

Current guidelines for respiratory protection of Australian health care workers against COVID-19 are not adequate and national reporting of health worker infections is required

C Raina MacIntyre
Professor
The Kirby Institute
Biosecurity Program
University of New South Wales
Kensington, New South Wales, Australia'

Michelle Ananda-Rajah
Consultant Physician General Medicine and Infectious Diseases
Monash University Central Clinical School
General Medicine and Infectious Diseases
The Alfred Health Centre
Melbourne, Victoria, Australia

Mark Nicholls
Intensive Care Specialist
Sydney, New South Wales, Australia

Ashley L Quigley
HDR Student
The Kirby Institute
University of New South Wales
Faculty of Medicine
Darlinghurst, New South Wales, Australia

Abstract

The guidelines for protection of health care workers (HCWs) in Australia state that a medical mask is indicated for routine care of COVID-19 patients, and a respirator only for aerosol-generating procedures. These guidelines are not aligned with the growing body of scientific evidence around transmission and prevention of SARS-CoV-2 infection. The initial proclamation that SARS-CoV-2 is spread by droplets and contact was not based on strong evidence, and there is no data quantifying the different modes of potential transmission. We outline the evidence of airborne transmission, and the implications for the occupational health and safety of Australian health workers. There have been over 500 health worker infections in Australia by July 2020, but no national reporting on health worker infections, and lack of transparency in attribution of source of infection when health workers become infected. We suggest that all health workers treating COVID-19 patients be provided airborne precautions, that the lessons of SARS are heeded and the precautionary principle be applied to health worker protection. We also require transparent national reporting of health worker infections. This is particularly urgent as numerous health worker infections have been reported in hospitals in Victoria during Australia's resurgence of COVID-19.

The guidelines for protection of health care workers (HCWs) in Australia state that a medical mask is indicated for routine care of COVID-19 patients, and a respirator only for aerosol-generating procedures.¹ These guidelines are not aligned with the growing body of scientific evidence around transmission and prevention of SARS-CoV-2 infection.

Hospital infection control paradigm has assumed since last century that pathogens can be classified by transmission modes of droplet, airborne or contact. Guidelines on “droplet precautions” (masks) and “airborne precautions” (respirators) assume that respiratory emissions can be separated into mutually exclusive types - droplet and airborne spread.^{1,2} This assumption is based on limited data from the 1930s, and likely an artificial division.² Newer studies show that droplets and aerosol particles exist in a continuum, and even a single large droplet may reduce in diameter and become airborne during its trajectory, because of evaporation. Despite hospital infection control guidelines stipulating that 2m is a safe distance from an infected patient, studies show that large droplets can travel distances well over 2m.²

Large droplets are predominantly thought to originate from the nose, throat and mouth; whereas airborne particles may originate from the lung, or from evaporation of large droplets from the upper airway.³ Research shows that the highest viral load of SARS-CoV-2 is found in bronchoalveolar lavage of the lower respiratory tract, and throat swabs are less likely to be positive.⁴ This is consistent with airborne potential for the virus, as a high viral load in the lower respiratory tract increases the likelihood of virus being exhaled in fine respiratory aerosols.³ Several studies show that SARS-CoV-2 is found in air samples and in air vents in COVID-19 wards.^{5,6} One study showed that seasonal coronaviruses are more likely to be aerosolised than other respiratory viruses such as influenza, and can be exhaled in normal tidal breathing in fine aerosols.⁷ Research conducted in five leading laboratories independently demonstrated that SARS-CoV-2 has more propensity for aerosolisation than SARS or MERS CoV (both of which are accepted as having airborne potential), and that viable virus can be detected in the air 16 hours after aerosolization.⁸

In terms of respiratory protection, a mask is designed to prevent a stream of liquid (such as a blood spurt) entering the mouth or nose of a surgeon, and is not regulated on filtration or fit. Its original purpose was protection of a surgical wound from contamination by the surgeon, but is now used to also protect proceduralists from spray or splatter. It is not designed for respiratory protection. A respirator, in contrast, is designed for respiratory protection. It is designed to filter 95% of airborne particles and to fit around the face.⁹ Without fit and seal around the face, air flows preferentially through gaps around the mask. The best available evidence specific to COVID-19 is a WHO commissioned systematic review and meta-analysis, which found that N95 respirators offer significantly better protection (96%) than surgical masks (67%) against SARS, MERS and SARS-CoV-2.¹⁰ Randomised clinical trials (RCTs) of other respiratory viruses including coronaviruses show significant efficacy of N95 respirators when used continually on shift, but fail to demonstrate efficacy of surgical masks.^{11,12} Even against infections assumed to be droplet spread, such as influenza, respirators are protective and masks are not.¹³ Two North American studies are often cited as proof of “equivalence” of masks and respirators, but neither had a control arm and therefore cannot prove efficacy^{14,15}.

Further, the intervention in these RCTs was targeted use of a N95 when doing aerosol generating procedures.^{14,15} A randomized controlled trial which compared targeted N95 use with continuous N95 use, showed that only continuous use is protective, and neither targeted use or medical masks are efficacious.¹² It is important to understand that inability to show superiority between two interventions is not the same as showing equivalence or non-inferiority. This common fallacy seems to be the driver of unwarranted claims that facemasks are non-inferior to respirators. The principle of equivalence in RCTs arose from drug trials, and requires an experimental treatment to be compared and shown to be equivalent against an established treatment which is already proven to be superior to placebo. A trial lacking a control arm which compares two interventions, neither of which are proven against placebo, and finds no difference cannot prove equivalence – it may show equal inefficacy. The failure to understand this basic concept has resulted in poor guidelines for HCWs.

During the COVID-19 pandemic, with scientific evidence accruing, daily rising HCW infections and uncertainty, the precautionary principle should be used.¹⁶ The precautionary principle stipulates there is an imperative to act in the face of imperfect evidence, because the potential benefits outweigh the harms. Health workers treating COVID-19 patients or suspected COVID-19 patients should be afforded optimal protection, which is a respirator. This should be feasible, given Australia has scaled up domestic manufacturing capacity for disposable masks and respirators. Supply shortage is no reason to recommend substandard protection for health workers.¹⁷ We could also consider re-usable elastomeric respirators as a cost-effective option. Notably, a review of health worker deaths in the UK, collated from open data, found none among intensivists and anaesthetists suggesting that their higher level of PPE was protective.¹⁸

There are no data to prove that contact and large droplets are the predominant mode of transmission. The evidence for airborne transmission is mounting.^{5,6} There is also evidence of hospital workers with no patient contact becoming infected during nosocomial outbreaks of SARS-CoV-2, suggesting a distal risk beyond the patient care area.¹⁹

Our health workers are a precious asset, and warrant the highest protection – not simply for their occupational health and safety, but for a functional and resilient health system. In Tasmania, one hospital outbreak resulted in over 1000 health workers being furloughed for quarantine. Outbreaks in emergency during the Victorian resurgence have resulted in at least one Melbourne hospital being over capacity and unable to accept ambulances, putting pressure on other health services. Through reviewing all media reports which mentioned hospitals and health workers as of July 2020, we estimated that about 6% (507/8449) of all cases in Australia are health workers. This includes about 216 in Victoria prior to the current resurgence, (only 17% are apparently attributed to occupational infection), 208 in NSW (about 88 attributed to the workplace), 73 in Tasmania (from a single hospital outbreak) and at least 10 infections from the rest of the country.²⁰ In the absence of national or even state reporting of health worker infections, we believe this is a minimal national estimate of health worker infections prior to the current resurgence in Victoria. We are also aware of hospital staff working in non-clinical duties acquiring infection during the current epidemic, which

suggests widespread risk in the hospital setting. Studies from other countries have documented a higher risk of COVID-19 in health workers.^{21,22} We call for transparent national reporting of health worker infections. This should be based on role and specialty, with adjudication of source attribution (workplace or elsewhere) by an independent panel separate to health services or agencies to avoid conflicts of interest.

We can also learn from SARS in 2003, where experts in Toronto argued over whether N95 respirators were really necessary. Vancouver used the precautionary principle and did not have health worker infections, but in Toronto, experts argued against the N95, which protects against airborne transmission, believing SARS was spread mostly by large droplets.²¹ As a result, they said, an N95 was unnecessary except for aerosol generating procedures, and a surgical mask was sufficient in most instances. These recommendations were made even though knowledge about SARS and about airborne transmission was still evolving.²¹ As a result, over 300 health workers in Toronto were infected and three died.²¹ During the SARS CoV-2 pandemic, we see the very same debate occurring. The lessons of the SARS Commission in Ontario, Canada, should be heeded. In the aftermath of SARS and deaths of health workers in Toronto, in 2006 the commission concluded: *“One example was the debate during SARS over whether SARS was transmitted by large droplets or through airborne particles. The point is not who was right and who was wrong in this debate. When it comes to worker safety in hospitals, we should not be driven by the scientific dogma of yesterday or even the scientific dogma of today. We should be driven by the precautionary principle that reasonable steps to reduce risk should not await scientific certainty.”*²¹ The report also warns that decisions about protection of health workers must involve broader stakeholder consultation, including the workers themselves, work health and safety experts, unions and the government agency responsible for industrial relations.²³ Several hospitals in Melbourne have reported health worker infections during the resurgence, and even more are in quarantine and unable to work. We must make the occupational health and safety of our health workers a national priority.

References

1. Guidance on the use of personal protective equipment (PPE) in hospitals during the COVID-19 outbreak. Infection Control Expert Group (ICEG) Endorsed Guidelines for Australia. <https://www.health.gov.au/resources/publications/guidance-on-the-use-of-personal-protective-equipment-ppe-in-hospitals-during-the-covid-19-outbreak>
2. Bahl P, Doolan C, de Silva C, Chughtai AA, Bourouiba L, MacIntyre CR. Airborne or droplet precautions for health workers treating COVID-19? *The Journal of Infectious Diseases* 2020.
3. de Gabory L, Alharbi A, Kérimian M, Lafon ME. The influenza virus, SARS-CoV-2, and the airways: Clarification for the otorhinolaryngologist. *Eur Ann Otorhinolaryngol Head Neck Dis* 2020.
4. Wang W, Xu Y, Gao R, et al. Detection of SARS-CoV-2 in Different Types of Clinical Specimens. *JAMA* 2020; **323**(18): 1843-4.
5. Guo ZDW, Z.Y; Zhang, S.F; L; et al. Aerosol and surface distribution of severe acute respiratory syndrome coronavirus 2 in hospital wards, Wuhan, China, 2020. <https://doi.org/10.3201/eid2607.200885>. *Emerg Infect Dis* 2020.
6. Santarpia JL, Rivera DN, Herrera V, et al. Transmission Potential of SARS-CoV-2 in Viral Shedding Observed at the University of Nebraska Medical Center. *medRxiv* 2020: 2020.03.23.20039446.
7. Leung NHL, Chu DKW, Shiu EYC, et al. Respiratory virus shedding in exhaled breath and efficacy of face masks. *Nature Medicine* 2020.
8. Fears AC, Klimstra WB, Duprex P, et al. Persistence of Severe Acute Respiratory Syndrome Coronavirus 2 in Aerosol Suspensions. *Emerg Infect Dis* 2020; **26**(9).
9. MacIntyre CR, Chughtai AA. Facemasks for the prevention of infection in healthcare and community settings. *BMJ (Clinical research ed)* 2015; **350**: h694-h.
10. Chu DK, Akl EA, Duda S, et al. Physical distancing, face masks, and eye protection to prevent person-to-person transmission of SARS-CoV-2 and COVID-19: a systematic review and meta-analysis. *The Lancet*.
11. MacIntyre C, Wang Q, Cauchemez S, et al. A cluster randomized clinical trial comparing fit-tested and non-fit-tested N95 respirators to medical masks to prevent respiratory virus infection in health care workers. *Influenza and Other Respiratory Viruses* 2011; **5**(3): 170-9.

12. MacIntyre CR, Wang Q, Seale H, et al. A randomized clinical trial of three options for N95 respirators and medical masks in health workers. *Am J Respir Crit Care Med* 2013; **187**(9): 960-6.
13. MacIntyre CR, Chughtai AA, Rahman B, et al. The efficacy of medical masks and respirators against respiratory infection in healthcare workers. *Influenza and other respiratory viruses* 2017; 11(6): 511-7.
14. Loeb M, Dafoe N, Mahony J, et al. Surgical mask vs N95 respirator for preventing influenza among health care workers: a randomized trial. *JAMA* 2009; **302**(17): 1865-71.
15. Radonovich LJ, Jr., Simberkoff MS, Bessesen MT, et al. N95 Respirators vs Medical Masks for Preventing Influenza Among Health Care Personnel: A Randomized Clinical Trial. *JAMA* 2019; **322**(9): 824-33.
16. Goldstein BD. The precautionary principle also applies to public health actions. *American journal of public health* 2001; **91**(9): 1358-61.
17. Greenhalgh T, Schmid MB, Czypionka T, Bassler D, Gruer L. - Face masks for the public during the covid-19 crisis. – *BMJ*. 2020 Apr 09; 369: - m1435.
18. Cook T, Kursumovic E, Lennane S. Exclusive: deaths of NHS staff from covid-19 analysed. *Health Serv J* 2020 Apr 22. <https://www.hsj.co.uk/exclusive-deaths-of-nhs-staff-from-covid-19-analysed/7027471.article>.
19. Hunter E, Price DA, Murphy E, et al. First experience of COVID-19 screening of health-care workers in England. *Lancet* 2020.
20. Quigley A, Stone H, Nguyenn PY, MacIntyre CR. The estimated burden of COVID-19 on Australian health care workers. 2020. Unpublished data.
21. Sikkema RS, Pas SD, Nieuwenhuijse DF, et al. COVID-19 in health-care workers in three hospitals in the south of the Netherlands: a cross-sectional study. *Lancet Infect Dis* 2020. DOI: 10.1016/s1473-3099(20)30527-2
22. Keeley AJ, Evans C, Colton H, et al. Roll-out of SARS-CoV-2 testing for healthcare workers at a large NHS Foundation Trust in the United Kingdom, March 2020. *Eurosurveillance* 2020; **25**(14): 2000433.
23. Campell A. SARS Commission Final Report: Spring of Fear. Canada: Government of Ontario, 2006. http://www.archives.gov.on.ca/en/e_records/sars/report/index.html