



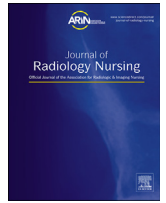
Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



Contents lists available at ScienceDirect

Journal of Radiology Nursing

journal homepage: www.sciencedirect.com/journal/journal-of-radiology-nursing

Featured Article

Adapting Lessons From SARS for the COVID-19 Pandemic—Perspectives From Radiology Nursing in Singapore



Agnes Sau Kheng Wong, RN, BSc Nursing ^{a,*}, Chin Chin Ooi, PhD, MMedUS ^{b,c},
Mabel Qi He Leow, PhD ^d, Yen San Kiew, MHLthSc (MRS) ^b,
Kenneth Chye Whatt Yeo, BSc (Hons) ^b, Soong Geck Tan, RN ^e,
Kiang Hiong Tay, MBBS, FRCR, FAMS ^{a,c}

^a Division of Radiological Sciences, Department of Vascular and Interventional Radiology, Singapore General Hospital, Singapore

^b Radiography Unit, Division of Radiological Sciences, Singapore General Hospital, Singapore

^c Duke-NUS Medical School, Singapore

^d University of Western Australia, Faculty of Health and Medical Sciences, Perth, Australia

^e Department of Infection Prevention and Epidemiology, Singapore General Hospital, Singapore

A B S T R A C T

Keywords:
COVID-19
Infection control
Infectious disease
Pandemic
SARS

When severe acute respiratory syndrome (SARS) hit Singapore in 2003, we began to formulate rigorous protocols and reconfigure our facilities to prevent in-hospital transmission. This became the foundation of our practices in COVID-19. However, some adaptations were made to suit the current needs of the department, and technology has been used for communication. This article describes the preparation and response of nursing in the radiology department in Singapore in SARS and coronavirus 2019 (COVID-19) outbreak. Protocols and measures taken during SARS and COVID-19 outbreak are described. Stringent infection control and prevention measures, detailed standard operating protocols for handling SARS and COVID-19 patients coming for radiological examinations and interventions, team segregation, safe distancing, efficient communication, and rigorous staff surveillance are paramount to ensure patient and staff safety. Our SARS experience has shaped our preparations and response toward the COVID-19 pandemic. To date, there have been zero health care worker transmissions in the department. The crisis has also enhanced the cohesiveness among staff because of the camaraderie and shared experience. The response and measures taken by the radiology department in a large acute care teaching hospital could be practiced in other similar health care settings.

© 2020 Association for Radiologic & Imaging Nursing. Published by Elsevier Inc. All rights reserved.

Introduction

When the severe acute respiratory syndrome (SARS) hit Singapore's shores in 2003, it was the country's first experience in managing an epidemic. The country was ill-prepared because of the lack of experience, resulting in extensive intrahospital transmissions, with cross-infection among health care workers (HCWs), outpatients, visitors, and inpatients. In fact, 40.8% of the patients with SARS in Singapore were HCWs, of whom five of them died—two doctors, two nurses, and one health care attendant (Ministry of Health, 2004).

During the SARS epidemic, the radiology department of Singapore General Hospital was one of the locations where the cross-infection occurred. An undiagnosed SARS inpatient came to our department for a barium enema examination and infected a few other patients, visitors, and an HCW while waiting in the corridor for the barium examination. This incident led us to formulate rigorous protocols as well as reconfigure of our facilities to prevent cross-infection among inpatients, outpatients, visitors, and HCWs.

Radiology nurses play a crucial role in the formulation and execution of these protocols as they interact directly with patients when they come to the radiology center for their imaging. The radiology nursing role is even more crucial in interventional radiology (IR) where they are closely involved during the preprocedure, intraprocedure, and postprocedure care of patients. Several of the infection prevention and control protocols that were developed during SARS epidemic were kept in place or improved on even after

The author(s) have no relevant disclosures. There was no grant funding or financial support for this manuscript.

* Corresponding author: Agnes Sau Kheng Wong, Diagnostic Radiology, Singapore General Hospital, 169608 Outram Road, Singapore.

E-mail address: agnes.wong.s.k@sgh.com.sg (A.S.K. Wong).

<https://doi.org/10.1016/j.jradnu.2020.06.008>

1546-0843/\$36.00/© 2020 Association for Radiologic & Imaging Nursing. Published by Elsevier Inc. All rights reserved.

the epidemic was over. This has helped the radiology department tremendously in the preparation for the 2019 coronavirus disease (COVID-19) pandemic.

Infection prevention and control measures

Before SARS epidemic, infection prevention and control (IPC) measures were primarily focused on preventing patients from acquiring an infection during surgical procedures and from contracting nosocomial infections. The concept of protecting HCWs from being infected by patients was quite rudimentary. Hence, when SARS struck, we were ill-prepared and many HCWs were infected. Protocols for hand hygiene, N95 mask fitting, proper use of personal protective equipment (PPE), including use of powered air-purifying respirator were literally written from scratch and training of staff to execute these protocols were carried out on the fly in the middle of the SARS epidemic.

After SARS epidemic, these protocols were further refined and became standard protocols for day-to-day practice. All newly recruited HCWs need to undergo N95 mask fitting and IPC training before they start working. From the IPC perspective, we are much better prepared for COVID-19 compared with SARS as the IPC protocols and practices are already in place.

Mask type and PPE recommendations

During SARS epidemic, it was mandatory for every HCW to wear an N95 mask all the time when in the hospital as it was unclear how the disease was transmitted. In addition, the intrahospital transmissions resulted in higher precaution being taken. After SARS

epidemic, the mask type and PPE recommendations are based on the mode of transmission of the infectious disease, for example, droplet, contact, and airborne transmission. For COVID-19, the recommendations are calibrated according to the level of infection risk. When handling patients with COVID-19, full PPE comprising surgical cap, eye protection (face shield or goggles), N95 mask, long-sleeved full-length gown, and gloves are recommended. For patients with low risk of COVID-19, only a surgical mask is recommended. For moderate to high-risk patients, for example, patients with pneumonia or patients under quarantine, a full PPE is recommended. Table 1 shows the PPE recommendations for the different radiology procedures.

Hand hygiene

Diligent hand hygiene with soap and water or alcohol-containing hand sanitizers are important IPC measures for both the SARS and COVID-19 outbreaks. During SARS epidemic, hand hygiene was a rudimentary concept. After SARS epidemic, the World Health Organization “5 moments of hand hygiene” became a mandatory competency which all our staff are required to demonstrate via completion of online self-directed training modules, followed by multiple-choice questions assessment. Educational posters are strategically and prominently displayed throughout the hospital, for example, lift cabins (elevator), lift lobbies, near washbasins, staff notice boards, etc. Hand sanitizers are widely available for staff and visitors in high touch areas. Random audits are regularly conducted to monitor compliance and results presented to senior hospital management. These measures have proven effective in inculcating the discipline of hand hygiene

Table 1
Personal protective equipment (PPE) requirements for radiology staff handling COVID-19 patients

Procedure	Hand hygiene	Airborne precaution	Eye protection	Contact precaution
Ultrasound, CT, and MRI examinations	Alcohol-based hand rub or hand washing (incorporating 7 steps)	*N95 mask	Face shield or goggles	Gloves + isolation gown
Fluoroscopic examinations • Barium studies, video fluoroscopy	Alcohol-based hand rub or hand washing (incorporating 7 steps)	*N95 mask	Lead glasses + face shield or goggles	Lead apron + isolation gown + gloves
Breast intervention procedure • Breast vacuum assisted procedure, breast biopsy	Alcohol-based hand rub or hand washing (incorporating 7 steps)	*N95 mask	Face shield or goggles	Sterile gloves + sterile gown
Interventional radiology procedures	Alcohol-based hand rub or hand washing (incorporating 7 steps)	*N95 mask	Lead glasses + face shield or goggles	Lead apron + sterile gloves + sterile gown
Aerosol generating procedures (AGP) • Water-soluble contrast or barium swallow/meal/enema/follow through studies • CT colonography • Nasal gastric tube insertion • Gastrointestinal tract stenting • Intubation, extubation, oro-naso suctioning • Cardiopulmonary resuscitation	Alcohol-based hand rub or hand washing (incorporating 7 steps)	†N95 mask	Lead glasses + face shield or goggles	Lead apron + isolation gown + gloves
Interventional radiology procedures that induces coughing or hemoptysis • Lung biopsy, pleural drainage, bronchial artery embolization	Alcohol-based hand rub or hand washing (incorporating 7 steps)	†N95 mask	Lead glasses + face shield or goggles	Lead apron + sterile gloves + sterile gown

* PAPR (powered air-purifying respirator) is used in cases in which health care worker failed mask fit-test for an N95 mask.

† PAPR may be used in addition to N95 mask for enhanced protection.

among all HCWs which has formed a strong foundation in our combat against COVID-19 (Gogna, et al., 2020).

Detailed protocols for handling SARS and COVID-19 patients coming for radiological examinations and interventions

Movement of patients with SARS was minimized to reduce cross-transmission risk. Portable imaging (radiography and ultrasound) by the patient's bedside in the isolation ward was widely used. IR procedures, especially those requiring ultrasound guidance, were also performed by the patient's bedside whenever possible. For patients with SARS who needed to be transported to the radiology department for imaging or interventions, detailed workflows were formulated. The workflow included transport of the patients, preparation of the scan/procedure room, PPE recommendations, and locations for donning and doffing PPE and disinfection of the scan/procedure room after scanning intervention. The formulation of the protocols required the participation and input of all stakeholders including radiologists, nurses, radiographers, isolation ward staff, infectious disease specialists, anesthetists, hospital's IPC team, security, and environmental services (Cheng et al., 2020). Simulations and rehearsals with after-action review to fine-tune the protocols were performed. The protocols were written down in detailed and endorsed by management before implementation. This same approach was adopted for COVID-19 patients.

Environmental hygiene

Disinfection of the environment and radiological equipment during SARS outbreak was performed or supervised by nurses and radiographers. Over time, specialized cleaning teams with expertise in cleaning and disinfection processes were engaged to perform terminal cleaning of the equipment and environment so that during the COVID-19 pandemic, the nurses and radiographers were spared from this role and could focus on their clinical responsibilities.

Infection prevention liaison officers and pandemic audits

During SARS outbreak, infection prevention liaison officers (IPLOs) comprising nurses, radiographers, and radiologists were appointed to help train our department staff in IPC measures as well as to conduct audits to ensure compliance to infection control practices. Thus, the role of IPLOs continues even after SARS epidemic. During the COVID-19 outbreak, these IPLOs helped to conduct refresher training in IPC protocols as well as to conduct walkabouts and audits. Any gaps or lapses detected are highlighted to the department's COVID-19 task force. The findings were addressed at the task-force meetings and timely rectifications or recommendations are shared with all staff. Members of the department management team regularly join in the walkabouts which enabled ground staff to bring up any issues and concerns directly to management.

Team segregation

One of the issues faced during SARS outbreak was the entire team could get quarantined if one team member got infected or exposed to an infected patient, leading to the complete shutdown of the clinical service. To prevent this situation, teams were segregated into smaller teams so that if one team gets quarantined, the remaining teams can continue to provide the service without interruption. At that time, the teams typically worked on alternate days so that one team came to work and the other team stayed at home. This arrangement effectively meant only half the manpower

was at work. This was possible because patients were frightened to come to the hospital, so the workload was dramatically reduced. For COVID-19, a similar approach was adopted except that alternate day work arrangement was not possible as the workload, although it is reduced, remains significant. The nurses were placed in smaller teams, and have to stay within the same team. During this period, they are not allowed to swap shifts with their colleagues. Interaction between different teams, especially during the change of shifts and movement across different work areas, are kept to a minimum. Social gatherings after work are also forbidden (Chen, Tan, & Chan, 2020).

Safe distancing

"Safe distancing" was practiced during SARS epidemic, but the term did not exist at that time. It was interesting to note that during SARS epidemic, no one needed any persuasion to adopt safe distancing measures because of fear of catching SARS and dying from it. In the COVID-19 pandemic, the fatality rate is not as high as SARS; hence, people are not as cooperative with the safe distancing measures. This has resulted in strict rules and even enactment of stringent laws to enforce safe distancing measures.

In our hospital, including our radiology department, safe distancing is strictly enforced (Chen et al., 2020). This is essential to prevent HCW-to-HCW transmission. Unlike SARS, intrahospital transmission of COVID-19 is rare. In fact, the chance of an HCW contracting COVID-19 in the community is higher than that in hospital because of strong IPC measures and adequate PPE when treating COVID-19 patients. Coupled with the risk of presymptomatic spread of COVID-19 infection, safe distancing and wearing of a surgical mask at all times when in hospital remain the only effective way to prevent HCW-to-HCW transmission (Chen et al., 2020).

The safe distancing measures were better defined during COVID-19 compared with SARS outbreak. For example, there are clear markings on the floor for safe distancing when queuing. The markings are even present in lift cabins to limit the number of people and dictate where one should stand in the lift. Face-to-face meetings are discouraged and replaced with video conferencing whenever possible (video conferencing was not available during SARS outbreak). Mealtimes are the most vulnerable as masks are off when eating. Staff are encouraged to eat alone or sit a distance apart and refrained from chatting when not using masks. The lunch and break times are staggered for the different teams to minimize face-to-face interactions across teams (Chen et al., 2020a).

Communications

Rapid dissemination of accurate information and unambiguous instructions are key during a disease outbreaks to prevent confusion as well as to allay anxiety and fear. During SARS outbreak, most of the communications were disseminated through hard-copy bulletins and daily roll-calls as not all staffs have emails and social media platforms were nonexistent. However, during the COVID-19 outbreak, information was disseminated much faster and easier because of the ubiquitous mass messaging media platforms such as WhatsApp (Mountain View, CA, USA), Tiger Connect (Santa Monica, CA, USA), and Telegram Messenger (Dubai, United Arab Emirates). This not only enables rapid communications but also facilitates workflow coordination across different teams in the department and even across departments throughout the hospital (Gogna et al., 2020).

Staff surveillance

Body temperature monitoring of staff was performed two to three times a day during SARS outbreak to detect fever clusters early, which could indicate HCW infections. This was a significant undertaking where temperature-measuring stations needed to be set up to measure staff's body temperature and the data were manually entered into a database. This body temperature–monitoring strategy was also adopted for the current COVID-19 outbreak (Gogna et al., 2020).

The difference is that every staff was issued a personal digital thermometer and the temperature readings are submitted using an electronic form via the internet where the data are centrally collated. Supervisors and managers can easily log into the system to monitor their staff's temperature readings.

Conclusion

A study previously conducted in Singapore found that nurses who experienced SARS were more prepared to handle an infectious disease outbreak (Koh, Hegney & Drury, 2012).

Our SARS experience has certainly shaped our preparations and response for the COVID-19 pandemic. Technological advancement over time has given us a huge advantage compared with the SARS period. The proliferation of social media platforms has allowed rapid sharing of information and communication among and between teams for a more coordinated response. Various electronic and online platforms have simplified or enabled implementation of measures and processes that are otherwise impossible or tedious to do, for example, tracking of staff's body temperature, logging of audit outcomes, online refresher training, and video conferencing.

The Chinese words for “crisis” is 危机 (Wei Ji) which literally translates to “danger” (Wei Xian) and “opportunity” 机会 (Ji Hui), that is, every crisis there are also opportunities (Weiland, 1998; Lexa, 2009). Both the SARS and COVID19 crises have created unique opportunities for us to improve our processes, workflows, and health care systems. The crisis has also increased the cohesiveness among staff because of the camaraderie and shared experience of a crisis.

Implications for Nursing Practice

This article has shared the key strategies to prevent cross-infection among inpatients, outpatients, visitors, and HCWs. Strict infection control protocols with regular audits should be part of routine nursing care. However, in a pandemic, more stringent protocols are required, especially in the transportation of patients to the department for imaging, maintaining environmental hygiene, and more frequent audits to discover any lapses in infection control. Team segregation can help to prevent shutdown of services if a staff gets infected, requiring the entire team to be quarantined. Online platforms can serve to allow rapid communication of information, and reduce face-to-face discussions. The response and

measures taken by the radiology department in a large acute care teaching hospital could be practiced in other similar health care settings.

Ethical approval

Institutional review board approval was not required because it is a special report on radiology nursing's leadership in responding to the coronavirus disease 2019 (COVID-19) pandemic.

Informed consent

Written informed consent was not required for this study because it is a special report on radiology leadership in responding to the coronavirus disease 2019 (COVID-19) pandemic.

Acknowledgments

The authors would like to acknowledge Singapore General Hospital and all colleagues from the Division of Radiological Sciences, Singapore General Hospital, for their efforts during the COVID-19 pandemic. The authors would like to thank Li Sheng for his valuable contribution in the preparation of the article.

All the authors attest to the following: (1) Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; (2) Drafting the work or revising it critically for important intellectual content; (3) Final approval of the version to be published; (4) Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

References

- Chen, R., Cheng, L., Liang Lim, J., Gogna, A., Ng, D., Yi Teo, L., et al. (2020a). Touch me not: physical distancing in radiology during coronavirus disease 2019 (COVID-19). *Journal of The American College of Radiology*, 17(6), 739–742.
- Chen, R., Tan, T., & Chan, L. (2020b). Adapting to a new normal? 5 key operational principles for a radiology service facing the COVID-19 pandemic. *European Radiology*, 1–4.
- Cheng, L., Chan, L., Tan, B., Chen, R., Tay, K., Ling, M., et al. (2020). Déjà Vu or Jamais Vu? How the severe acute respiratory syndrome experience influenced a Singapore radiology department's response to the coronavirus disease (COVID-19) epidemic. *American Journal of Roentgenology*, 214(6), 1206–1210.
- Gogna, A., Punamiya, S., Gopinathan, A., Irani, F., Toh, L., Wen Cheong, L., et al. (2020). Preparing IR for COVID-19: The Singapore experience. *Journal of Vascular And Interventional Radiology*, 31(6), 869–875.
- Koh, Y., Hegney, D., & Drury, V. (2012). Nurses' perceptions of risk from emerging respiratory infectious diseases: A Singapore study. *International Journal of Nursing Practice*, 18(2), 195–204.
- Lexa, F. (2009). Leading in a crisis, part 1. *Journal of The American College of Radiology*, 6(7), 521–522.
- Ministry of Health. (2004) *The communicable disease surveillance in Singapore 2003*. Retrieved from <https://www.moh.gov.sg/resources-statistics/reports/the-communicable-disease-surveillance-in-singapore-2003>. Accessed May 25, 2020.
- Weiland, A. (1998). Beyond fear—forging a new path. *The Journal of Bone & Joint Surgery*, 80(7), 935–940.