EDITORIAL

The use of N95 respirators in long-term care settings for the care of residents infected with COVID-19

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Current scientific evidence suggests that SARS-CoV-2, the causative agent of COVID-19, is predominantly spread from person-to-person through direct or indirect contact with infected persons through respiratory droplets [1, 2]. These droplets, which are >5µm, can be transmitted when a person is within 6 ft. of an infected person who has respiratory symptoms that emit droplets that may directly deposit on mucous membranes through a ballistic trajectory. To prevent infection from these droplets, surgical masks are considered as appropriate facial personal protective equipment (PPE) for the care of patients with suspected or confirmed COVID-19 infection [3].

However, concerns have been raised about possible SARS-CoV-2 spread through aerosols even in the absence of aerosol-generating medical procedures (AGMPs). Airborne transmission involves the dissemination of droplet nuclei (aerosols) which are <5µm in diameter and have the ability to remain infectious when suspended in air over long distances and time [3]. This mechanism of transmission has been well described during medical procedures which generate aerosols [4]. Examples of AGMPs include but are not limited to intubation, manual ventilation, open endotracheal suctioning, cardio pulmonary resuscitation, bronchoscopy, sputum induction, non-invasive ventilation (i.e., BiPAP), open respiratory/airway suctioning, high-frequency oscillatory ventilation, tracheostomy care, nebulized therapy/aerosolized medication administration, high flow heated oxygen therapy devices, and post-mortem care [4]. Reducing airborne transmission of virus in healthcare settings require measures to avoid inhalation of infectious aerosols, including ventilation, air filtration, and the use of appropriate respirators [6].

Airborne transmission of SARS-CoV-2 is an evolving science as researchers continue to generate evidence to support their hypotheses [7]. For example, long-range transmission of SARS-CoV-2 between people in adjacent rooms but never in each other's presence in quarantine hotels was used to suggest that the virus could be transmitted by airborne route [8]. Asymptomatic or pre-symptomatic transmission of SARS-CoV-2 from people who were not coughing or sneezing was also used to suggest a possible airborne route of transmission [9]. Another study simply considered higher indoor compared to outdoor transmission to hypothesize airborne spread [10]. In other studies, SARS-CoV-2 was identified in air samples from rooms occupied by COVID-19 positive patients in the absence of aerosol-generating healthcare procedures, as well as in-air filters and building ducts in hospitals with COVID-19 patients [11, 12, 13]. Although the predominant mode of transmission is via respiratory droplets, these studies and others have built a strong argument regarding the potential for airborne transmission.

Having a complete understanding of the mechanism of transmission is essential to build a consensus for the choice of facial respiratory protective equipment when providing care to persons with COVID-19. Increasingly, most jurisdictions now require healthcare workers to wear a fit-tested, seal-checked N95 respirator (or approved equivalent) when providing direct care to – or interacting with – a suspected, probable or confirmed case of COVID-19, including during AGMPs. Unlike surgical masks, respirators protect the wearer by filtering the air and fitting closely on the face to filter out particles, including viruses. They can also prevent the wearer from spreading pathogens by containing droplets and particles from their breath. In fact, respirators particularly reduce the wearer's exposure to airborne particles and a tight-fitted respirator is able to filter at least 95% of particles or pathogens measuring a median of 0.3 µm [14, 15, 16]. As the use of respirators become more and more popular in long-term care settings, clear guidelines are needed for their appropriate use. In this Editorial, I look at the key properties of a suitable respirator and the appropriate use of respirators for airborne precautions in long-term care settings.

According to the United States Centers for Disease Control and Prevention (CDC), respirators can provide different levels of protection depending on the type and how they are used. A well-fitted N95 respirator that is approved by the National Institute for Occupational Safety & Health (NIOSH) is considered to provide a good level of protection. Other types (e.g., N99, N100, P95, P99, P100, R95, R99, and R100) also offer comparable or even better protection than an N95 respirator [17]. Let's look at some of the criteria that long-term care homes must consider when choosing a respirator:

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(1) *Filtration efficiency* – The respirator must be made of materials (e.g., polypropylene), which should consist of several layers with the ability to filter out tiny particles. These materials are typically non-woven and sometimes carry an electrostatic charge, which attracts tiny particles and traps them in the filter. N95 respirators, e.g., are thought to filter out 95% of particles that are 0.3 µm in size [17].

(2) *Fit* – Fit is critical to the level of protection offered by respirators [18]. For all respirators to provide the expected protection, they must fit the wearer's face, i.e., the respirator must form a firm seal around the wearer's nose, mouth, and chin that conforms as closely as possible to the contours of the face. A fit evaluation will require the wearer to feel on his or her face if air is coming out of any gaps after wearing the respirator. Following exhalation, if jets of air are felt coming out, it means the respirator doesn't fit well. Long-term care homes must ensure that every employee that is required to use a respirator must undergo a formal fit test. Fit testing uses a test agent, either qualitatively detected by the wearer's sense of taste, smell, or involuntary cough (irritant smoke), or quantitatively measured by an instrument to verify the respirator fit.

(3) *Comfort* – If a respirator is uncomfortable (able to cause soreness or skin breakdown especially around the nose), it doesn't matter how efficient it is, it will not be used properly as the wearer may have to adjust it repeatedly or remove it more frequently, which may increase the risk of self-contamination. To be functional, a respirator should be breathable, easy to put on and take off, and wearable for long periods of time.

Once the right respirator is selected, it must be used appropriately. Ideally, in acute care settings, patients that are placed under airborne precautions are often cared for in negative pressure rooms – also known as airborne infection isolation rooms (AIIR). A single-occupancy patient care room equipped with a special air handling (negative pressure) and ventilation system which is used to isolate persons with a suspected or confirmed airborne infectious disease in order to contain the transmission of infectious agents inside the isolation room. Staff typically don PPE in the corridor and entry into the AIIR is through an anteroom (if available). To doff the PPE (including N95 respirators), the staff would move from the isolation room to the anteroom with the door between the isolation room and anteroom closed and doff PPE in the anteroom [19]. After doffing, staff will then open the door leading to the corridor and exit the anteroom.

As N95 respirators continue to be used for potential airborne precautions in the absence of ideal airborne infection isolation conditions, it is essential that a clear guideline is established for their usage under these circumstances. Particularly, it is critical to establish where to don or doff the respirator to avoid potential airborne exposure. Also, N95 respirators are often considered uncomfortable for regular or prolonged use, and misuse of the respirator because of discomfort could lead to inadvertent face contamination, thus negating the potential protective benefits [20].

To wear the respirator properly, the wearer needs to position the respirator in one hand with the nose piece at the fingertips and the headbands hanging below the hand. Next, the wearer needs to hold the respirator under the chin with the nosepiece up and pull the top strap (on double strap respirators) over to the upper area of the back of the head, and the bottom strap positioned around the neck below the ears without crisscrossing the straps. It is essential to place fingertips from both hands at the top of the metal nose clip (if present) and slide the fingertips down both sides of the metal strip to mould the nose area to the shape of your nose and perform a seal check. While all respirators provide some level of protection, properly fitting respirators provide the highest level of protection.

Once used, it is assumed that the respirator could be potentially contaminated. Therefore, utmost care is required in the doffing process. Taking off the respirator (in the absence of an anteroom) will require the wearer to move away from the patient care area. Tilt head forward and pull the bottom strap over the back of the head, followed by the top strap, without touching the respirator. Discard respirator in waste container by touching only the strap. Hand hygiene needs to be performed for 20 seconds after doffing the respirator.

Together, considering that the faces of individuals are different, and respirators also come in different shapes and forms, once respirators with the right filtration efficiency are chosen, facilities must have different options of respirators for their employees in order to create possibilities for the right fit and comfort. Employees must wear the properly fitted respirator when required, and must receive education on seal-check and the effective donning and doffing of respirators. When used as an airborne infection control precaution, facility infection prevention and control teams must clarify where to don or doff respirators even in the absence of an airborne infection isolation capacity.

REFERENCES

1. Luo, L., Liu, D., Liao, X., Wu, X., Jing, Q., Zheng, J., et al. (2020). Modes of contact and risk of transmission in COVID-19 among close contacts (pre-print). *MedRxiv*. doi:10.1101/2020.03.24.20042606.
2. Burke, R.M., Midgley, C.M., Dratch, A., Fenstersheib, M., Haupt, T., Holshue, M., et al. (2020). Active Monitoring of Persons Exposed to Patients with Confirmed COVID-19 — United States, January–February 2020. *MMWR Morb Mortal Wkly Rep*, 69, 245-6.
3. World Health Organization (2014). Infection prevention and control of epidemic- and pandemic-prone acute respiratory infections in health care. *WHO*. Available: www.who.int/csr/bioriskreduction/ infection_control/publication/en/.
4. BC Center for Disease Control (2020). Coronavirus (COVID-19); Aerosol Generating Medical Procedures (AGMP). http://www.bccdc.ca/Health-Professionals-Site/Documents/AGMPs_requiring_N95.pdf

5. World Health Organization (2020). Advice on the use of masks in the context of COVID-19. Interim guidance. WHO, available at https://www.who.int/publications/i/item/advice-on-the-use-of-masks-in-the-community-during-home-care-and-in-healthcare-settings-in-the-context-of-the-novel-coronavirus-(2019-ncov)-outbreak).
6. World Health Organization (2020). Transmission of SARS-CoV-2: implications for infection prevention precautions. Scientific Brief. 9 July 2020.
7. Duval, D., Palmer, J.C., Tudge, I., Peace-Smith, N. O., Connell, E., Bennett, A et al. (2022). Long distance airborne transmission of SARS-CoV-2: rapid systematic review. *BMJ*, 377: e068743 doi:10.1136/bmj-2021-068743.
8. Eichler, N., Thornley, C., Swadi, T et al. (2021). Transmission of severe acute respiratory syndrome coronavirus 2 during border quarantine and air travel, New Zealand (Aotearoa). *Emerging Infect Dis.* https://doi.org/10.3201/eid2705.210514.
9. Johansson, M.A., Quandelacy, T.M., Kada, S., et al. (2021). SARS-CoV-2 transmission from people without COVID-19 symptoms. JAMA Netw Open, 4(1):e2035057.
10. Bulfone, T.C., Malekinejad, M., Rutherford, G.W., Razani, N. (2021). Outdoor transmission of SARS-CoV-2 and other respiratory viruses: a systematic review. *J Infect Dis*, 223, 550-561.
11. Van Doremalen, N., Bushmaker, T., Morris, D.H., et al (2020). Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. *New Engl J Med.*, 382, 1564-1567.
12. Lednicky, J.A., Lauzard, M., Fan, Z.H., et al. (2020). Viable SARS-CoV-2 in the air of a hospital room with COVID-19 patients. *Int J Infect Dis.*, 100, 476-482.
13. Nissen, K., Krambrich, J., Akaberi, D., et al. (2020). Long-distance airborne dispersal of SARS-CoV-2 in COVID-19 wards. *Sci Rep.*, 10, 1-9.
14. National Institute for Occupational health and Safety. How to Properly Put on and Take off a Disposable Respirator. DHHS (NIOSH) Publication No. 2010-133.
15. Chung, S.J., Ling, M.L, Seto, W.H., et al. (2014). Debate on MERS-CoV respiratory precautions: Surgical mask or N95 respirators? *Singapore Med J*, 55, 294-7.
16. MacIntyre, C.R., Wang, Q., Cauchemez, S., et al. (2011). 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 Other Respir Viruses*, 5,170-9.
17. Centers for Disease Control and Prevention (CDC). Types of Masks and Respirators. Updates of January 28, 2022. https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/types-of-masks.html.
18. O'Kelly, E., Arora, A., Pirog, S., Ward, J., Clarkson, P.J. (2021) Comparing the fit of N95, KN95, surgical, and cloth face masks and assessing the accuracy of fit checking. *PLoS ONE*, 16(1): e0245688.
19. National Institute for Occupational Safety and Health (NIOSH). NIOSH guide to the selection and use of particulate respirators. Atlanta: US Centers for Disease Control and Prevention; 1996. Available: www.cdc.gov/niosh/docs/96-101/.
20. Degesys, Nida, F., et al. (2020). Correlation Between N95 Extended Use and Reuse and Fit Failure in an Emergency Department. *JAMA, 324(1):94-96.*