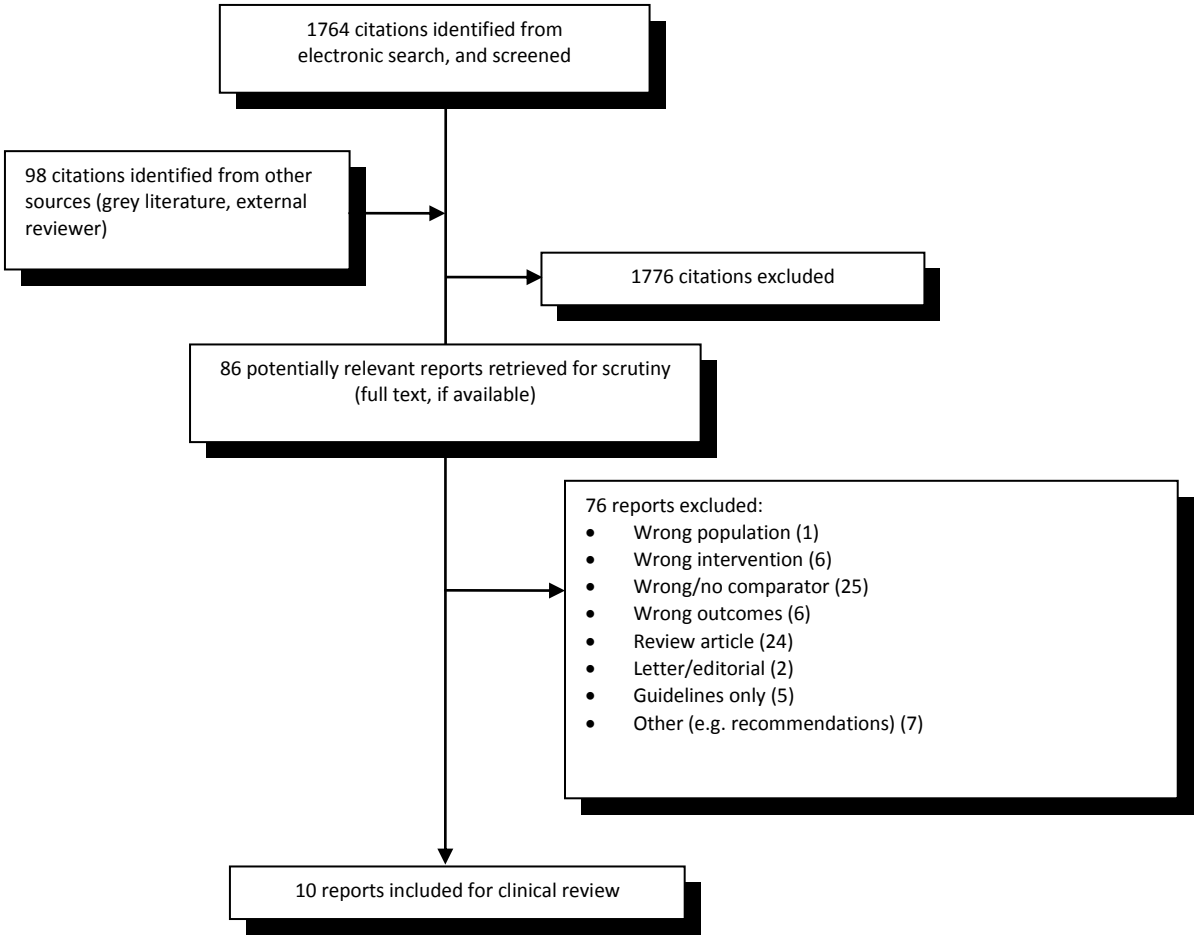


Table L.1 Summary of results from studies selected in the systematic review *Aerosol-generating procedures and risk of transmission of acute respiratory diseases: A systematic review*

Aerosol-generating procedures	Odds ratio[a] (95% CI)
Tracheal intubation (4 cohort studies)	3.0 (1.4, 6.7)
	22.8 (3.9, 131.1)
	13.8 (1.2, 161.7)
	5.5 (0.6, 49.5)
Pooled estimate (I^2 = 39.6%)	6.6 (2.3, 18.9)
Tracheal intubation (4 case–control studies)	0.7 (0.1, 3.9)
	9.2 (4.2, 20.2)
	8.0 (3.9, 16.6)
	9.3 (2.9, 30.2)
Pooled estimate (I^2 = 61.4%)	6.6 (4.1, 10.6)
Suction before intubation (2 cohort studies)	13.8 (1.2, 161.7)
	1.7 (0.7, 4.2)
Pooled estimate (I^2 = 59.2%)	3.5 (0.5, 24.6)
Suction after intubation (2 cohort studies)	0.6 (0.1, 3.0)
	1.8 (0.8, 4.0)
Pooled estimate (I^2 = 28.8%)	1.3 (0.5, 3.4)
Nebulizer treatment (3 cohort studies)	6.6 (0.9, 50.5)
	0.1 (0.0*, 1.0)
	1.2 (0.1, 20.7)
Pooled estimate (I^2 = 73.1%)	0.9 (0.1, 13.6)
Manipulation of oxygen mask (2 cohort studies)	17.0 (1.8, 165.0)
	2.2 (0.9, 4.9)
Pooled estimate (I^2 = 64.8%)	4.6 (0.6, 32.5)
Bronchoscopy (2 cohort studies)	3.3 (0.2, 59.6)
	1.1 (0.1, 18.5)
Pooled estimate (I^2 = 0%)	1.9 (0.2, 14.2)
Non-invasive ventilation (2 cohort studies)	2.6 (0.2, 34.5)
	3.2 (1.4, 7.2)
Pooled estimate (I^2 = 0%)	3.1 (1.4, 6.8)
Insertion of nasogastric tube (2 cohort studies)	1.7 (0.2, 11.5)
	1.0 (0.2, 4.5)
Pooled estimate (I^2 = 0%)	1.2 (0.4, 4.0)

Aerosol-generating procedures	Odds ratio[a] (95% CI)
Chest compressions (1 case–control study)	4.5 (1.5, 13.8)
Chest compressions (2 cohort studies)	3.0 (0.4, 24.5)
	0.4 (0.0**, 7.8)
Pooled estimate (I^2 = 27.3%)	1.4 (0.2, 11.2)
Defibrillation (2 cohort studies)	0.5 (0.0**, 12.2)
	7.9 (0.8, 79.0)
Pooled estimate (I^2 = 55.3%)	2.5 (0.1, 43.9)
Chest physiotherapy (2 cohort studies)	1.3 (0.2, 8.3)
	0.5 (0.1, 3.5)
Pooled estimate (I^2 = 0%)	0.8 (0.2, 3.2)
High-frequency oscillatory ventilation (1 cohort study)	0.7 (0.1, 5.5)
High-flow oxygen (1 cohort study)	0.4 (0.1, 1.7)
Tracheotomy (1 case–control study)	4.2 (1.5, 11.5)
Intubation, tracheotomy, airway care, and cardiac resuscitation (1 case–control study)	6.2 (2.2, 18.1)
Manipulation of BiPAP mask (1 cohort study)	4.2 (0.6, 27.4)
Endotracheal aspiration (1 cohort study)	1.0 (0.2, 5.2)
Suction of body fluid (1 case–control study)	1.0 (0.4, 2.8)
Administration of oxygen (1 case–control study)	1.0 (0.3, 2.8)
Mechanical ventilation (1 cohort study)	0.9 (0.4, 2.0)
Manual ventilation before intubation (1 cohort study)	2.8 (1.3, 6.4)
Manual ventilation after intubation (1 cohort study)	1.3 (0.5, 3.2)
Manual ventilation (1 cohort study)	1.3 (0.2, 8.3)
Collection of sputum sample (1 cohort study)	2.7 (0.9, 8.2)

BiPAP: bilevel positive airway pressure; CI: confidence interval

* actual value is 0.01; ** actual value is 0.02

[a] Studies included in this table met the criteria for inclusion in a systematic review of the evidence (i.e. they measured the risk of SARS transmission to health-care workers who were exposed to the listed procedures compared to workers who were not exposed the same procedures). Inclusion in this table is not a validation of study quality.

Figure L.2A Risk of SARS transmission to health-care workers exposed to tracheal intubation

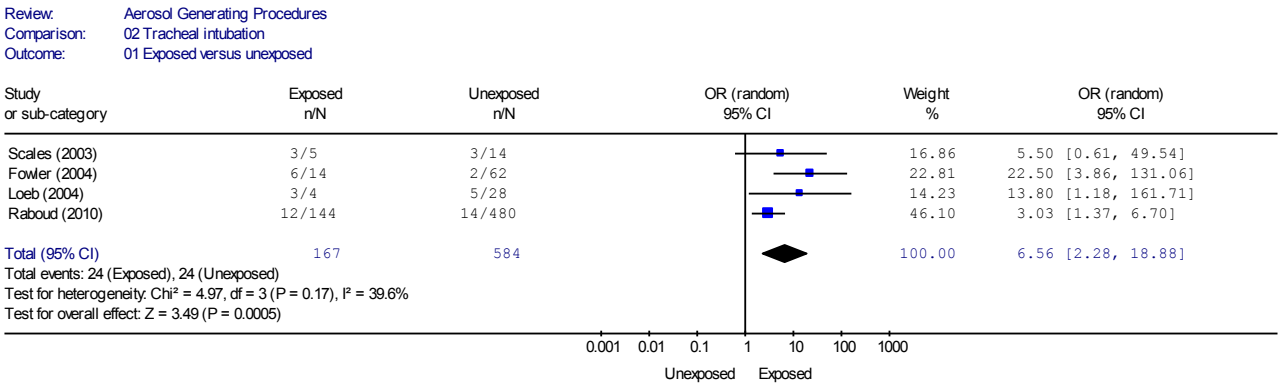
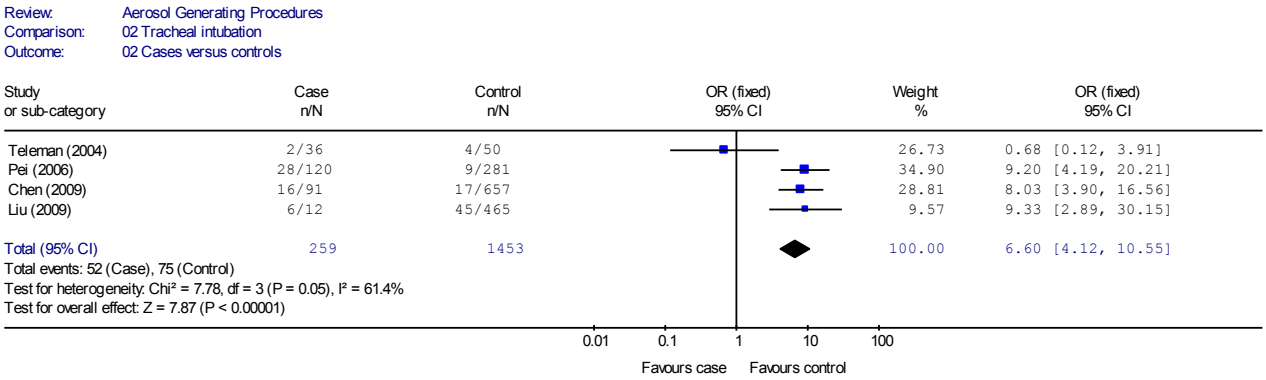


Figure L.2B Tracheal intubation as risk factor for SARS transmission



CI, confidence interval; n, number of events; N, sample size; OR, odds ratio; SARS, severe acute respiratory syndrome

L.2 Summary of *Physical interventions to interrupt or reduce the spread of respiratory viruses*

Systematic review objective

This 2011 review – *Physical interventions to interrupt or reduce the spread of respiratory viruses* (*51*) – examined evidence for the effectiveness of physical barriers (e.g. screening at entry ports, isolation, quarantine, social distancing, barriers, personal protection and hand hygiene) in reducing the spread of respiratory viruses. It represents an update of a previously conducted systematic review of the same topic in 2010 (*266*), with some adaptations designed to inform the review of the WHO interim guidelines *Infection prevention and control of epidemic- and pandemic-prone acute respiratory diseases in health care*, 2007 (*16*).

Methods

The authors used predefined criteria to search the relevant databases, including The Cochrane Library, the Cochrane Central Register of Controlled Trials (CENTRAL 2010, Issue 3), which includes the Acute Respiratory Infections Group's Specialised Register, MEDLINE (1966 to October 2010), OLDMEDLINE (1950 to 1965), EMBASE (1990 to October 2010), CINAHL (1982 to October 2010), LILACS (2008 to October 2010), Indian MEDLARS (2008 to October 2010) and IMSEAR (2008 to October 2010). Of 3775 titles identified, 3560 were scanned and excluded, 215 were retrieved in full text and 67 were selected for inclusion. Included studies were those that investigated any intervention intended to prevent transmission of respiratory viruses compared with no intervention or with another intervention and that measured several negative outcomes associated with respiratory virus transmission (i.e. death, number of cases of viral illness, severity of viral illness and proxies for the preceding outcomes).

Results and conclusions

After screening potential publications for inclusion criteria, a total of 67 studies were included in the review, comprising RCTs, cluster-RCTs and observational studies, with a mixed risk of bias. The review identified seven studies – four RCTs and three observational studies – that were not in the previous review (*266*).

The risk of bias for most of the RCTs and cluster-RCTs was high, with the exception of one cluster-RCT that was considered of medium risk of bias and one RCT that was considered of low risk of bias. Data from observational studies were of mixed quality. The results of the case–control studies were considered sufficiently homogeneous to allow pooling and meta-analysis. Most of the information sources studied SARS; therefore, applying the review findings to other diseases will require additional research.

The results of the best quality cluster-RCTs suggest that respiratory virus spread can be prevented by hygiene measures, such as handwashing, especially when interventions are aimed at young children or households with young children. The conclusion that hygiene measures reduce transmission from children to other members of the household was broadly supported by other studies, although these conclusions came from studies that have a greater potential for confounding. No conclusion could be drawn regarding the benefit of adding virucidals or antiseptics to standard handwashing. The pooled case-control studies suggested that implementing transmission barriers, isolation and hygiene measures are effective at reducing respiratory virus transmission. Facial masks (surgical masks or N95 respirators) were the intervention that was found to perform most consistently, and the evidence did not indicate superiority of N95 respirators over simple surgical masks in

decreasing transmission of acute respiratory disease. One study found that screening at entry ports was associated with a marginal delay in spread; however, this association was not significant. The review found limited evidence that social distancing or spatial separation (i.e. keeping a distance of at least 1 m between infected patients and others) was effective. The results are summarized in Table L.2, below.

Table L.2 Summary of main results from the systematic review *Physical interventions to interrupt or reduce the spread of respiratory viruses*

Intervention	RCT (*N* = 6)	Cluster-RCT (*N* = 17)	Case–control (*N* = 9)	Prospective cohort (*N* = 16)	Retrospective cohort (*N* = 6)	Before–after (*N* = 13)
Handwashing	–	2 trials in children, effective (*267, 268*)	7 studies OR 0.54 (95% CI 0.44–0.67)(*154, 269-274*)	2 studies found effect (*275, 276*) 2 found no effect on ARIs (*277, 278*)	–	1 study in military recruits: handwashing more than 5 times per day effective (*279*)
Handwashing with antiseptic	–	2 trials in children, effective: antiseptic more effective (*280, 281*) 1 trial in children: antiseptic ≡ soap (*98*)	–	2 studies found added effect of antiseptic (*282, 283*) 1 study found no difference (*284*)	–	–
Handwashing and surface disinfection	–	1 study in day-care centre, effective (*285*) 1 study in school, no effect of adding disinfection to handwashing and cleaning on ARI (*286*) 1 study in families, no effect of adding disinfection to handwashing and cleaning on ARI (*287*) 1 study, no effect of handwashing with disinfection of surfaces in child day care (*288*)	–	–	–	1 study in special school with children with Down syndrome < 5 yrs effective (*289*)
Hand disinfection	3 trials effective (*290, 291*)	–	–	–	–	–
Gargling with iodine	1 trial effective (*292*)	–	–	–	–	–

Intervention	RCT (*N* = 6)	Cluster-RCT (*N* = 17)	Case–control (*N* = 9)	Prospective cohort (*N* = 16)	Retrospective cohort (*N* = 6)	Before–after (*N* = 13)
Nose wash	–	–	2 studies OR 0.30 (95% CI 0.16 to 0.57) (*269, 293*)	–	–	–
Virucidal tissues	–	1 trial small effect (*294*) 2 trials non-significant difference (*294, 295*)	–	1 study effective (*296*)	–	–
Disinfection of living quarters	–	–	1 study OR 0.30 (95% CI 0.23 to 0.39) (*270*)	–	–	–
Use of eye protection	–	–	3 studies OR 0.10 (95% CI 0.05–0.17) (*269, 274, 293*)	–	–	–
Barriers (masks, gloves, gowns combined)	–	–	2 studies OR 0.09 (95% CI 0.02 to 0.35) (*154, 271*)	1 study: masks + gowns no added effect to handwashing (*297*)	–	3 studies: combined with isolation effective 1 study: barriers combined with isolation effective (*298*) 1 study: masks and gowns added to isolation not effective (*299*) 1 study: gowns and gloves effective in paediatric ward (*300*)

Intervention	**RCT (*N* = 6)**	**Cluster-RCT (*N* = 17)**	**Case–control (*N* = 9)**	**Prospective cohort (*N* = 16)**	**Retrospective cohort (*N* = 6)**	**Before–after (*N* = 13)**
Mask	1 trial: surgical masks no effect (*301*)	1 trial: no effect if mask added to handwashing (*302*) 1 trial: no effect of P2 mask (*303*) 1 trial: mask added to handwashing effective if implemented < 36 hours after onset of illness (*265*) 1 trial: if mask added to handwashing effective during weeks 4 to 6 (*304*) 1 trial: no effect added to handwashing (*305*)	7 studies OR 0.32 (95% CI 0.26 to 0.39) (*154, 269-271, 273, 274, 293*)	3 studies: masks effective (*58, 306, 307*), with air filter safer (*210*)	1 study: harm related to mask wearing (*308*)	1 study in children's hospital effective (*309*)
N95 respirator	1 trial: surgical masks non-inferior to N95 respirators (*310*)	–	3 studies OR 0.17 (95% CI 0.07 to 0.43) (*154, 272, 293*)	–	1 study: harm related to N95 respirator wearing (*308*)	–
Gloves	–	–	6 studies OR 0.32 (95% CI 0.23 to 0.45) (*154, 269, 271, 272, 274, 293*)	–	1 study: harm related to glove wearing (*308*)	–
Gowns	–	–	5 studies OR 0.33 (95% CI 0.24 to 0.45) (*154, 269, 271, 272, 274*)	–	1 study: harm related to gown wearing (*308*)	1 study: no added effect in neonatal intensive care unit (*311*)

Intervention	RCT (*N* = 6)	Cluster-RCT (*N* = 17)	Case–control (*N* = 9)	Prospective cohort (*N* = 16)	Retrospective cohort (*N* = 6)	Before–after (*N* = 13)
Distancing	–	–	–	1 study: no effect in military recruits (*312*) 2 studies: cohorting in hospitals effective (*56, 58*)	1 study: cohorting in paediatric wards effective (*313*) 1 study: cohorting and handwashing in paediatric wards effective (*314*) 1 study: cohorting with handwashing and gowns effective in military hospital (*315*)	2 studies: early identification of cases and isolation effective (*298, 316*) 1 study: cohorting in combination with barriers effective in children's hospital (*317*) 1 study: cohorting of RSV cases and education effective in paediatric hospital (*318*) 1 study: isolation of close contacts in paediatric ward effective (*147*)
Quarantine	–	–	–	1 study: quarantine of anyone with known or suspected exposure effective during SARS epidemic (*319*)	1 study: isolation of close contacts effective (*320, 321*) 1 study: marginal non-significant benefit of border entry screening (*322*)	1 study: closure of primary school effective (*323, 324*) 1 ecological study: quarantine may be effective in SARS epidemic (*55*)

ARI: acute respiratory infection; CI: confidence interval; OR: odds ratio; RCT, randomized controlled trial; RSV, respiratory syncytial virus; SARS, severe acute respiratory syndrome

L.3 Summary of *Physical interventions to interrupt or reduce the transmission of respiratory viruses – resource use implications: A systematic review*

Systematic review objective

This 2011 review – *Physical interventions to interrupt or reduce the transmission of respiratory viruses – resource use implications: A systematic review* (*207*) – examined the economic literature related to resource implications and costs and cost effectiveness of physical barriers used to interrupt or reduce the spread of respiratory viruses. It was intended to supplement information provided in the Cochrane Review, *Physical interventions to interrupt or reduce the spread of respiratory viruses* (*51*) (Section L.2), and represents an important source of information for decision-makers considering the resource use implications of these interventions.

Methods

The authors used a peer-reviewed search strategy to search the following electronic bibliographic databases: EMBASE 1980 to 2010 Week 43, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid MEDLINE(R) 1950 to 2010, The Cochrane Library (2010, Issue 10), including the NHS Economic Evaluation Database (NHS EED), Health Economic Evaluations Database (HEED), CINAHL and PubMed. The initial search was completed in November 2010, with regular alerts established on EMBASE, MEDLINE and PubMed through April 2011. The publications identified were limited to economic studies published between 1995 and 2010. The search was not limited by language. Additional relevant information sources were sought through searches of the web sites of health technology assessment and related agencies, professional associations and other specialised databases, and of Google, Google Scholar and other Internet search engines, plus review of bibliographies and abstracts of key papers and consultation with experts.

The literature search yielded 1146 citations, the abstracts of which were screened for inclusion criteria. A total of 158 were retrieved for more detailed evaluation, of which 39 studies were subjected to full review. Seven studies reported information on resource use of physical interventions or assessed the cost effectiveness of physical interventions and were, therefore, selected for inclusion in the systematic review (Fig. L.3).

Results and conclusions

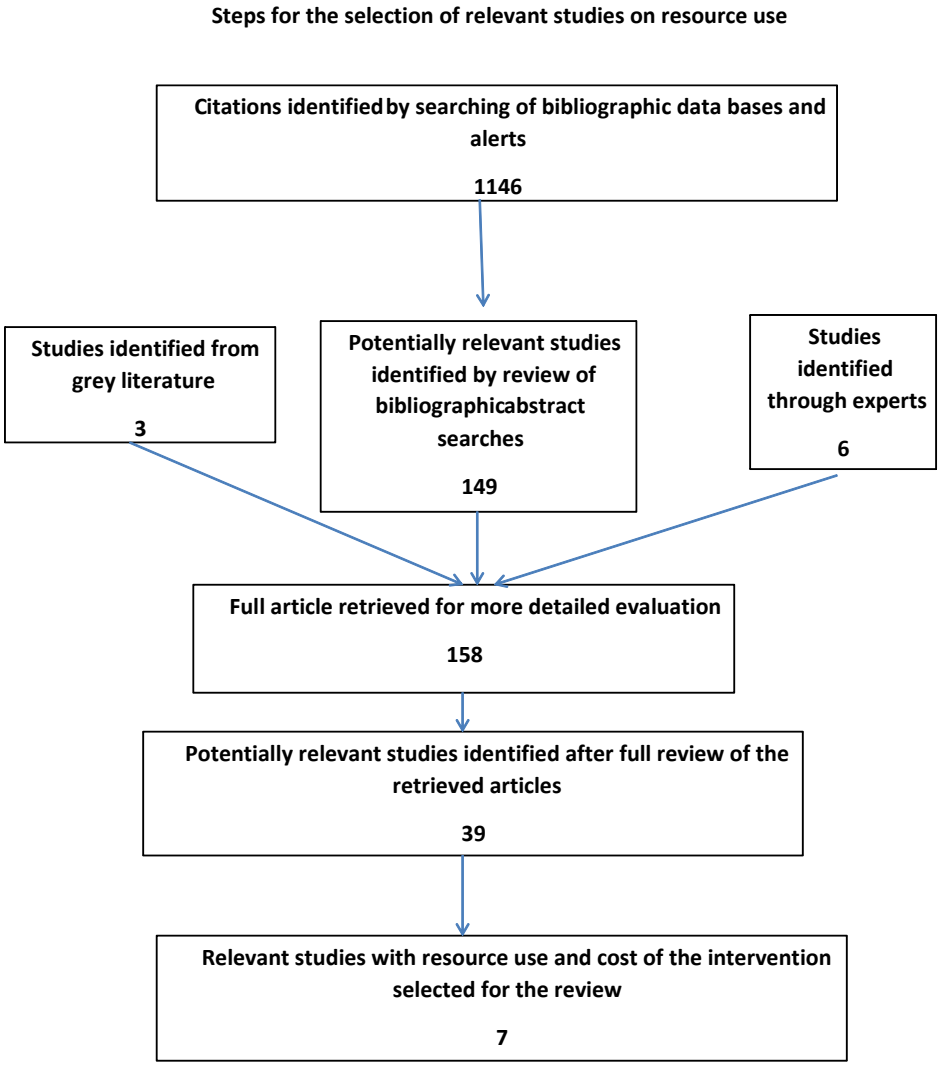
Using the GRADE appraisal methodology, the evidence provided by all seven studies was of very low quality, largely due to issues of study design, indirectness, and precision or sample size. The authors noted that, in some cases, the reliability of modelling results was questionable due to sensitivity to input assumptions. In addition, all economic studies included in the review were designed to address specific study questions and were conducted in settings subject to local recommendations and policies that differed from place to place. As a result, direct comparison of the findings and formulation of general conclusions was difficult.

A major finding of this review was the serious lack of high-quality research examining resource use and economic implications associated with PPE and other physical barriers for the interruption or reduction of respiratory virus transmission. In general, the current evidence

suggests that the use of PPE (e.g. medical masks, respirators, eye protection, gloves and gowns) to reduce the burden of respiratory viruses may be economically attractive, particularly in situations of rapid or prolific transmission and high fatality rate. The authors noted that these results depend on multiple assumptions, including transmission rate, facility infection rate and compliance with the interventions. In addition, the results suggested that there is an increase in the use of physical interventions to interrupt or reduce the spread of respiratory viruses during epidemics and pandemics, with two studies indicating that PPE may actually be overused during pandemics. The authors concluded that, while appropriate use of PPE is likely to be cost effective in certain situations, overuse could eliminate the overall cost effectiveness.

The authors noted that generalizability of the results to different respiratory virus types and settings other than hospitals still needs to be evaluated.

Figure L.3 Selection of publications for *Physical interventions to interrupt or reduce the transmission of respiratory viruses – resource use implications: A systematic review*



L.4 Summary of *The effectiveness of vaccination of healthcare workers for the protection of patients at higher risk of acute respiratory disease: A systematic review*

Systematic review objective

This review – *The effectiveness of vaccination of healthcare workers for the protection of patients at higher risk of acute respiratory disease: A systematic* review (*130*) – examined evidence for the effectiveness of influenza and pneumococcal vaccination of health-care workers in protecting patients at higher risk of severe or complicated disease from ARI.

Methods

The authors used a predefined strategy to search electronic health-care databases including EMBASE, CINAHL, MEDLINE, PubMed, The Cochrane Library, J-Stage, BDSP, EASTVIEW, Index-F, eLIBRARY, WHO regional indexes, and the WHO portal of clinical trials; they also accessed relevant evidence-based reviews, guidelines and grey literature. Publications were reviewed against eligibility criteria in a three-stage process to ensure appropriate study types (experimental or observational study or systematic review), subject population (patients of all ages who were at higher risk of severe or complicated illness as a result of ARI), intervention (vaccination of any person providing health care to high-risk patients with influenza or pneumococcal vaccines in any dose, preparation or schedule), comparator (no vaccination, placebo or use of long-term prophylaxis) and outcome (cases of or consultations for ARI; cases of, consultations for or laboratory evidence of ILI where relevant; mortality from respiratory infection, ILI, acute respiratory disease or associated complications; or measurements of health-care usage due to respiratory infection, ILI or acute respiratory disease). Reference and citation tracking was undertaken for all citations meeting eligibility criteria at the full-text stage.

Of the 12 352 total citations identified, 11 234 were excluded following a review of the titles, 941 following a review of the abstracts, and 160 following review of the full text (Fig. L.4). A total of 20 papers were included, 17 from the original search and an additional 3 records identified from citation or reference tracking. Of these, 14 were primary research papers and 6 were reports of two systematic reviews.

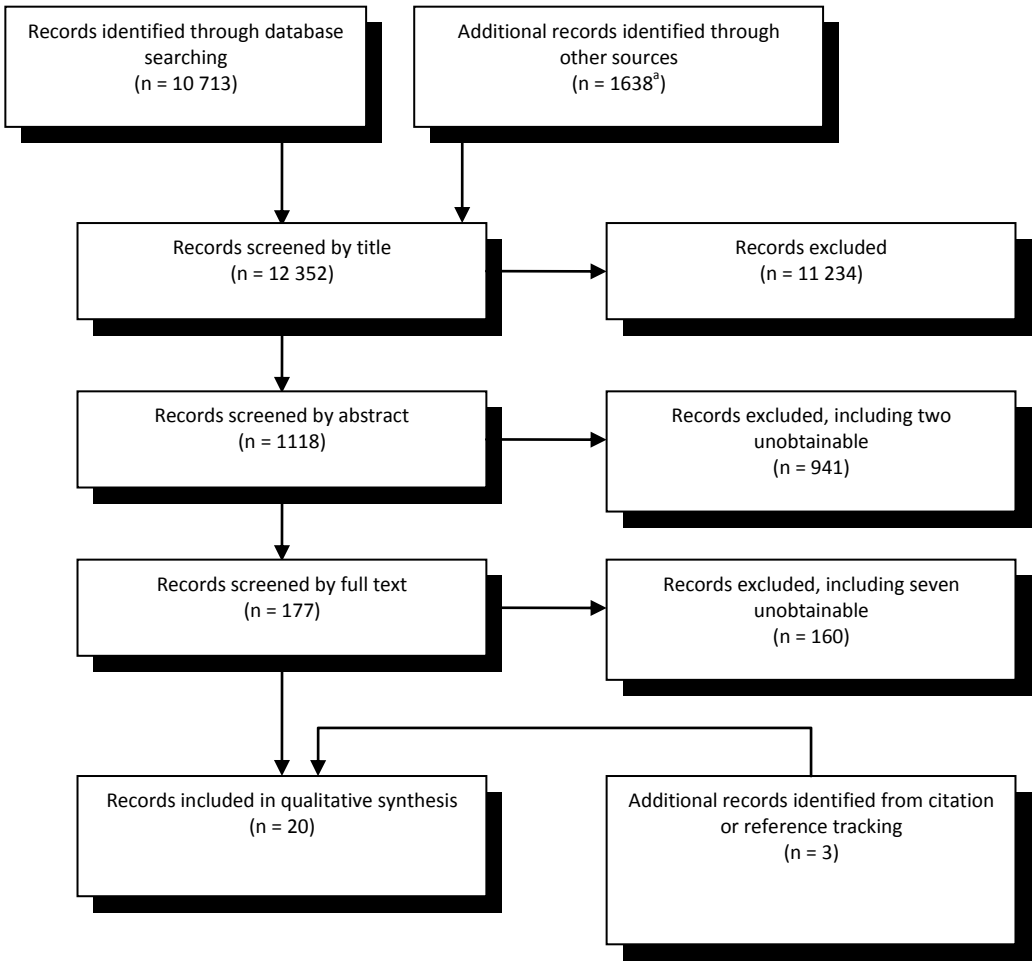
Results and conclusions

There was marked heterogeneity in the populations, interventions or exposures and outcomes considered, limiting the comparability of the included papers. Of the 14 primary research papers, 11 were in long-term residential care settings, and all were judged to be at risk of bias. Four were RCTs, and data from these had been pooled in a previous systematic review. This demonstrated a statistically significant protective effect with regard to measures of ILI and all-cause mortality among elderly residents. Additional observational data identified in this review suggested a uniform direction of effect across several measures of ILI, with a similar pattern for laboratory-confirmed influenza. The authors concluded that, although limited, a true underlying protective effect for patients at higher risk of severe or complicated ARI disease due to vaccination of health-care workers in long-term residential settings is likely (Table L.3).

The authors identified a major research gap in the topic area, noting that existing evidence provides little information about groups other than those in long-term residential settings. More

research is required to determine the effectiveness of vaccination of health-care workers in protecting other higher-risk patient populations.

Figure L.4 Selection of publications for *The effectiveness of vaccination of healthcare workers for the protection of patients at higher risk of acute respiratory disease: A systematic review*



[a] Includes one paper not identified with the original search strategy but transferred from a parallel review conducted in the same department.

Table L.3 Summary of findings from *The effectiveness of vaccination of healthcare workers for the protection of patients at higher risk of acute respiratory disease: A systematic review*

Outcome	Evidence available	Narrative synthesis
Acute respiratory disease	Statistical estimates from one RCT (*325*) providing two different measures of effect (clinical episodes of viral illness / lower respiratory tract infection).	Inconsistent effect but uniform in direction, suggesting possible protection. Difficult to ascertain whether this may be attributable to influenza infection due to the nonspecific nature of the measures used.
Clinically defined cases of ILI / influenza	Statistical estimates of clinically defined ILI measured from three RCTs (*325-327*) and two prospective cohort studies (*328, 329*), although different definitions employed. Further observational data from one cross-sectional study with no supporting statistical analysis. Additional (*330*) statistical estimate of cases of influenza from one cross-sectional study (*331*).	Pooled data (*332*) from the three RCTs suggest a statistically significant protective effect when adjusted for clustering. This is supported by additional observational data; two of the three studies providing statistical analyses (*328, 329*) demonstrating effects that were consistent in direction, although at higher risk of bias.
GP consultations for ILI	Statistical estimate from one RCT (*327*).	Small, statistically significant reduction in the rate of consultations for one season only, although overall statistically significant protective effect when converted to an adjusted odds ratio (*331*).
Outbreaks / cluster of ILI	Statistical estimates from three observational studies (*329, 333, 334*), although different definitions employed.	All three studies demonstrate statistically significant protective effects although imprecise estimates and a high risk of bias.
Laboratory-diagnosed influenza	Statistical estimates from one RCT (*335*) and two observational studies (*336, 337*). Observational data from a further RCT (*325*).	Pooled data from two RCTs (*331*) suggest a non-significant protective effect. Direction of effect supported by data from two additional observation studies (*336, 337*) which demonstrated statistically significant protective effects. Notable risk of bias and imprecision due to very small sample sizes.
Laboratory-confirmed outbreaks of influenza	Statistical estimate from one observational study (*338*).	No statistically significant difference, although vaccination coverage appeared higher in homes experiencing outbreaks. Analyses were, however, unadjusted and imprecise due to small numbers.
Respiratory mortality	Statistical estimates from four RCTs (*325-327, 335*) although each provided a different measure (respiratory deaths, deaths associated with pneumonia, deaths with ILI and laboratory-diagnosed influenza at death).	Pooled estimate (*331*) using data for respiratory deaths (*326*) and deaths associated with pneumonia (*325*) suggest a small, non-significant protective effect. Small, non-significant protective effects for mortality following ILI (*327*), and mortality due to laboratory-confirmed influenza (*335*), were also demonstrated in individual studies Generalisability was limited because of the different measures employed.
All-cause mortality	Statistical estimate from four RCTs (*325-327, 335*).	Inconsistent effect, but uniform in direction. Pooled data (*331*) suggest a statistically significant protective effect when adjusted for clustering.
Hospitalization	Statistical estimates from two RCTs (*326, 327*) providing three different	No clear effect demonstrated.

Outcome	Evidence available	Narrative synthesis
	measures of effect (hospitalization, hospitalization for respiratory causes and admission with ILI).	

GP, general practitioner; ILI: influenza-like illness; RCT, randomized controlled trial

Annex M Management of conflict of interest

All guideline group members, external peer reviewers and representatives of the Global Infection Prevention and Control Network member institutions participating in the GRADE process for the development of these guidelines submitted a declaration of interests form, together with their curriculum vitae. The potential interests declared by members of the guideline development group and external expert and resource persons are summarized below.

Professor Barry Cookson declared that he had once served on a panel and provided one-to-one expert advice (on three occasions) on effectiveness and strategy for products in the previous three years. The companies were Wyeth, Rubbermaid, 3M and Vernacare/Baxter. The products were a vaccine for Staphylococcus, microfiber cleaning wipes, and disinfectants. All consultancies had ceased by the time of his involvement in the review of these guidelines. These interests were deemed not to conflict with his ability to review the guidelines, since the financial compensation received during that time were not significant and the work had already ceased.

Professor Babacar Ndoye declared that he received support from bioMérieux Clinical Diagnostics, the Pasteur Institute, and local companies for participating or organizing meetings, workshops or conferences, none of which exceeded US$1,000. Professor Wing Hong Seto declared that he received travel support for speaking at a scientific conference organized by Pfizer. These were not deemed to be conflicts, since the amounts received were not significant.

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