

# Risk management of febrile respiratory illness in Emergency Departments

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## SUMMARY

Febrile Respiratory Illness (FRI) is defined as a new or worsening episode of either cough or shortness of breath, presenting with fever (temperature 38°C or higher) or chills in the previous 24 hours. Some FRI could cause large outbreaks of potentially life-threatening diseases (multi- or extensively drug resistant MTB, SARS, pandemic influenza) if not adequately controlled. Emergency Departments (EDs) are preferential sites of disease transmission because of the presence of both infectious and susceptible patients in the same space, the lack of rapid isolation of infectious patients, and the frequent and close contacts among patients and HCWs often not protected by PPE.

The management of risk of FRI transmission is thus extremely important in EDs, where all procedures of infection control should be in place and continually monitored and assessed. In this article the main procedures for the management of risk of FRI transmission in EDs are described and discussed.

**KEY WORDS:** Respiratory infections, Respiratory hygiene, Emergency department, Isolation precautions

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## INTRODUCTION

Febrile Respiratory Illness (FRI) is defined as a new or worsening episode of either cough or shortness of breath, in conjunction with fever (temperature 38°C or higher) or chills in the previous 24 hours (London Laboratory Service Group, 2007). This definition includes both upper and lower respiratory tract illnesses, which are mainly infectious diseases caused by many different pathogens.

According to literature (van Gageldonk-Lafeber, 2005; Lieberman, 2001) 35-40% of FRI remain undiagnosed. Viruses are the causative agents in

about 50-55% of FRI, and one half of these cases is due to Influenza viruses A and B. Bacteria contribute to the aetiology of FRI in the remaining 10-15%.

The most frequent FRI agents are listed in Table 1 (Zambon, 2001; van Gageldonk-Lafeber, 2005; Lieberman, 2001; Lieberman, 1998).

TABLE 1 - Most frequent agents of FRI.

### Virus:

- Influenza viruses A and B
- Rhinovirus
- Respiratory syncytial viruses A and B
- Parainfluenza viruses 1-3
- Human metapneumovirus

### Bacteria:

- $\beta$ -haemolytic streptococci
- Streptococcus pneumoniae
- Chlamydia pneumoniae
- Mycoplasma pneumoniae
- Bordetella pertussis
- Legionella pneumophila

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Other pathogens, such as *Mycobacterium tuberculosis*, Severe Acute Respiratory Syndrome - Coronavirus (SARS-CoV) and emerging avian or pandemic strains of Influenza virus, are also potential causative agents of severe FRI.

Almost all FRI pathogens are directly transmissible from person to person, and if not adequately controlled some of them (i.e. *Mycobacterium tuberculosis* [MTB], *Bordetella pertussis*) could cause large outbreaks of potentially life-threatening diseases (multi- or extensively drug resistant MTB [MDR-TB, and XDR-TB, respectively], SARS, pandemic influenza).

Health care settings could have an important role both in spreading and in controlling FRI. The recent SARS epidemic was a dramatic example of this dual role of the health care setting. Initially, hospitals represented the most important sites of SARS disease transmission: about 60% of new infections had been hospital-acquired (Drosten, 2003), and the disease struck heavily among health care workers (HCWs) who mainly became infected after unprotected, close contacts with patients or during high-risk, aerosol-generating procedures. HCWs represented about 21% of all SARS cases (Drosten, 2003).

On the other hand, infection control measures strongly reduce the risk of transmission of FRI in hospital settings when adequately applied. Indeed, safe hospital procedures such as early isolation of infectious patients, medical surveillance of contacts, and use of appropriate Personal Protective Equipment (PPE) are essential for the prevention and control of an outbreak, as has been the case for the containment of SARS (Yen, 2006; Dwosh, 2003).

Among health care settings, Emergency Departments (EDs) in particular are preferential sites of disease transmission, owing to the following factors:

- the presence of infectious patients and many susceptible individuals in the same limited space;
- the lack of isolation of infectious patients because of mis-diagnosis or unavailability of adequate facilities;
- the frequent and close contacts among patients and HCWs often not protected by PPE.

The management of risk of FRI transmission is thus extremely important in EDs, where all procedures of infection control should be in place

and continually monitored and assessed (Rothman, 2006; Rothman, 2007).

In this article the main procedures for the management of risk of FRI transmission in EDs are described and discussed.

## RISK MANAGEMENT OF FRI IN EDs

Respiratory pathogens are transmitted mainly by droplets. Droplets are particles with a diameter larger than 5  $\mu\text{m}$ , produced with cough and sneezes, and deposited on the nasal, oral or ocular mucosa of the new host or in the immediate environment; droplets do not travel in air further than 1-2 metres from the source, and no special ventilation is required for their containment.

In addition to droplet transmission, direct or indirect contact with patients' secretions play a substantial role for some of these pathogens (i.e. Adenovirus, Respiratory Syncytial Virus, SARS-CoV).

For some FRI pathogens, airborne transmission may occur through the inhalation of droplet nuclei deposited in distal airways; droplet nuclei are particles with a diameter smaller than 5  $\mu\text{m}$ , produced with cough and sneezes and transported by air farther than 1-2 metres from the source for a long period of time; special ventilation is therefore required to dilute their burden in a closed space. Airborne transmission has been demonstrated to be the obligate route for some agents, while for others it is either preferential, or "opportunistic" (Roy, 2004). The only pathogen for which the airborne route is considered obligate is *Mycobacterium tuberculosis*, including MDR- and XDR- strains. Diseases with preferential airborne transmission are caused by agents that can naturally initiate infection through multiple routes but are predominantly transmitted by droplet nuclei such as varicella virus, that can cause pneumonia in addition to the typical exanthema. For the SARS-CoV the occurrence of airborne transmission under certain conditions is due to the virus itself, or to the host (as in the case of the so-called superspreaders); it has also been postulated that aerosol-generating medical procedures can contribute to spreading the disease, leading to the recent definition of an airborne "opportunistic" transmission. Finally, airborne transmission has been considered in some outbreaks of influenza,

although droplet spread is the most frequent mode of transmission in health care settings. Thus, the majority of FRI pathogens can be controlled by applying droplet precautions.

However, for the most dangerous infections such as SARS, human H5N1 influenza, or pandemic influenza, even if airborne transmission has not been definitively proven, this event should be taken into account, according to a general Precaution Principle as suggested by the World Health Organization (WHO) and the Centers for Diseases Control and Prevention (CDC) (WHO, 2006; CDC, 2004).

Even before the emergence of SARS, some decision trees have been proposed to help physicians in EDs rapidly identify patients with pulmonary tuberculosis that require true airborne isolation (Wisnivesky, 2005). The current infection control guidelines, updated after the SARS epidemic, stress the importance of incorporating into routine practice simple measures designed to contain respiratory droplets and secretions, to reduce the possibility of transmission of other febrile respiratory infections. These measures, called 'respiratory hygiene' or 'cough etiquette', have been recently added by WHO to standard precautions (infection control procedures that should be applied in health care settings at all times and in all areas) for all patients presenting to healthcare settings with fever and cough.

TABLE 2 - Respiratory hygiene/cough etiquette measures.

*Measures targeted to patients:*

Persons with respiratory symptoms should apply the following measures:

- cover their nose and mouth when coughing/sneezing with tissue or surgical mask;
- dispose of used tissues and masks;
- perform hand hygiene after contact with respiratory secretions.

*Measures targeted to common areas in Healthcare Settings:*

- seats in common areas at least 1 metre apart;
- strategies in place to promote Respiratory Hygiene/Cough Etiquette measures (visual alerts, pamphlets, information given by nurses);
- a supply of disposable tissues and masks, a trash can for used tissues and masks, and a facility for hand-hygiene should be present.

*Measures targeted to HCWs:*

- correct selection, donning and removal of PPE

Respiratory hygiene consists of measures targeted to patients and HCWs, and also concern structural characteristics of the first point of contact within a health care setting (e.g., the reception and triage areas in emergency departments), as described in detail below (Table 2).

*First contact with the patient and triage procedures*

Triage is a process for sorting people seeking medical evaluation into groups based on their need for or likely benefit from immediate medical treatment. Currently applied modalities of triage are based mostly on clinical urgency.

During triage, if the patient is affected by a FRI, standard measures should be applied, including Respiratory Hygiene/Cough Etiquette.

Visual alerts promoting Respiratory Hygiene/Cough Etiquette measures should be predisposed along the routes leading into EDs, and a supply of surgical masks should also be provided. Ideally, every patient with a FRI should enter the ED with the surgical mask already worn, and should be directed toward dedicated triage and waiting areas, and examination rooms by clear visual indications, or should be accompanied by staff of the hospital reception.

Waiting areas are limited spaces where ill people wait for medical attention and where the risk management of human-to-human transmissible FRI requires the application of some procedures. The common waiting area should be large enough to allow patients with FRI to be seated at a distance of at least one metre from other persons, and all strategies for increasing adherence to Respiratory Hygiene/Cough Etiquette measures should be applied. The waiting time of these patients should be reduced as much as possible. EDs should review their existing infection control practices and consider whether these are adequate to prevent intra-hospital transmission of infection, from the time a patient with an unrecognised, but highly infectious, disease arrives in the department, through the initial evaluation and investigation, to the point when the patient is admitted or transferred elsewhere. With this aim, the triage staff dedicated to patients with FRI should perform the appropriate clinical assessment of disease severity giving priority to medical evaluation, followed as soon as possible by a "transmission-oriented triage".

The present threats to global health (international spreading of H5N1 influenza, pandemic threats, possible SARS-CoV resurgence, spread of other naturally emerging - i.e. XDR-TB - or deliberately released life-threatening, highly transmissible respiratory infections) strongly suggest applying the Precaution Principle as suggested by WHO and CDC (WHO, 2006; CDC, 2004), i.e. a syndromic approach with a high index of clinical awareness, as the early detection of these diseases is essential for preventing the spread inside health care settings and community.

For these reasons, additional modalities of triage should be developed for human-to-human transmissible FRI, especially for those causing life-threatening diseases. This "transmission-oriented triage" should be based on the probability of the disease spreading inside the ED, and should assess the need and urgency of isolation, in addition to severity.

A potential diagnosis of a life-threatening, highly infectious disease should be always taken into account in the presence of a patient with a FRI. With this aim, algorithms for the management of FRI patients should be in place, which include case definitions for life-threatening, highly infectious diseases. (HPA, 2006). Widespread use of rapid diagnostic tools may play a key role in identifying highly infectious diseases in EDs. A detailed analysis of the role of rapid diagnostic tests, which is beyond the aims of the present paper, has been published (Kaye, 2005; Louie, 2004).

A few specific questions should be added to history-taking performed on all patients presenting with FRI, to explore if:

- the patient visited within a stated incubation period (i.e. 10 days for SARS and H5N1), a country where highly infectious FRI are endemic or where an outbreak of these diseases is currently ongoing;
- the patient is a worker potentially exposed to agents of highly infectious FRI (HCWs, laboratory workers, veterinarians, others);
- the patient has been exposed to a patient with diagnosed or suspected highly infectious FRI;
- the patient belongs to a cluster of unexplained FRI.

If an airborne transmitted or a highly infectious disease is suspected following transmission-oriented triage, in addition to applying standard and Respiratory Hygiene/Cough Etiquette precau-

TABLE 3 - *Minimal requirements of AII rooms.*

- 
- Negative pressure towards external ambient (staff corridor or anteroom if existing);
- 
- At least 6 air changes per hour;
- 
- Exhausting of air directly outside or recirculation of air after filtration with HEPA (High Efficiency Particulate Air) filters;
- 
- Self-closing sealed door and sealed windows.
- 

tions, the patient should be referred to a dedicated Airborne Infection Isolation (AII) room, or a room whose doors are kept closed during waiting times. For patients with suspected airborne or highly infectious diseases, the same AII room should be used both as waiting area and examination room, to avoid the transport of the patient through common areas as far as possible.

The minimal requirements of AII rooms are listed in Table 3.

If negative pressure rooms are not available, the examination should be performed in a closed room, and adequate ventilation should be assured for some minutes before it is used for another patient. Even if isolated in an AII room, the waiting time of these patients should be minimized as much as possible.

#### *Isolation*

After examination, if a patient with FRI requires admission, isolation measures should be put in place. Patients with FRI for whom the suspect of an airborne transmitted or highly infectious disease can be ruled out should be admitted to a single room if available, with adequate droplet precautions in place. If only multi-bed rooms are available, cohorting of patients is necessary and beds should be placed at least 2 metres apart, with curtains around them as a further means of separation; sharing of supplies and surfaces among patients must be avoided. All patients with FRI should always wear a surgical mask when outside the isolation room.

For patients with a suspected airborne transmitted or highly infectious disease, the use of an AII room is strongly encouraged for isolation, and transfers inside the hospital should be organized along reserved routes if possible.

If AII rooms do not exist or are not available, dis-

placement of the patient to another hospital provided with negative pressure rooms should be considered. When another solution is not manageable, the patient should be isolated in a single room, or cohorted with other patients with the same pathology. During the isolation period, the door of the room should be kept closed, and only HCWs essential for patient's care should enter the room, equipped with the appropriate PPE.

### PPE

The use of appropriate PPE is crucial throughout the management of FRI patients. Indeed, as emerged during the SARS epidemic and as evidenced by a recent study (Wang, 2007) HCWs from the EDs faced a relatively high risk for potential infection by the SARS virus and other HIDs than the corresponding risk for those HCWs who worked in the ordinary ward.

During triage of patients with FRI the HCWs should wear PPE according to standard precautions, including Respiratory Hygiene/Cough Etiquette measures (Table 4).

PPE should be carefully selected on the basis of the risk evaluated during the transmission-oriented triage of the patient with FRI. Table 4 shows the suggested PPE, depending on the suspected route of transmission.

The following principles should guide the use of personal protective equipment:

- avoid any contact between contaminated PPE and surfaces, clothing or people outside the patient care area;
- discard the used PPE in appropriate disposal bags, according to the policy of the hospital;
- do not share PPE;
- change PPE completely and thoroughly wash hands each time you leave a patient to attend to another patient or another duty.

### Education and Training of HCWs

During the SARS epidemic, some HCWs acquired infection despite the use of appropriate PPE (Drosten, 2003): these episodes evidenced that the procedures of donning and removal of PPE are as important as their correct selection. Mainly during removal of PPE, it is important to avoid contact between face and contaminated gloves, because of the risk of mucous membrane contamination.

Moreover, special attention should be used when respirators are worn. Many types of respirators are available and a Respiratory Protection Programme should be implemented in any workplace, but fit-testing and user seal-checking must be considered as essential components of this programme. Fit-testing, mandatory in the USA, is conducted by a supervisor or trainer who exposes the wearer to a challenge agent (i.e. smells) during normal and deep breathing. Fit-test helps

TABLE 4 - Selection of PPE for HCWs giving care to FRI affected patients according to suspected route of transmission.

Patient with FRI not likely to be airborne transmitted or highly infectious	Standard precautions, including Respiratory Hygiene/Cough Etiquette measures	- Gloves, when touching blood, body fluids, secretions, excretions or mucous membranes; - Surgical mask or other mask covering the nose, protective eyewear (either goggles, or face shield), and waterproof gown, always.
Patient with FRI likely to be airborne transmitted	Standard and airborne precautions	- Gloves, when touching blood, body fluids, secretions, excretions or mucous membranes; - Protective eyewear (either goggles, or face shield), and gown, during procedures that are likely to generate splashes of blood, body fluids secretions or excretions; - Respirator (at least FFP2, N95 NIOHS equivalent); surgical mask not indicated.
Patients with FRI likely to be highly infectious	High isolation	- Gloves (or double gloves if appropriate), always; - protective eyewear (goggles or face shield), and waterproof gown (or total body tyvek suite, if appropriate), always; - Respirator (at least FFP2 or N95 NIOSH equivalent); surgical mask not indicated

to determine that a particular model and size of respirator is the "correct" one for each worker, and should be conducted before every exposure. User seal-checking should be performed every time before entering the patient's room. It is conducted by the wearers themselves, and is aimed to determine whether the respirator fits the face properly: by breathing in and out deeply through the respirator, the HCWs can verify the complete adherence of the respirator to their own face.

Continuous education is required for the correct application of preventive measures. Specific training sessions should be programmed, and all HCWs working in EDs (physicians, nurses, paramedics) should be strongly encouraged to participate. Teachers with different expertise should be involved in the training sessions (Emergency physicians, infection control experts, including nurses, epidemiologists, public health experts). The most appropriate training should include not only theoretical knowledge, but practical sessions that could be performed within the ED. Specific simulations should be planned to verify the applicability of procedures.

## CONCLUSION

FRI are one of the most common problems prompting visits to EDs. According to a recent study (Knott, 2004), about 25% of febrile patients presenting to EDs had a final diagnosis of upper or lower respiratory tract infections. A study conducted in the Netherlands demonstrated that the overall incidence of FRI referring to general practitioners was 545 cases per 10,000 person-years (van Gageldonk-Lafeber, 2005). Referring only to lower respiratory tract infections, the overall incidence is 44 cases per 1000 population per year, according to another study (Macfarlane, 1993). The incidence is 2-4 times higher in people aged 60 and over.

Since Influenza viruses are causative agents in about 25% of cases, the numbers of patients with FRI referring to EDs soar during the influenza epidemic seasons.

Although many FRI are self-limited viral illnesses, some may result in substantial morbidity and mortality, and may cause large outbreaks involving hospital populations and the whole community.

The experience of SARS taught us that infection control procedures, including isolation, are our best defence against a sudden, new contagion.

This is evident confronting the different experiences with SARS in Canada. On March 7, 2003, two men with undiagnosed SARS were admitted to hospitals in two Canadian cities. In Toronto, this event caused an outbreak of disease that killed 44 people and infected a further 330. In Vancouver, instead, a well-established worker safety and infection control culture enabled Vancouver General Hospital to prevent the disease from spreading.

A patient arrived in Vancouver after a trip to Asia. He felt ill and went to the emergency room at Vancouver General at 4:55 p.m. Because of his fever and difficulty breathing, the staff removed him from the common waiting area within five minutes. He was put on "full respiratory precautions". HCWs wore tight N95 masks to filter out microbial particles. In a short time the patient had been moved to a negative pressure room to prevent infectious agents from flowing to other parts of the hospital.

On the same evening, another patient was taken to Scarborough Grace General Hospital in Toronto. The patient waited in Scarborough Grace's emergency room for 16 hours. Two patients waiting with him contracted SARS. After this initial exposure, a large nosocomial and community outbreak of SARS began. Of all the people who contracted SARS in Ontario, 77% acquired it in a hospital.

This experience shows that should a patient affected by pandemic flu or another highly contagious pathogen arrive in an ED, the occurrence or not of a large outbreak would depend largely on what hospitals do when this patient is admitted. If hospitals have effective infection control procedures in place, an epidemic might be contained. The Vancouver experience proved it.

The triage procedures are a focal point in the process of early detecting and isolating patients affected by highly infectious diseases.

During the SARS epidemic, in countries where local transmission occurred, many hospitals experienced new modalities of triage, with the aim of separating SARS patients from others as early as possible (Murphy, 2006). In a hospital in Singapore, triage was performed in a tent located outside the ED, where some vital parameters

(body temperature, blood pressure, respiratory frequency and oxygen saturation) were monitored and patients scored on the basis of SARS risk, and referred to different routes.

In a Chinese hospital triage procedures were performed outside the building, under parasols situated at least 2 metres apart.

In several hospitals in affected countries, the triage nurses, equipped with adequate PPE, waited for patients outside EDs: body temperature was monitored and instructions given on correct behaviour for limiting the spread of SARS inside EDs.

In Canada, several approaches were followed during the SARS outbreak. In 3 hospitals in Toronto, patients with FRI were initially assessed within existing facilities, before EDs were equipped with new AII rooms. Another hospital triaged suspected SARS cases into available negative air pressure wards, until a temporary AII tent in the ED was completed. One site subsequently constructed a large outdoor SARS assessment unit, in a large tent. In all these EDs, when AII were temporarily not available for the examination and assessment of patients because of overcrowding, people with fever and respiratory symptoms were asked to wait outside in the driveway. Sometimes the presence of guards at entrances to the EDs was necessary, and some EDs were closed and did not accept public without symptoms suggesting SARS.

Besides infection control procedures, the early clinical suspicion of an airborne or highly infectious disease is another important tool for prevention of disease transmission. Continually updated algorithms and case-definitions for the most dangerous diseases should be present in EDs and well-known by triage and first-contact staff and emergency physicians, especially if an outbreak of such diseases is ongoing in some part of the world.

With the same aim, the use in EDs of rapid laboratory diagnostics and imaging tests should be promoted and implemented. For a useful role in EDs, rapid laboratory tests should have a very high sensitivity, reducing the false negative results as much as possible. For example, a very sensitive rapid test would be an essential tool in EDs during the next influenza pandemic, supporting physicians in recognising patients not affected by flu. Imaging studies, including chest ra-

diography and CT, have been widely used in EDs during SARS epidemics. A study conducted in the ED of a Hong Kong hospital during the period of SARS activity (Chan, 2005) showed that serial chest radiography, performed in patients suspected to have SARS, had a sensitivity of 94.4%, specificity of 93.9%, positive predictive value 71.4%, and negative predictive value 99.0%. This confirms that the role of imaging is extremely important in EDs, especially when an outbreak is ongoing.

In recent years some improvements in hospital preparedness have been made, but audits conducted in hospitals in high-income countries have shown that they are under-prepared. A survey was conducted recently to assess the preparedness of EDs in the United Kingdom for the management of potential biological incidents (Anathallee, 2007). Among 203 hospitals surveyed, only 49 (24%) had isolation facilities available within EDs. Of these 49 EDs, only 30 (61%) reported that an independent ventilation system for airborne isolation existed in isolation rooms. In conclusion the authors stated that EDs in the UK are not prepared for emerging biological threats and bioterrorism, and that with the existing facilities and procedures currently in place it is highly likely that an infectious agent will spread inside hospitals in any future biological incident. Similar audits conducted in the United States showed similar results (Srinivasan, 2004; Rebmann, 2007).

As emerged during SARS, the policies applied in EDs were very different and not coordinated. We strongly believe that it is time to develop well-established and widely accepted procedures for facing the next health threats. The lesson taught by SARS is that time for preparedness is now.

To tackle new health threats, hospital preparedness is as important as clinical awareness. At the current time of heightened risk, such as the possibility of an influenza pandemic or the threat of bioterrorism, preparedness policies should be implemented both at national and local levels. Ideally, AII rooms for isolation of suspected patients should be present in each ED. Probably this goal is difficult to fulfil because it is an expensive solution and it would take a considerable time to achieve, but the number of these facilities should be increased as far as possible. Where this solution is not affordable, specific procedures, such as

designation of existing areas within EDs as potential isolation facilities, should be in place to reduce the risk of disease spreading within the hospital facility and the community.

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