



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

International Journal of Nursing Studies

journal homepage: www.elsevier.com/ijns

Guest Editorial

Policies on the use of respiratory protection for hospital health workers to protect from coronavirus disease (COVID-19)



1. Introduction

Novel Coronavirus (COVID-19) emerged in China in December 2019 and as of 3rd March 2020, more than 90,800 cases and 3100 deaths have been reported from 72 countries (World Health Organisation (WHO) 2020). Most of the cases and deaths have occurred in Wuhan city in China where the outbreak started. As drugs or vaccines are not yet available, various non-pharmaceutical measures have been recommended to reduce the spread of infection, including hygiene and disinfection, improving environmental control, early detection and reporting, isolation, quarantine, use of personal protective equipment, social distancing and travel restrictions ((World Health Organization (WHO) 2014; Bell et al., 2006)). In most pandemic plans, tiered strategies which target front line health workers first, followed by the general community, are usually defined. Yet many of these strategies have some level of controversy attached and lack a large evidence base (MacIntyre et al., 2014). Some are starting to be phased out in some settings such as the use of thermal scanners at airports, due to a lack of evidence, especially for infections with pre-symptomatic transmission (Gunaratnam et al., 2014). However, the use of other interventions continues to be debated.

The lack of agreement on the selection and use of masks (medical or surgical facemasks) and respirators (N95/P2/FFP2 or equivalent) is reflected in inconsistent and conflicting policies worldwide (MacIntyre et al., 2014a; Chughtai et al., 2013). Masks and respirators are commonly used to protect healthcare workers from respiratory infections, particularly during the initial periods of outbreaks/ pandemics when other control measures not yet available (Aiello et al., 2010a; Aledort et al., 2007). In this paper we examined existing policies of selected health organization and countries on the use of masks and respirators to protect hospital health workers from COVID-19.

2. Health workers' policies for the use of masks/respirators for novel coronavirus (COVID-19)

While there is a high level of agreement amongst key agencies that masks and respirators play a role in the protection of health workers, there are currently discrepancies between these agencies regarding how and when the different products are used. The World Health Organization (WHO), the US Centers for Disease Control and Prevention and other leading health organisations have different recommendations for the selection of respiratory protec-

tion. For example, the WHO recommends using masks to protect health workers from COVID-19 during routine care and respirators during aerosol generating procedures (World Health Organisation (WHO) 2020). In contrast, the US Centers for Disease Control and Prevention (Center for Disease Control and Prevention (CDC) 2020) and the European Center for Disease Prevention and Control (European Centre for Disease Prevention and Control (ECDC) 2020) recommend using respirators during both routine care of COVID19 patients and high risk situations. Individual countries also have different policies; some are in line with the WHO, and others with the US Centers for Disease Control and Prevention. For example, the Australian (Communicable Diseases Network Australia (CDNA)) and Canadian guidelines (Government of Canada) align with the WHO, while UK (Public Health England) and Chinese guidelines (Chinese Center for Disease Control and Prevention 2020) align with the US Centers for Disease Control and Prevention and European Center for Disease Prevention and Control. While all organisations recommend using N95/ P2/FFP2 or equivalent respirators, Public Health England (UK) recommends using filtering facepiece 3 (FFP3) respirators for all cases and the European Center for Disease Prevention and Control recommends using FFP3 during aerosol generating procedures. Australian guidelines also recommend powered air purifying respirators while performing aerosol generating procedures on multiple patients. Although US Centers for Disease Control and Prevention guidelines also discuss powered air purifying respirators indication of their use is not clear.

These conflicting policies may cause confusion for hospital managers, nurses and other health workers. Conflicting guidelines have resulted in a large amount of online debate between infectious disease providers and infection prevention control experts about what approaches should be adopted. History is repeating itself with the same controversies around powered air purifying respirators during the Ebola epidemic in 2014 (MacIntyre et al., 2014a; MacIntyre et al., 2014b). The policies and guidelines regarding the use of masks/respirators for health organisations are also inconsistent for other infections such as severe acute respiratory syndrome coronavirus (SARS-CoV), Middle East respiratory syndrome coronavirus (MERS-CoV), pandemic influenza and Ebola virus disease (MacIntyre et al., 2014a; Chughtai et al., 2013).

The only similarity is that all health organisations and countries generally recommend the use of masks by suspected or infected cases of COVID-19 (i.e. source control) to prevent spread of infections. They simultaneously state that community use of masks has no benefit. Yet there are more randomised controlled clinical

trials (RCTs) supporting the use of masks in the community than for source control. The community trials show a benefit of face masks with or without hand hygiene, conditional on compliance (Simmerman et al., 2011; Aiello et al., 2012; Aiello et al., 2010b; Suess et al., 2012; MacIntyre et al., 2009; Cowling et al., 2009). There are only two RCTs of clinical efficacy of source control (Canini et al., 2010; MacIntyre et al., 2016), and one small experimental RCT of 9 subjects (Johnson et al., 2009). These suggest a benefit, but larger trials are needed.

3. What level of respirator protection should be used for coronavirus (COVID-19)?

The main difference in masks and respirators is their intended use. Masks were originally designed to prevent spread of infections from wearers to other people around them, referred to as “source control”. They are also used to protect from infections transmitted through the droplet mode and splashes or sprays of blood or body fluids. Disposable medical or surgical masks are common types of face masks used by both health workers and general public. In contrast to this, respirators are designed for respiratory protection. A medical or surgical mask may be enough to prevent droplet transfer, while a respirator is required for airborne infection. In terms of mask use, the physical barrier may also prevent contact transmission such as hand to face/mouth/nose. A respirator may provide protection against multiple modes of transmission, including droplet, airborne and hand-to-mouth/nose transmission. Whilst the relative contribution of each mode is difficult to quantify, clinically, the debate about the modes of transmission is academic if an intervention is shown to prevent infection.

Like other coronavirus diseases (e.g. SARS and MERS), COVID-19 is believed to be transmitted through droplet and contact modes however other transmission modes, such as airborne, are likely given the virus is found in higher concentrations in the lungs than the upper respiratory tract (World Health Organisation (WHO) 2020). There had been evidence of airborne transmission of SARS as well, therefore respirators were recommended for SARS during 2002–03 outbreak (McKinney et al., 2006). In Canada, initially masks were recommended, but this recommendation was later changed to respirators due to the deaths of health workers. A recent study demonstrated the presence of coronavirus in anal swabs from infected patients and possibility of transmission through faecal-oral route (Zhang et al., 2020). Transmission dynamics for COVID-19 are still unclear and pharmaceutical control measures are not yet available, therefore N95 or higher respirators should be offered to health workers who are working at the front-line (MacIntyre et al., 2014a; MacIntyre et al., 2014b). Health workers and other first responders in high coronavirus transmission areas (e.g. Wuhan) should use respirators during routine care of coronavirus cases. Health workers and first responders in low risk countries should use a respirator when encountering a suspected or confirmed case of coronavirus. If respirators are not available, then masks should be used.

4. Policies on extended use and reuse of masks

Extended use and reuse of masks and respirators was a common practice during past epidemics and pandemics due to shortage of products (Chughtai et al., 2015; Beckman et al., 2013; Lautenbach et al., 2010; Rebmann and Wagner, 2009). According to the US Centers for Disease Control and Prevention, extended use refers to “the practice of wearing the same N95 respirator for repeated close contact encounters with several patients, without removing the respirator between patient encounters” (Center for

Disease Control and Prevention (CDC) 2014a). The US Centers for Disease Control and Prevention defines re-use as “the practice of using the same N95 respirator for multiple encounters with patients but removing it (‘doffing’) after each encounter” (Center for Disease Control and Prevention (CDC) 2014a). Shortages of respirators were reported in many hospitals in US and Japan during the 2009 influenza H1N1 pandemic and staff had to use medical masks (Lautenbach et al., 2010; Rebmann and Wagner, 2009; Tomizuka et al., 2013).

Currently, the single use of medical mask and FFP respirators is recommended, but this is not always feasible. During a pandemic or extended outbreak, medical masks and FFP respirators may not be available for everyone. Therefore the US Centers for Disease Control and Prevention and other health organisations have previously considered the extended use and re-use of medical masks and respirators during outbreaks, pandemics and other high demand situations ((Center for Disease Control and Prevention (CDC) 2014a; Occupational Safety and Health Administration (OSHA) 2009; Institute of Medicine (IOM) National Academy of Sciences 2006)). During recent COVID-19 epidemics the shortage of masks and respirators have been reported from many countries. However, the outer surface of medical masks or respirators may be contaminated and may be a source of infection ((Institute of Medicine (IOM) National Academy of Sciences 2010; Viscusi et al., 2009)). A recent study showed that pathogens may be present on the outer surface of around 10% masks and risks increase with prolonged mask use (Chughtai et al., 2019). The number of viral particles and length of survival are important factors to consider in case re-use is deemed essential (Institute of Medicine (IOM) National Academy of Sciences 2010).

Currently there is a lack of data regarding the period for which the same mask or respirators may be continuously used, and none of guideline address this. Available data suggest that respirators may be used intermittently or continuously for around eight hours (Center for Disease Control and Prevention (CDC) 2014b) and that adverse effects of facemasks increase with more than eight hours use (Shenal et al., 2012). It has been suggested that extended use of facemasks is acceptable if the mask is not wet and soiled. However there are currently no clinical studies supporting this practice ((Occupational Safety and Health Administration (OSHA) 2009; Sonoma County Department of Health Services 2006)).

5. Respiratory protection program

Policies and guidelines should also mention implementation of a comprehensive respiratory protection program for respirator use, which includes selection of certified respirators, training and fit checking and testing, and inspection, maintenance and storage (Occupational Safety and Health Administration (OSHA) 2002). Certified respirators should be used in healthcare settings and certification processes should be managed by a regulatory body, for example in the US the National Institute for Occupational Safety and Health regulates the certification process under regulation 42 CFR 84 (National Institute for Occupational Safety and Health (NIOSH) 1995). Similarly, in Europe, the European Norm standard (European Directive) and in Australia, AS/ NZS 1716 standard regulates respirator use (Standards Australia Limited/Standards New Zealand 2012). All guidelines, except the WHO and the Australian guidelines, briefly discuss the need for fit testing but do not provide detail on fit testing procedures. The WHO and the Australian guidelines do not mention fit testing and instead mention fit check (or seal-check) which is not equivalent to fit testing. All guidelines however highlight the importance of training for respiratory (and other personal protective equipment) use.

6. Conclusion

Summing up, in the case of serious emerging infections, like COVID-19, the precautionary principle should be used for front-line health workers and a properly fitted respirator should be used. If respirators are not available, masks should be used. Extended use and reuse are high risk practices and may lead to self-contamination to the wearer and should be avoided. In case of shortage, extended use should be balanced against the risk of infections and the wearer should not remove masks between patients encounters. There should be a uniform policy around the use of personal protective equipment to avoid confusion which places occupational health and safety of health workers as a high priority.

Conflict of interest

Abrar Ahmad Chughtai had testing of filtration of masks by 3 M for his PhD more than 5 years ago. 3 M products were not used in his research. He also has worked with CleanSpace Technology on research on fit testing of respirators (no funding was involved). C Raina MacIntyre receives funding from NHMRC (center for Research Excellence and Principal Research Fellowship) and Sanofi currently. She has received funding from 3 M more than 10 years ago for face mask research.

Funding

There was no funding involved.

References

- Aiello, A.E., Coulborn, R.M., Aragon, T.J., Baker, M.G., Burrus, B.B., Cowling, B.J., et al., 2010a. Research findings from nonpharmaceutical intervention studies for pandemic influenza and current gaps in the research. *Am. J. Infect. Control* 38 (4), 251–258.
- Aiello, A.E., Perez, V., Coulborn, R.M., Davis, B.M., Uddin, M., Monto, A.S., 2012. Facemasks, hand hygiene, and influenza among young adults: a randomized intervention trial. *PLoS One* 7 (1), e29744.
- Aiello, A.E., Murray, G.F., Perez, V., Coulborn, R.M., Davis, B.M., Uddin, M., et al., 2010b. Mask use, hand hygiene, and seasonal influenza-like illness among young adults: a randomized intervention trial. *J. Infect. Dis.* 201 (4), 491–498.
- Aledort, J.E., Lurie, N., Wasserman, J., Bozzette, S.A., 2007. Non-pharmaceutical public health interventions for pandemic influenza: an evaluation of the evidence base. *BMC Public Health* 7, 208.
- Beckman, S., Materna, B., Goldmacher, S., Zipprich, J., D'Alessandro, M., Novak, D., et al., 2013. Evaluation of respiratory protection programs and practices in California hospitals during the 2009–2010 H1N1 influenza pandemic. *Am. J. Infect. Control* 41 (11), 1024–1031.
- Bell, D., Nicoll, A., Fukuda, K., Horby, P., Monto, A., Hayden, F., et al., 2006. Non-pharmaceutical interventions for pandemic influenza, national and community measures. *Emerging Infect. Dis.* 12 (1), 88–94.
- Government of Canada. Coronavirus Disease (COVID-19): For health Professionals [Available from: <https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/health-professionals.html#i>].
- Canini, L., Andreoletti, L., Ferrari, P., D'Angelo, R., Blanchon, T., Lemaître, M., et al., 2010. Surgical mask to prevent influenza transmission in households: a cluster randomized trial. *PLoS One* 5 (11), e13998.
- Center for Disease Control and Prevention (CDC), 2020. Interim Healthcare Infection Prevention and Control Recommendations For Patients Under Investigation for 2019 Novel Coronavirus January 2020 [Available from: <https://www.cdc.gov/coronavirus/2019-nCoV/infection-control.html>].
- Center for Disease Control and Prevention (CDC), 2014a. Questions and Answers Regarding Respiratory Protection For Preventing 2009 H1N1 Influenza Among Healthcare Personnel [Available from: http://www.cdc.gov/h1n1flu/guidelines_infection_control_qa.htm#ex_use].
- Center for Disease Control and Prevention (CDC), 2014b. Recommended Guidance for Extended Use and Limited Reuse of N95 Filtering Facepiece Respirators in Healthcare Settings [Available from: <http://www.cdc.gov/niosh/topics/hcwcontrols/recommendedguidanceexuse.html>].
- Chinese Center for Disease Control and Prevention, 2020. New Coronavirus Pneumonia Prevention and Control Plan, 4th Edition [Available from: <http://www.nhc.gov.cn/jkj/s3577/202002/573340613ab243b3a7f61df260551dd4.shtml>].
- Chughtai, A.A., Seale, H., MacIntyre, C.R., 2013. Availability, consistency and evidence-base of policies and guidelines on the use of mask and respirator to protect hospital health care workers: a global analysis. *BMC Res. Notes* 6, 216.
- Chughtai, A.A., MacIntyre, C.R., Peng, Y., Wang, Q., Ashraf, M.O., Dung, T.C., et al., 2015. Practices around the use of masks and respirators among hospital health care workers in 3 diverse populations. *Am. J. Infect. Control* 43, 1116–1118.
- Chughtai, A.A., Stelzer-Braid, S., Rawlinson, W., Pontivivo, G., Wang, Q., Pan, Y., et al., 2019. Contamination by respiratory viruses on outer surface of medical masks used by hospital healthcare workers. *BMC Infect. Dis.* 19 (1), 491.
- Communicable Diseases Network Australia (CDNA). CDNA National Guidelines For Public Health Units [Available from: <https://www1.health.gov.au/internet/main/publishing.nsf/Content/cdna-song-novel-coronavirus.htm>].
- Cowling, B.J., Chan, K.H., Fang, V.J., Cheng, C.K., Fung, R.O., Wai, W., et al., 2009. Facemasks and hand hygiene to prevent influenza transmission in households: a cluster randomized trial. *Ann. Intern. Med.* 151 (7), 437–446.
- European Centre for Disease Prevention and Control (ECDC), 2020. Infection Prevention and Control For the Care of Patients With 2019-nCoV in Healthcare Settings [Available from: <https://www.ecdc.europa.eu/sites/default/files/documents/novel-coronavirus-infection-prevention-control-patients-healthcare-settings.pdf>].
- European Directive. Guidelines On the Application of Council Directive 89/686/EEC of 21 December 1989 On the Approximation of the Laws of the Member states Relating to Personal Protective Equipment.
- Gunaratnam, P.J., Tobin, S., Seale, H., Marich, A., McAnulty, J., 2014. Airport arrivals screening during pandemic (H1N1) 2009 influenza in new south wales, Australia. *Med. J. Aust.* 200 (5), 290–292.
- Institute of Medicine (IOM) National Academy of Sciences, 2006. Reusability of Facemasks During an Influenza Pandemic: Facing the Flu.
- Institute of Medicine (IOM) National Academy of Sciences, 2010. Preventing Transmission of Pandemic Influenza and Other Viral Respiratory Diseases: Personal Protective Equipment for Healthcare Personnel Update 2010. The National Academies Press, Washington D.C.
- Johnson, D.F., Druce, J.D., Birch, C., Grayson, M.L., 2009. A quantitative assessment of the efficacy of surgical and N95 masks to filter influenza virus in patients with acute influenza infection. *Clin. Infect. Dis. Off. Publ. Infect. Dis. Soc. Am.* 49 (2), 275–277.
- Lautenbach, E., Saint, S., Henderson, D.K., Harris, A.D., 2010. Initial response of health care institutions to emergence of H1N1 influenza: experiences, obstacles, and perceived future needs. *Clin. Infect. Dis. Off. Publ. Infect. Dis. Soc. Am.* 50 (4), 523–527.
- MacIntyre, C.R., Chughtai, A.A., Seale, H., Richards, G.A., Davidson, P.M., 2014. Respiratory protection for healthcare workers treating ebola virus disease (EVD): are facemasks sufficient to meet occupational health and safety obligations? *Int. J. Nurs. Stud.* 51 (11), 1421–1426.
- MacIntyre, C.R., Chughtai, A.A., Seale, H., Richards, G.A., Davidson, P.M., 2014. Uncertainty, risk analysis and change for ebola personal protective equipment guidelines. *Int. J. Nurs. Stud.* 52 (5), 899–903.
- MacIntyre, C.R., Cauchemez, S., Dwyer, D.E., Seale, H., Cheung, P., Browne, G., et al., 2009. Face mask use and control of respiratory virus transmission in households. *Emerg. Infect. Dis.* 15 (2), 233–241.
- MacIntyre, C.R., Zhang, Y., Chughtai, A.A., Seale, H., Zhang, D., Chu, Y., et al., 2016. Cluster randomised controlled trial to examine medical mask use as source control for people with respiratory illness. *BMJ Open* 6 (12), e012330.
- McKinney, K.R., Gong, Y.Y., Lewis, T.G., 2006. Environmental transmission of SARS at amoy gardens. *J. Environ. Health* 68 (9), 26–30 quiz 51–2.
- National Institute for Occupational Safety and Health (NIOSH), 1995. NIOSH Guide to the Selection and Use of Particulate Respirators.
- Occupational Safety and Health Administration (OSHA). U.S. department of labor. Pandemic Influenza Preparedness and Response Guidance for Healthcare Workers and Healthcare Employers. 2009.
- Occupational Safety and Health Administration (OSHA). U.S. department of labor. respiratory protection. OSHA 3079. 2002 (Revised).
- Public Health England. Guidance. COVID-19: Infection Prevention and Control Guidance [Available from: <https://www.gov.uk/government/publications/wuhan-novel-coronavirus-infection-prevention-and-control/wuhan-novel-coronavirus-wn-cov-infection-prevention-and-control-guidance>].
- Rebmann, T., Wagner, W., 2009. Infection preventionists' experience during the first months of the 2009 novel H1N1 influenza pandemic. *Am. J. Infect. Control* 37 (10), e5–e16.
- Shenal, B.V., Radonovich Jr, L.J., Cheng, J., Hodgson, M., Bender, B.S., 2012. Discomfort and exertion associated with prolonged wear of respiratory protection in a health care setting. *J. Occup. Environ. Hyg.* 9 (1), 59–64.
- Simmerman, J.M., Suntarattiwong, P., Levy, J., Jarman, R.G., Kaewchana, S., Gibbons, R.V., et al., 2011. Findings from a household randomized controlled trial of hand washing and face masks to reduce influenza transmission in Bangkok, Thailand. *Influenza Other Respir. Viruses* 5 (4), 256–267.
- Sonoma County Department of Health Services, 2006. Pandemic Influenza – phase 6 infection Control Recommendations Template [Available from: <http://www.sonoma-county.org/health/topics/pdf/infectioncontrol/phase6icrecommendations.pdf>].
- Standards Australia Limited/Standards New Zealand. Respiratory protective devices. Australian/New Zealand Standard. AS/NZS 1716: 2012.
- Suess, T., Remschmidt, C., Schink, S.B., Schweiger, B., Nitsche, A., Schroeder, K., et al., 2012. The role of facemasks and hand hygiene in the prevention of influenza transmission in households: results from a cluster randomised trial; Berlin, Germany, 2009–2011. *BMC Infect. Dis.* 12, 26.

- Tomizuka, T., Kanatani, Y., Kawahara, K., 2013. Insufficient preparedness of primary care practices for pandemic influenza and the effect of a preparedness plan in Japan: a prefecture-wide cross-sectional study. *BMC Fam. Pract.* 14, 174.
- Viscusi, D.J., Bergman, M.S., Eimer, B.C., Shaffer, R.E., 2009. Evaluation of five decontamination methods for filtering facepiece respirators. *Ann. Occup. Hyg.* 53 (8), 815–827.
- World Health Organisation (WHO), 2020. Novel Coronavirus (2019-nCoV) Situation Reports Available from: <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports>.
- World Health Organization (WHO), 2014. Infection Prevention and Control of Epidemic- and Pandemic-Prone Acute Respiratory Infections in Health Care.
- World Health Organisation (WHO). Infection prevention and control during health care when novel coronavirus (nCoV) infection is suspected. Interim guidance 2020 [Available from: [https://www.who.int/publications-detail/infection-prevention-and-control-during-health-care-when-novel-coronavirus-\(ncov\)-infection-is-suspected](https://www.who.int/publications-detail/infection-prevention-and-control-during-health-care-when-novel-coronavirus-(ncov)-infection-is-suspected)].
- World Health Organisation (WHO), 2020. Novel Coronavirus (2019-nCoV) [Available from: <https://www.who.int/westernpacific/emergencies/novel-coronavirus>].
- Zhang, W., Du, R.-H., Li, B., Zheng, X.-S., Yang, X.-L., Hu, B., et al., 2020. Molecular and serological investigation of 2019-nCoV infected patients: implication of multiple shedding routes. *Emerg. Microbes Infect.* 9 (1), 386–389.

Abrar A. Chughtai*, Holly Seale, Md Saiful Islam,
Mohammad Owais

*School of Public Health and Community Medicine, UNSW Medicine,
University of New South Wales, Samuels Building, Kensington 2052,
NSW, Australia*

C. Raina Macintyre
*Biosecurity Program, The Kirby Institute, The University of New
South Wales, Sydney, Kensington 2052, NSW, Australia AND College
of Public Service & Community Solutions, Arizona State University,
Phoenix, AZ, USA Arizona State University, Tempe, AZ, United States*

* Corresponding author.

E-mail address: abrar.chughtai@unsw.edu.au (A.A. Chughtai)

Received 6 March 2020

Accepted 6 March 2020