February 16, 2020

Selection of Protective PPE for Nurses and Other Health Care Workers Caring for Patients with COVID-19

As of February 12, 2020, the U.S. Centers for Disease Control and Prevention (CDC) recommends, among other measures, that patients with suspected or confirmed COVID-19 should be isolated in a negative pressure isolation room. Nurses and other health care workers entering the isolation room to provide care to the patient should follow standard, contact, and airborne precautions, according to the CDC, which includes the following personal protective equipment (PPE): gloves, gowns, respiratory protection at least as protective as a fit-tested NIOSH-certified disposable N95 filtering facepiece respirator, and eye protection such as goggles or a disposable face shield.

However, the CDC's PPE recommendations are not as protective as they should be. Much is still unknown about COVID-19 and the virus that causes it, SARS-CoV-2. **In emerging infectious disease events like COVID-19, it is of the utmost importance that health care employers and public health agencies follow the precautionary principle—we cannot wait until we know for certain that something is harmful before action is taken to protect people's health**. Health care employers must implement the fullest protections, including isolating both possible and confirmed COVID-19 cases in negative pressure rooms, providing protective PPE, and ensuring that COVID-19 patients are 1:1 or cohorted assignments, in order to ensure that health care workers maintain their right to a safe and healthy workplace and to prevent the continued spread of COVID-19.

Given the central role that health care facilities played in the spread of both Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS), the recent reports of over 1700 health care workers infected with COVID-19 in China underlines the importance of U.S. health care facilities providing the highest level of protection to nurses and other health care workers.[2,3]

---

1 Please note that there are other weaknesses in the CDC's "Interim Infection Prevention and Control Recommendations for Patients with Confirmed 2019 Novel Coronavirus (2019-nCoV) or Persons Under Investigation for 2019-nCoV in Health care Settings." This document deals only with PPE.

Considerations for selecting PPE for nurses and other health care workers caring for patients with COVID-19:

There are three possible transmission pathways that viruses, especially those that cause respiratory symptoms, can follow: contact (direct/indirect), droplet, and aerosol transmission. There is currently no available evidence regarding the transmission pathway for SARS-CoV-2/COVID-19. SARS-CoV-2/COVID-19 is similar to SARS-CoV and, to a lesser degree, MERS-CoV. There is sufficient evidence to indicate that direct and indirect contact, droplet, and aerosol transmission are important to the transmission of both SARS-CoV and MERS-CoV.

Consideration of the potential for each transmission pathway, in the context of the precautionary principle, informs PPE selection.

1. **Transmission via contact (direct and indirect):** Contact transmission can occur through direct contact where the microorganism is transferred from one infected person to another. It can also occur through indirect contact via a contaminated object or surface.
    a. **Consideration of the available evidence:**
        i. Direct contact is likely to be involved in the spread of any virus with respiratory symptoms, including SARS-CoV-2/COVID-19.
        ii. Indirect contact: Researchers conducted a literature review on role of fomites (indirect contact) in transmission of MERS-CoV and SARS CoV: "There is a general perception that enveloped viruses, such as influenza and human coronaviruses including MERS-CoV and SARS-CoV, have a very limited capacity to survive on dry surfaces. However, several studies suggest that SARS-CoV, MERS-CoV and influenza virus have the capacity to survive on dry surfaces for a sufficient duration to facilitate onward transmission."[4]
            1. "SARS-CoV and MERS-CoV appear to have an unusual capacity to survive on dry surfaces compared with other human coroanviruses (229E, OC43, and NL63). SARS-CoV...survived for more than six days when dried on to Petri dishes compared with human coronavirus HCoV-229E, which survived for less than 72 h. Although data are limited, it appears that MERS-CoV may survive on surfaces for longer than most human coronaviruses."[4]
            2. Capacity to survive on wide range of porous and non-porous materials including metals, plastics, woven and non-woven fabrics, paper, wood, glass, stethoscopes, tissue, Formica, bank notes, tiles, eggs, feathers, and soft toys. Includes PPE such as gloves, gowns, and respirators.[4]
    b. **Level of PPE to prevent direct/indirect contact transmission:** Given the lack of information about SARS-CoV-2 and what is known about SARS-CoV and MERS-CoV, ensuring that nurses and other health care workers have all body surfaces and clothing covered is important. **Recommendation: coveralls that are impervious to viral penetration (ASTM F1671/ISO 16604 or similar) plus PAPR**.
        i. Basic isolation gowns, as recommended by the CDC, are insufficient protection for the following reasons:
            1. Isolation gowns leave parts of the health care worker's skin and clothing vulnerable to exposure. A recent study found that after doffing PPE (gloves, face mask, and gown), 21% of bare hand samples, 11% of scrub samples, and 7% of face samples showed contamination with viral particles matching the infected patient receiving care.[5] In an emergent infectious disease event, this is an unacceptable risk.

2. Isolation gowns may not meet standards for preventing viral penetration (ASTM F1671/ISO 16604 or similar).

2. **Transmission via respiratory droplets:** Droplet transmission generally occurs when respiratory droplets transmit infection from one person to the mucous tissues of another person (e.g., someone coughing in another person's face).

   a. **Consideration of the available evidence:**

      i. Respiratory droplets are likely to be involved in the spread of any virus with respiratory symptoms, including SARS-CoV-2/COVID-19.

   b. **Level of PPE to prevent respiratory droplet transmission:** Given the lack of information about SARS-CoV-2 and what is known about SARS-CoV and MERS-COV, ensuring that nurses and other health care workers have all body surfaces and clothing covered is important. **Recommendation: coveralls that are impervious to viral penetration (ASTM F1671/ISO 16604) plus powered air-purifying respirator (PAPR)**.

3. **Transmission via respiratory aerosols:** Aerosol transmission describes the current understanding of how aerosols (particles suspended in the air) behave.[2] Respiratory symptoms such as coughing and sneezing create a wide range of particle sizes. Particles can also be created by breathing and talking. The fate of these particles is complex and dependent on many factors, including liquid in the particle evaporates and shrinks particles to 50% of their original size within a second of release, some particles impact onto surfaces, some particles remain suspended in air for long periods of time, some particles are dispersed by air currents, other particles settle on surfaces due to gravity. Inhalation of aerosols can occur near the point of generation and further from the point of generation (after aerosols have diffused). There are no hard and fast rules for safe distances.[6]

   a. **Consideration of the available evidence:**

      i. Aerosol transmission has been implicated in epidemiologic modeling and other studies of SARS-CoV[7,8] and of MERS-CoV.[9,10]

      ii. "Coronaviruses especially have the ability to survive for long periods in aerosols. …One study has evaluated the survival of MERS-CoV aerosols, find a 7% reduction over 10 min (at 40% RH). By contrast, H1N1 suffered a 95% reduction over the same time period, suggesting that influenza virus may be less robust as an aerosol than coroanviruses." [4]

   b. **Level of PPE to prevent respiratory aerosol transmission:** Given the lack of information about SARS-CoV-2 and what is known about SARS-CoV and MERS-COV, ensuring that nurses and other health care workers have all body surfaces and clothing covered is important. Respiratory protection is necessary. **Recommendation: coveralls that are impervious to viral penetration (ASTM F1671/ISO 16604) plus powered air-purifying respirator (PAPR)**.

      i. The combination of goggles plus an N95 respirator, as recommended by the CDC, is strongly not recommended by OSHA.[11] Goggles may disrupt the seal of the N95 respirator, undermining the protection that should be provided.

      ii. Goggles plus an N95 respirator leaves portions of the face uncovered and vulnerable to exposure.

      iii. Given the expected/existing global shortage of N95s and the CDC's recommendations to conserve stock and extend/reuse N95 respirators, PAPRs are more protective because they can be disinfected. SARS-CoV has been shown (via a surrogate virus) to survive on N95 respirator material for extended periods.[12] Reuse of N95 respirators may pose an additional exposure hazard.

References

1 U.S. Centers for Disease Control and Prevention, “Interim Infection Prevention and Control Recommendations for Patients with Confirmed 2019 Novel Coronavirus (2019-nCoV) or Persons Under Investigation for 2019-nCoV in Health care Settings.” Feb 12, 2020, retrieved from https://www.cdc.gov/coronavirus/2019-nCoV/hcp/infection-control.html.

2 Center for Infectious Disease Research and Policy (Feb 14, 2020), “COVID-19 sickens over 1,700 health workers in China, killing 6.” Retrieved from http://www.cidrap.umn.edu/news-perspective/2020/02/covid-19-sickens-over-1700-health-workers-china-killing-6.

3 Kutter, J.S., et al., Transmission routes of respiratory viruses among humans. Current Opinion in Virology, 2018. 28: p. 142-151.

4 Otter, J.A., et al., Transmission of SARS and MERS coronaviruses and influenza virus in health care settings: the possible role of dry surface contamination. Journal of Hospital Infection, 2016. 92(3): p. 235-250.

5 Phan, L.T., et al., Respiratory viruses on personal protective equipment and bodies of health care workers. Infection Control & Hospital Epidemiology, 2019. 40(12): p. 1356-60.

6 Jones, R.M. and L.M. Brosseau, Aerosol transmission of infectious disease. Journal of Occupational and Environmental Medicine, 2015. 57(5): p. 501-8.

7 Christian, M.D., et al., Possible SARS Coronavirus Transmission during Cardiopulmonary Resuscitation. 2004. 10(2): p. 287-293.

8 Yu, I.T.S., et al., Evidence of Airborne Transmission of the Severe Acute Respiratory Syndrome Virus. New England Journal of Medicine, 2004. 350(17): p. 1731-1739.

9 Xiao, S., et al., A study of the probable transmission routes of MERS-CoV during the first hospital outbreak in the Republic of Korea. Indoor Air, 2018. 28(1): p. 51-63.

10 Lee, J., et al., Quantity, Size Distribution, and Characteristics of Cough-generated Aerosol Produced by Patients with an Upper Respiratory Tract Infection. Aerosol and Air Quality Research, 2019. 19: p. 840-53

11 U.S. Occupational Safety and Health Administration. OSHA Technical Manual, Section VIII: Chapter 2, Respiratory Protection. Retrieved from https://www.osha.gov/dts/osta/otm/otm_viii/otm_viii_2.html.

12 Casanova, L., et al., Coronavirus Survival on Health care Personal Protective Equipment. Infection Control & Hospital Epidemiology, 2010. 31(05): p. 560-561.