

Implementation of Measures to Prevent the Spread of SARS in a Radiology Department*

AD King and ASC Ching

CHAPTER

15

| | | | |
|--|-----|--|-----|
| Introduction | 149 | General measures to be taken by managers in the radiology department | 152 |
| Infection control measures to be taken by staff | 150 | Infection control measures for specific modalities | 155 |
| Infection control measures to be taken by patients | 151 | Conclusion | 157 |

Introduction

Patients infected by severe acute respiratory syndrome (SARS) require imaging during the course of their disease. Plain radiography and computed tomography (CT) will be employed routinely, although during an epidemic all imaging modalities may be requested at some point. Infection control is concerned with protecting the individual against infection and containing an outbreak, at the same time as providing medical care for those patients with SARS. In a radiology department it is, of course, of utmost importance that the staff are protected, but for those centres that also have to maintain essential services for patients without SARS, there is the additional consideration of preventing cross

infection between patients. When planning control measures against any infection, details of the mode of infection. Transmission must be taken into account, for the SARS coronavirus the important points to take into consideration are shown in Table 15.1. The format of this chapter may appear laborious,

Table 15.1 SARS virus.

1. Found in the respiratory secretions, saliva, blood, urine and faeces of patients.
2. Spread mainly by droplets and aerosolized respiratory secretions, droplet infection usually occurring within 3 feet of a patient.
3. Spread also through direct contact with patient's secretions and excreta.
4. Relatively robust, surviving on surfaces sometimes for more than 24 hours, so that infection can then be transferred inadvertently from surfaces when staff touch their eyes, mouth and other mucosal areas.
5. Symptoms of SARS may be mild and non-specific, especially in the elderly population. A high index of suspicion and stringent infection control measures should therefore be applied to all patients.

*At the time of writing this chapter our department has been imaging patients with SARS for 4 months. Unfortunately, one member of our staff, a radiographer working for cardiology in the cardiac catheter laboratory, was in the first wave of medical staff to contract the disease. This occurred before we were aware of the very existence of SARS. Since that time with good fortune and the implementation of strict infection control measures no other staff in the radiology department has contracted the disease at work, and to our knowledge no patients have contracted SARS in the radiology department.

but it is designed to provide practical checklists covering some of the most important issues that need to be considered when preparing a department for the battle against infection.

Infection control measures to be taken by staff

Staff education

This is one of the most important aspects of infection control:

- All staff must be fully aware of the infection control guidelines of the department and hospital, and should be trained in infection control measures before entering any high-risk area.
- Personal hygiene cannot be overemphasized, especially the obsessive washing of hands and avoidance of touching the mouth, eyes or masks [1].
- There are general measures that can be taken to reduce infection. These include minimizing personal accessories brought to work, avoiding visits to other staff during imaging sessions, covering pagers with a disposable plastic bag and refraining from eating or drinking in scanning rooms. At meal breaks while eating and drinking staff should not talk and should face away from colleagues.
- Infection control measures need to be continued at home to reduce the potential risk of spreading infection in family members. These include changing clothes and taking a shower immediately on returning home, avoiding close contact with family members, wearing a mask, avoiding sharing food, eating utensils and towels, frequent hand washing for all the family using liquid soap.
- All staff are responsible for monitoring their own health closely. If they develop a febrile illness they must take immediate sick leave and attend a screening clinic in the hospital.

Personal protective apparel

- The amount of personnel protective apparel that is worn will depend upon the level of risk, remembering that both under-protection and over-protection are hazardous. For contact with patients with suspected or confirmed SARS the personal protective apparel is shown in Figure 15.1 and Table 15.2.



Fig. 15.1 Standard personal protective apparel for staff in the high-risk patient areas in a radiology department.

Table 15.2 Personal protective apparel for staff.

1. N95 mask (this must be tested to ensure it fits properly, a surgical mask is not acceptable in areas where there are respiratory aerosols).
2. Disposable isolation gown (water-proof or water-repellent gown according to the nature of activity and risk of exposure, gowns should be disposed of when soiled or when leaving high-risk areas).
3. Latex gloves to be changed between each patient (plus, of course, hand washing), ensuring there is no gap between the gloves and gown.
4. Disposable cap.
5. Visor/goggles/face-shield (for high-risk procedures goggles should be worn in addition to the face-shield).
6. Work shoes (covers are optional but shoes should not have laces).

Plus additional personal protection apparel according to risk.

- Changing into protective apparel should be done in designated areas using the correct sequence for 'putting on' and 'taking off' personal protective apparel is shown in Figure 15.2. It is essential

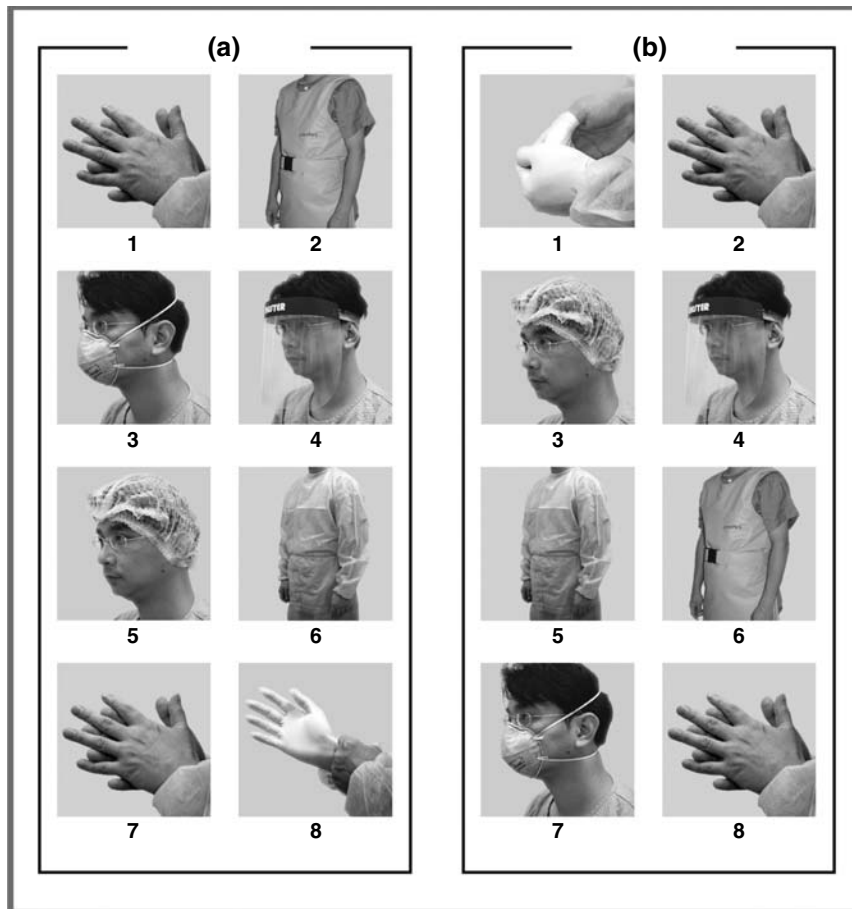


Fig. 15.2 Sequential steps for (a) 'putting on' and (b) 'taking off' personal protective apparel.

that meticulous care is taken when 'taking off' the apparel to avoid self-contamination.

- Once the protective apparel is discarded it must be placed in a designated bag in a bin with a lid.
- High-dose contamination requires immediate decontamination in a shower.

Key points

1. Staff education for infection control at work and at home
2. Use of personal protective apparel

Wash hands obsessively! Do not touch mouth, eyes or masks!

Infection control measures to be taken by patients

The measures will be determined by patient's risk group, for this purpose patients are divided into four groups:

1. Outpatients without suspected SARS
 - Use a questionnaire on arrival to screen for SARS, any patient with suspected SARS should have the examination postponed and asked to attend a screening clinic.
 - Instruct patients to wash their hands before and after attending the radiology department and wear a mask.
2. Outpatients with suspected SARS undergoing screening chest X-ray

Table 15.3 Personal protective apparel for patients.

-
1. Clean gown or isolation gown
 2. Cap
 3. Surgical mask
 4. Hand washing is mandatory, gloves are optional
-
- Instruct patients to wash their hands before and after attending the radiology department and wear a mask.
3. Inpatients without suspected or confirmed SARS
 - All inpatients with a febrile illness should be suspected of having SARS and the procedures listed below should be taken. All other inpatients are potentially at risk of SARS because of cross infection within hospital and the level of protective measures will have to depend upon resources and risk of the procedure.
 - Before calling any non-SARS patient to radiology, the SARS status should be checked again to ensure it has not changed since the examination was requested.
 4. Inpatients with suspected or confirmed SARS
 - Change the patient into the protective apparel shown in Table 15.3 before entering the radiology department.
 - Request the ward staff to site and remove intravenous lines for contrast injection on the ward and where possible obtain signed consent forms on the ward and fax to the department. Patients who require oxygen should have a nasal cannula rather than an oxygen mask and high-flow oxygen supply to these patients should be avoided.
 - Leave clinical records and packets of radiographs on the patient trolley and handle only if absolutely essential.
 - Minimize the chance of contracting the disease from patients, by keeping the time spent in direct contact to a minimum, the distance from a patient to a maximum and the number of working staff to a minimum, while maintaining good quality care.

Key points

- Divide patients into different risk categories, screen outpatients and check the category has not changed before calling an inpatient to the department.

- Patients with SARS and suspected SARS should wear personal protective apparel and avoid wearing oxygen masks.
- Keep contact with SARS and suspected SARS patients to a minimum, site intravenous lines on the ward, fax signed consent forms to the department and avoid handling ward notes and X-ray packets.

General measures to be taken by managers in the radiology department

There are many issues to take into account when reorganizing a radiology department and these do not always fit into neatly organized categories. Below is a list of some of the major points that need to be taken into consideration.

Patient segregation

Some departments have to continue providing a radiology service to patients with non-SARS-related illnesses at the same time as imaging those patients with suspected or confirmed SARS. In this scenario patients have to be segregated according to risk and special consideration has to be given to non-SARS patients who are especially vulnerable to infection, such as patients who are pregnant, immunosuppressed or the newborn:

- The best way to achieve segregation is to site equipment for imaging SARS patients away from the main radiology department, preferably close to the infectious disease wards or screening clinics.
- Some equipments, such as CT may not be moved and patients with SARS will have to attend the main radiology department. The only option in this circumstance is to segregate patients by time. The allocation of bookings should be from low to high-risk; outpatients without suspected SARS (low-risk), inpatients without a febrile illness or suspected/confirmed SARS (moderate risk because of risk of cross infection), inpatients with a febrile illness (high risk) and inpatients with suspected/confirmed SARS (ultra-high-risk).

- Waiting areas for patients have to be segregated and clearly marked, where possible there should be different routes for access.
- Do not forget that patients with SARS need to be segregated on their way to the department by using designated lifts.
- In order for patient segregation to be successful, the different modalities in radiology must coordinate the time slots for the different categories of patients, and outpatients should be instructed to attend their appointments on time to ensure there is no overcrowding and no overlap with higher-risk patients.
- To prevent unnecessary waiting in the department, the examination room should be ready to accept high- and ultra-high-risk patients as soon as they arrive and an efficient portering system is required to ensure the patient returns to the ward promptly.
- Patients' relatives or visitors should not be allowed in the department unless it is absolutely necessary.
- Set up a contingency plan for a sudden surge in SARS patients and massive high-dose contamination.

Designate areas for staff to change into personal protective apparel

- Set up designated areas close to the scanning rooms.
- Keep the areas stocked with personal protective apparel and avoid contamination during storage.
- Standardize the layout of these areas and restrict the number of staff changing at any one time to prevent overcrowding.
- Post instructions showing the correct sequence for 'putting on' and 'taking off' apparel on the walls of the changing areas (Figure 15.2) [2–4].
- Arrange bins for the disposal of contaminated and non-contaminated items; these bins should have a lid and be emptied regularly before they become full.
- Divide the department into clean areas (i.e. offices) and dirty areas (i.e. scanning rooms), and ensure that contaminated apparel is removed before entering clean areas.

Staff education and enforcement of infection control measures

- Set up a team (preferably including a manager, nurse, radiographer, radiologist, clerk and cleaner) to introduce guidelines, educate staff, provide regular updates, monitor and audit measures. Appoint one team member as the infection control officer with overall responsibility for control within the department, as well as being the designated person to receive and implement hospital guidelines.
- Training and access to advice are of the utmost importance for infection control, all members of staff must be included. Emergency advice should be available 24 hours a day.
- Set up an effective method for disseminating information. Dissemination of information is particularly important as measures often change daily, especially at the beginning of an outbreak. E-mail is a good way to provide this information but many staff members may not have access, so *noticeboards* or a cascade system of *word of mouth* may need to be introduced.
- Encourage all staff to monitor their colleagues and correct any mistakes immediately.

Showering system

- Ensure there is a showering system available within the department for emergency use by any staff member who is contaminated by patient's secretions or who has performed cardio-pulmonary resuscitation.
- Equip with an emergency kit containing shampoo, soap, towels, a clean change of clothes and disposable bags for contaminated items.

Appointments

- Decrease appointments to allow sufficient time to carry out all infection control measures and discontinue non-essential services.
- Hospitals that do not have electronic means for receiving examination requests should institute a fax system for requests. In this way clinicians are discouraged from visiting the department

and potentially contaminated request forms are not sent from the wards. All requests for patients with suspected or confirmed SARS must be clearly marked.

- Clinicians must be prudent in their requests ensuring that any examination for higher-risk patients will have a direct impact on patient management, and these examinations should be performed by experienced staff.

Cleaning and disinfection

Complete cleaning and disinfection of the working environment and equipment is mandatory. As a result cleaning of all rooms and equipment in the department will need to be increased which will require extra manpower. This area must be given a high priority and if necessary non-cleaning staff may have to assist if there is a shortage of manpower:

- Those areas which have a high throughput of SARS patients, such as general radiography and CT, will need special attention.
- Cleaning can be facilitated by removing all unnecessary clutter and by drawing up a list of items, such as door handles, soap dispensers and computers, that may be easily overlooked in the cleaning process. Recommendations for cleaning are shown in Table 15.4.
- Provide adequate instruction and supervision of cleaners, especially in handling patient's excreta and cleaning toilets. Items in a room that cannot be easily cleaned, such as soft furnishings and computers, can be removed or covered with disposable coverings.
- Couch linen needs to be changed regularly and always after high- and ultra-high-risk patients are scanned.

Staffing arrangements

- Rotate staff through the high-risk areas to reduce their viral load but at the same time ensure that staff working in the higher-risk areas are experienced in working in this environment.
- Provide staff with adequate rest to prevent mistakes in infection control procedures.
- Pregnant staff should not be put in a high-risk environment.

Table 15.4 General principles on cleaning and disinfection in the radiology department during a SARS outbreak.

- Cleaners must receive full training in infection control and wear protective apparel and wash hands frequently.
- Cleaning will need to be more frequent and more thorough and should follow a schedule together with extra cleaning after a room has been used by a patient/batch of patients with SARS. After the examination of any patients with severe coughing, the room and especially nearby surfaces should be thoroughly disinfected before the next patient is examined.
- Before cleaning, one must ensure that the imaging machine and devices are suitable for general cleaning and disinfection.
- In addition to the usual surfaces that need cleaning there should be a list of items that require special attention and may be normally overlooked, i.e. handles, soap dispensers, telephone, cabinets, intercom, keyboards and mouse of computer workstations.
- Computers and workstations may have to be cleaned with special agents such as ethyl alcohol.
- Ventilation fans need regular cleaning.

Resuscitation

Resuscitation is a very high-risk procedure!

- Fully stock the emergency resuscitation trolley with protective apparel. The resuscitator bags must have viral filters and the resuscitator bag-valve-filter mask should fit tightly to avoid air leakage.
- Arrange practice drills and ensure that all staff know they must be fully protected before starting resuscitation.
- Avoid intubation by inexperienced staff.

Key points

1. Segregate different risk groups of patients
 - Preferably by relocating equipment to SARS areas, but if this is not possible segregate patients by time
 - Do not forget to segregate waiting areas and lift access
 - Restrict relatives and visitors

2. Staff education and enforcement of infection control measures
 - Set up an infection control team
 - System to disseminate information quickly and efficiently
 - Continual training, updating and monitoring
3. Designate areas for staff to change into personal protective apparel
 - Clear instructions for putting on and taking off apparel
 - System for disposal of contaminated items
4. Showers
 - Ensure showering system for high-dose decontamination
5. Appointments
 - Reduce number of appointments
 - Fax system for request forms
6. Cleaning and disinfection
 - Increase resources
7. Staffing
 - Rotate staff through high-risk areas and allow sufficient rest
 - Move pregnant staff to low-risk areas
8. Resuscitation
 - Fully stocked emergency trolley with protective apparel and resuscitator bags with viral filters. Avoid intubation by inexperienced staff.

Infection control measures for specific modalities

General radiography

This is the area that will see the greatest increase in workload and will cause a great deal of stress and anxiety among radiographers in the initial stages of an outbreak. It is very important that staff are well educated in infection control measures before undertaking these duties and are provided with full personal protective apparel.

Satellite X-ray rooms should be set up for screening and a specific room should be designated in the accident and emergency department for X-raying suspected cases. Equipment including portable

X-ray machines will require frequent cleaning. There will be a great increase in the demand for portable X-rays on the SARS wards and on intensive care units (ICUs). Radiographers may have to spend prolonged periods of time in very close contact with SARS patients as they position the X-ray cassettes. Radiographers may also encounter practical difficulties including a limitation of space in which to manoeuvre the portable machines and a lack of cassettes. To prevent radiographers having to repeatedly go between the wards and the main department extra cassettes will have to be purchased. When cassettes are brought back to the department they must be protected by a disposable cover and after use all cassettes from the contaminated areas should be disinfected. Where possible two radiographers should be used: one 'dirty' radiographer to perform the positioning and one 'clean' radiographer to operate the control panels. During an outbreak all patients having a chest radiograph, irrespective of the provisional diagnosis, should be considered as high risk and procedures taken accordingly. There should be access to an instant reporting system for all patients with suspicious chest X-rays in screening clinics and routine radiography sessions. If the likelihood of SARS is high, then the room should be cleaned before the next patient is examined.

Key points

- High throughput of patients will be stressful for radiographers who will require priority in training
- Set up satellite X-ray equipment for screening and examining SARS patients
- Use 'paired' radiographers
- Increased demand for cassettes; cassettes require disinfection
- Access to instant film reporting service for screening films

CT

This is the second modality that will encounter the greatest number of patients with SARS. Fortunately most patients require a high-resolution CT (HRCT) which is a quick examination that does not require intravenous contrast, so direct contact can be limited

to the short time it takes to position the patient on the scanner. One 'clean' radiographer should remain in the control room to operate the scanner while a second 'dirty' radiographer performs the positioning. Equipment that is not in use, such as the injection pump, should be moved away and covered. The room and the equipment should be thoroughly cleaned after the last batch of higher-risk patients.

Key points

- High throughput of patients with SARS, so priority should be given to training these staff
- HRCT is a quick investigation that requires no intravenous contrast, so contact time with the patient is short
- One CT scanner may have to scan both high- and low-risk patients, so patients will need to be segregated by time
- High input of resources and stringent measures for cleaning and disinfection
- Use 'paired' radiographers
- Cover equipment that is not being used such as the contrast pump

Ultrasound

Ultrasound is potentially a high-risk procedure because of the prolonged contact with patients at close quarters. Some patients with a febrile illness may undergo abdominal ultrasound with a provisional diagnosis of a non-SARS-related illness such as a postoperative collection or cholangitis, only to be diagnosed with SARS later on. Therefore, a high index of suspicion should be maintained for ultrasound examinations. Rooms and ultrasound machines should be designated for high- and ultra-high-risk patients and a portable machine should be left on the ICU. If equipment allows it may also be prudent to allocate a machine for non-SARS patients who are at particular risk of infection (obstetrics, neonatal unit or bone marrow transplant unit). The ultrasound examination should be kept as short as possible to answer the clinical question and if appropriate a CT scan should be considered as an alternative examination, especially if there are wound

dressings or colostomy bags on the abdomen. When performing abdominal ultrasound deep breathing should be avoided or performed with the patient turned on their side facing away from the sonographer. Gloves must be changed after each patient and hands washed. The transducer should be cleaned after each patient and covered with disposable covers for all inpatients.

Key points

- High risk because of prolonged period of contact at close quarters, consider CT as an alternative
- High index of suspicion of SARS is required
- Designate US machines for different risk levels of patients
- Avoid asking patient to take deep breaths
- Disinfect transducers after each patient

Fluoroscopy/contrast studies

Many of these examinations, such as a barium enema, small bowel enema, sialogram and dactocystogram carry a potentially high risk to staff and other patients. Where possible the examination should be avoided all together in those patients with suspected/confirmed SARS. Fortunately these examinations are rarely required for patients with SARS, although they may be performed inadvertently on patients in whom SARS is not initially suspected, especially the elderly with bowel problems. Therefore, the highest level of infection control should be taken in all cases and staff should ensure that their personal protective apparel includes a face-shield. There must be a designated place and procedure for safe disposal of all fluids.

Key points

- Most fluoroscopic examinations are high risk due to close contact, and handling patients excreta and secretions
- System for safe disposal of bodily fluids
- Be aware that patients with SARS may present with diarrhoea

Angiography and interventional radiology

These are also high-risk procedures because of contact with patients' fluids together with a prolonged time in close contact with the patient [5]. Therefore similar points to those for fluoroscopy above are applied. Where possible a dedicated room and ultrasound machine should be used for suspected and confirmed SARS cases.

Magnetic resonance imaging

All metallic items and false teeth should be removed on the ward and the patient's mask should not have a metallic bar. All inpatients with suspected or confirmed SARS should have the safety questionnaire filled out on the ward and faxed to the department, this will ensure that patients in whom magnetic resonance imaging (MRI) is contraindicated are not brought to the scanner. Once again two radiographers should be employed one 'clean' radiographer to stay in the control room and one 'dirty' radiographer to position the patient. The call bell must be covered with a disposable plastic bag. Potentially MRI possesses a higher risk of cross infection because of the prolonged period of time in which a patient lies in very close proximity to the equipment, therefore thorough cleaning of MRI machine, coils, injector and room must be performed especially following the examination of any inpatients.

Key points

- Fill out MRI safety questionnaire before arrival in MRI department
- The patient's mask should not have a metallic bar
- Use 'paired' radiographers
- Thorough disinfection of the MRI to prevent cross infection

Nuclear medicine

Staff should take extra precautions in handling patients with SARS and in particular

aerosol-generating procedures such as pulmonary ventilation scans should not be performed. Unfortunately, recent information suggests that some patients with SARS may have pulmonary embolism or thromboembolic phenomena. In these cases the perfusion study alone may be insufficient because it can show defects due to the pneumonia. Therefore the role of nuclear medicine may be limited for the investigation of suspected pulmonary embolism and other imaging modalities will have to be considered such as contrast-enhanced helical CT.

Key points

- Avoid ventilation lung scan using aerosol-generated procedures
- Modify diagnostic algorithm for acute pulmonary embolism

Conclusion

Even in the most difficult of circumstances it is possible to run a radiology service during an outbreak of SARS while protecting staff and preventing cross infection between patients. However, it requires meticulous planning, great effort to maintain high vigilance and a very strict adherence to infection control measures. As we continue to increase our knowledge of how the infection spreads and improve our understanding of SARS, we are able to better tailor our infection control measures.

Acknowledgements

We would like to acknowledge the input from our whole department, our hospital infection control team, the management at the Prince of Wales Hospital, and the Hong Kong Health Authority who issued guidelines for us to follow (which were posted on their web page) and gave their support in these difficult times.

References

1. King AD, Ching AS, Chan PL, Cheng AY, Wong PK, Ho SS, Griffith JE, Lyon DJ, Fung KS, Choi P, Li CK, Cheng AF and Ahuja AT. Severe acute respiratory syndrome: avoiding the

- spread of infection in a radiology department. *Am J Roentgenol* 2003;**181**(1): 25–27.
2. Department of Diagnostic Radiology and Organ Imaging page. The Chinese University of Hong Kong web site. Available at: www.droid.cuhk.edu.hk (accessed 13 June 2003).
 3. Hong Kong Hospital Authority web page. Hospital Authority Guidelines on Severe Acute Respiratory Syndrome web site. Available at: http://ha.home/ho/ps/sars_infection_control.htm (accessed 20 June 2003).
 4. First data on stability and resistance of SARS coronavirus compiled by members of WHO laboratory network. Available at: http://www.who.int/csr/SARS/survival_2003_05_04/en/index.html (accessed 30 June 2003).
 5. Hong Kong SAR Government. Department of Health web page. Health advice: for people who have been in close contact with patients. Available at: <http://www.info.gov.hk/dh> (accessed 24 May 2003).