California Nurses Association
National Nurses United
OUR PATIENTS. OUR UNION. OUR VOICE.

OAKLAND
155 Grand Avenue
Suite 100
Oakland CA 94612
phone: 800-287-5021

SACRAMENTO
Government Relations
980 9th Street
Suite 700
Sacramento CA 95814
phone: 916-446-5019
fax: 916-446-3880

Via Electronic Mail

January 9, 2023

Chief Jeff Killip
Division of Occupational Safety and Health
1515 Clay Street, Suite 1901
Oakland, CA 94612

Deputy Chief Eric Berg
Division of Occupational Safety and Health
1515 Clay Street, Suite 1901
Oakland, CA 94612

RE: Ebola Virus Disease Guidance in Hospital Settings

Dear Chief Killip and Deputy Chief Berg:

As the largest union of direct care nurses in California, representing more than 100,000 registered nurses in our state, California Nurses Association/National Nurses United (CNA) writes to reiterate our concerns with the recent Ebola Virus Disease (EVD) guidance published by California Department of Public Health (CDPH) and CDPH's interpretation of current Division of Occupational Safety and Health (Cal/OSHA) guidance on EVD. We appreciate that Cal/OSHA discussed these concerns with us earlier this week and provide below our detailed analysis of CDPH's EVD guidance.

As you know, CDPH recently issued guidance in All Facilities Letters (AFL) 22-24 for hospitals on EVD information and preparedness as well as "Interim Guidance on Personal Protective Equipment to by Used by Healthcare Workers in the Inpatient Hospital Setting During Management of Patients with Suspected or Confirmed Ebola Virus Disease (EVD) in California" (hereinafter "CDPH Interim EVD PPE Guidance"). CDPH purports that AFL 22-24 and the CDPH Interim EVD PPE Guidance are meant to align with Cal/OSHA's current EVD guidance for hospitals as well as recently issued Centers for Disease Control and Preventions' (CDC) guidance on EVD in U.S. health care settings. However, CDPH's interpretation of Cal/OSHA's EVD guidance inappropriately downgrades the protections for health care workers caring for patients with suspected or confirmed cases of EVD and inappropriately creates two-tiered, symptoms-based protections for health care workers.

As the current EVD outbreak in Uganda continues, California's hospitals must use the precautionary principle when preparing for potential EVD exposure in our state. To this end, CNA urges Cal/OSHA to clarify that CDPH's Interim EVD PPE Guidance does not align with Cal/OSHA's 2014 EVD guidance. Moreover, we urge Cal/OSHA to make its 2014 EVD guidance permanent. Below, we provide more detailed analysis on our concerns regarding CDPH's recent EVD guidance. In Appendix A, we additionally have included a list of selected literature on personal protective equipment (PPE) necessary for health care workers treating patients with suspected or confirmed EVD.

I. Cal/OSHA must not defer to CDPH to establish EVD protections for health care workers.

As the state agency charged with protecting workers from occupational illness, Cal/OSHA's guidance on EVD must adhere to the highest levels of protections for California's health care workers. While CDPH and CDC's recent EVD guidance for health care workers may be well intentioned, Cal/OSHA must not relinquish its duty to establish standards to protect workers from significant risks of workplace injury and illness to other regulators.

Importantly, Cal/OSHA, not CDPH, has the expertise and authority to interpret and provide occupational safety and health standards of EVD. As the state body charged with ensuring the health and safety of California's workers, Cal/OSHA must implement strong, protective standards for health care workers who may be exposed to dangerous and deadly infectious disease, such as EVD. CDPH, in contrast, does not have the expertise in occupational safety and health and has different priorities than Cal/OSHA. Unlike Cal/OSHA, CDPH is charged with developing guidance on public health considerations and may prioritize other considerations above worker health and safety.

As described below, CDPH's Interim EVD PPE Guidance rolls back the protections for health care workers recommended in Cal/OSHA's 2014 EVD guidance. Cal/OSHA must not acquiesce to other regulatory agencies' attempts to determine workplace safety and health standards.

II. Cal/OSHA provides a single level of PPE recommendations for health care workers caring for potential or confirmed EVD cases, but CDPH dangerously recommends two tiers of protections.

CNA is concerned that CDPH, in its EVD guidance, provides a two-tiered system of protections for health care workers based on patient symptoms, which would unnecessarily put

health care workers at risk of exposure to or infection from EVD. CDPH's EVD guidance would create two levels of personal protective equipment (PPE) and other protective measures for health care workers based on patient symptoms. However, based on the current available data on EVD, a symptoms-based system of occupational protections for health care workers does not make sense.

CDPH's symptom-based distinction of protections inappropriately places health care workers at risk of EVD transmission. The precautionary principle demands that we should not downgrade the PPE ensemble for health care workers caring for suspected or confirmed EVD cases based on patient symptoms. For workers caring for suspected or confirmed EVD patients experiencing "wet" symptoms, CDPH guidance is essentially the same as Cal/OSHA's guidance for PPE albeit Cal/OSHA specifies a few additional details than the CDPH guidance.[1] However, CDPH creates a second, lower tier of protections for workers caring for EVD patients experiencing "dry" symptoms. Specifically, CDPH lowers recommendations for respiratory protection for health care workers caring for patients with dry symptoms to an N95 respirator plus a face shield. Additionally, CDPH states in its EVD guidance that it agrees with CDC guidance, and CDC's guidance creates an even lower two-tier standard than CDPH's. CDC's guidance provides no respiratory protection for health care workers caring for patients with dry symptoms, which places health care workers at risk of infection with EVD.[2]

[1] For example, Cal/OSHA also specifies with respect to the PPE ensemble for health care workers caring for suspected or confirmed EVD patients that seams on coveralls must be protected against passage of fluids, that boots must not create a slipping hazard, and that PAPRs must be used by employees cleaning Ebola-contaminated surfaces.

[2] CDC's guidance recommends the following PPE for patients with "dry" symptoms: single-use (disposable) fluid-resistant gown that extends to at least mid-calf or single-use (disposable) fluid-resistant coveralls without integrated hood; single-use (disposable) full face shield; single-use (disposable) facemask; single-use (disposable) gloves with extended cuffs.

For patients with "wet" symptoms: single-use (disposable) impermeable gown OR single-use (disposable) impermeable coverall; a powered air-purifying respirator OR a NIOSH-certified N95 respirator in combination with a single-use (disposable) surgical hood extending to shoulders and single-use (disposable) full face shield; single-use (disposable) examination gloves with extended cuffs; single-use (disposable) boot covers, and a single-use (disposable) apron.

U.S. Centers for Disease Control and Prevention, "For U.S. Healthcare Settings: Donning and Doffing Personal Protective Equipment (PPE) for Evaluating Persons Under Investigation (PUIs) for Ebola Who Are Clinically Stable and Do Not Have Bleeding, Vomiting, or Diarrhea," page last reviewed October 20, 2022, https://www.cdc.gov/vhf/ebola/healthcare-us/ppe/guidance-clinically-stable-puis.html.

U.S. Centers for Disease Control and Prevention, "Guidance on Personal Protective Equipment (PPE) To Be Used By Healthcare Workers during Management of Patients with Confirmed Ebola or Persons under Investigation (PUIs) for Ebola who are Clinically Unstable or Have Bleeding, Vomiting, or Diarrhea in U.S. Healthcare Settings, Including Procedures for Donning and Doffing PPE," page last reviewed October 20, 2022, https://www.cdc.gov/vhf/ebola/healthcare-us/ppe/guidance.html.

Creating tiers of PPE ensembles in EVD guidance places workers at risk of EVD exposure and infection for several reasons. Downgrading or removing respiratory protection for workers caring for patients with dry symptoms is dangerous because EVD patients with dry symptoms can transmit the virus and infection can occur with exposure to ten or fewer viral particles.[3] Additionally, while onward transmission has been found more common from primary cases with wet symptoms in an outbreak investigation, researchers found that **one-third** of households with primary cases with dry symptoms still had onward transmission.[4] While there is some documentation that viral load of a patient is highest closest to death, it is possible that increased transmission during the wet symptom period is in part due to the increased need for hands on care from family members, contributing to increased transmission.

Moreover, symptoms-based levels of protections are misguided because the transition from dry to wet symptoms for EVD cases is not standard in time or symptoms. A literature review of EVD studies found that the mean time from onset of dry to wet symptoms was 6.05 days, plus or minus 2.38 days.[5] In other words, EVD patient symptoms can transition from dry to wet in a very short period such that symptoms-based downgrading of PPE ensembles place health care workers at risk of exposure.

Further, aerosol transmission of Ebola virus can occur through a variety of situations during patient care of patients with EVD, including during dry symptoms, thus strong, optimal protections for health care workers, including PAPRs, must be maintained throughout the patient's disease course.

Aerosol transmission of Ebola virus can occur during:

---

[3] Osterholm, M.T., K.A. Moore, et al., "Transmission of Ebola Viruses: What We Know and What We Do Not Know," mBio, 2015, 6(2), https://doi.org/10.1128/mBio.00137-15.

Petrosillo, N., E. Nicastri, et al., "Ebola virus disease complicated with viral interstitial pneumonia: a case report," BMC Infectious Diseases, 2015, 15:432, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4608352/.

Morawska, L., G.R. Johnson, et al., "Size distribution and sites of origin of droplets expelled from the human respiratory tract during expiratory activities," J Aerosol Science, 2009, 40(3), https://doi.org/10.1016/j.jaerosci.2008.11.002

[4] Glynn et al., "Variability in Intrahousehold Transmission of Ebola Virus, and Estimation of the Household Secondary Attack Rate," *The Journal of Infectious Diseases*, November 2017, https://doi.org/10.1093/infdis/jix579.

[5] Velásquez et al., "Time From Infection to Disease and Infectiousness for Ebola Virus Disease, a Systematic Review," *Clinical Infectious Diseases*, June 2015, https://doi.org/10.1093/cid/civ531.

- Aerosol-generating procedures performed on patients, which are often unpredictable and may be needed at any time during patient care of patients with Ebola virus disease.[6, 7, 8]
- Cleaning tasks, including changing of bed linens. [9, 10, 11]
- Doffing of contaminated PPE.[12, 13, 14]
- Flushing toilets, which can generate aerosols containing pathogens in flushed waste and those aerosols can remain for longer than thirty minutes post-flush. [15, 16, 17, 18]
    - Flushometer toilets commonly found in health care settings can significantly increase the amount of aerosol compared to gravity-fed toilets.[19]
    - Human excreta, including stool and vomitus, from bedpans are often disposed of manually by health care workers into toilets.[20]

---

[6] O'Neil, C., J. Li, et al., "Characterization of Aerosols Generated During Patient Care Activities," Clinical Infectious Diseases, 2017, 65(8): 1335-41, https://doi.org/10.1093/cid/cix535.

[7] Klompas, M., M. Baker, and C. Rhee, "What Is an Aerosol-Generating Procedure?," JAMA Surgery, Dec 15, 2020, https://jamanetwork.com/journals/jamasurgery/article-abstract/2774161.

[8] Judson, S.D. and V.J. Munster, "Nosocomial Transmission of Emerging Viruses via Aerosol-Generating Medical Procedures," Viruses, 2019, 11(10): 940, https://doi.org/10.3390/v11100940.

[9] Zemouri, C., H. de Soet, et al., "A scoping review on bio-aerosols in healthcare and the dental environment," PLOS ONE, 2017, https://doi.org/10.1371/journal.pone.0178007.

[10] Handorean, A., C.E. Robertson, et al., "Microbial aerosol liberation from soiled textiles isolated during routine residuals handling in a modern health care setting," Microbiome, 2015, 3(72), https://doi.org/10.1186/s40168-015-0132-3.

[11] Owen, L. and K. Laird, "The role of textiles as fomites in the healthcare environment: a review of the infection control risk," PeerJ, Aug 25, 2020, https://peerj.com/articles/9790/.

[12] Obuhoro, O. and R.M. Jones, "Assessing patterns of body contamination after personal protective equipment removal among health care workers: A scoping review," AJIC, Sept 16, 2022, https://doi.org/10.1016/j.ajic.2022.09.008.

[13] Andonian, J., S. Kazi, et al., "Effect of an Intervention Package and Teamwork Training to Prevent Healthcare Personnel Self-contamination During Personal Protective Equipment Doffing," Clinical Infectious Diseases, 2019, 69: S248-55, https://doi.org/10.1093/cid/ciz618.

[14] Phan, L.T., D. Maita, et al., "Personal protective equipment doffing practices of healthcare workers," JOEH, 2019, https://doi.org/10.1080/15459624.2019.1628350.

[15] Johnson, D.L., K.R. Mead, et al., "Lifting the lid on toilet plume aerosol: A literature review with suggestions for future research," AJIC, 2013, 41(3): 254-8, https://doi.org/10.1016/j.ajic.2012.04.330.

[16] Barker, J. and M.V. Jones, "The potential spread of infection caused by aerosol contamination of surfaces after flushing a domestic toilet," J Applied Microbiology, 2005, https://doi.org/10.1111/j.1365-2672.2005.02610.x.

[17] Johnson, D., R. Lynch, et al., "Aerosol Generation by Modern Flush Toilets," Aerosol Sci and Tech, 2013, 47(9), https://doi.org/10.1080/02786826.2013.814911.

[18] Knowlton, S.D., C.L. Boles, et al., "Bioaerosol concentrations generated from toilet flushing in a hospital-based patient care setting," Antimicrobial Resistance & Infection Control, 2018, https://doi.org/10.1186/s13756-018-0301-9.

[19] Boles, C., G. Brown, and M. Nonnenmann, "Determination of murine norovirus aerosol concentration during toilet flushing," Scientific Reports, 2021, https://doi.org/10.1038/s41598-021-02938-0.

[20] Hallam, C., A. Denton, and G. Thirkell, "COVID-19: considerations for the safe management and disposal of human excreta," Infection Prevention in Practice, 2020, 2(4), https://doi.org/10.1016/j.infpip.2020.100085.

  - Patients with Ebola virus disease may generate up to nine liters of liquid waste a day.[21]
- Respiratory aerosol generation by infected patients.
  - Animal and human data show that aerosol transmission of Ebola virus is possible and can lead to infection and fatal disease. [22, 23, 24, 25]
  - Cough is one of the most common symptoms in patients with Ebola virus disease and virus has been detected in respiratory tract samples from patients prior to wet symptom onset. [26, 27, 28]
- Gastrointestinal aerosol generation by infected patients.
  - Vomiting can generate aerosols that can contain Ebola virus.[29]
  - Filoviruses can survive when suspended in the air up to at least 90 minutes.[30]

Additionally, asymptomatic EVD cases have been documented, which renders symptoms-based levels of occupational protections inappropriate. For example, one study documented viral RNA samples indicative of possible EVD transmission several days before the onset of obvious EVD symptoms in a pregnant woman.[31] Another study found that 25 percent of individuals in a Sierra Leone village were infected with EVD but had no symptoms and concluded that it is likely that some transmission occurs from minimally symptomatic cases.[32]

---

[21] Lowe, J.J., S.G. Gibbs, et al., "Nebraska Biocontainment Unit perspective on disposal of Ebola medical waste," AJIC, 2014, 42(12), https://doi.org/10.1016/j.ajic.2014.10.006.

[22] Weingartl H.M., Embury-Hyatt C., Nfon C., Leung A., Smith G., Kobinger G. Transmission of Ebola virus from pigs to non-human primates. Sci. Rep. 2012;2:4. doi: 10.1038/srep00811.

[23] Petrosillo, N., E. Nicastri, et al., "Ebola virus disease complicated with viral interstitial pneumonia: a case report," BMC Infectious Diseases, 2015, 15:432, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4608352/.

[24] Lalle, E., M. Biava, et al., "Pulmonary Involvement during the Ebola Virus Disease," Viruses, 2019, 11(9): 780, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6784166/.

[25] Jones, R.M. and L.M. Brosseau, "COMMENTARY: Ebola virus transmission via contact and aerosol—a new paradigm," CIDRAP, 2014, https://www.cidrap.umn.edu/ebola/commentary-ebola-virus-transmission-contact-and-aerosol-new-paradigm.

[26] Lalle, E., M. Biava, et al., "Pulmonary Involvement during the Ebola Virus Disease," Viruses, 2019, 11(9): 780, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6784166/.

[27] Petrosillo, N., E. Nicastri, et al., "Ebola virus disease complicated with viral interstitial pneumonia: a case report," BMC Infectious Diseases, 2015, 15:432, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4608352/.

[28] Petrosillo, N., E. Nicastri, et al., "Ebola virus disease complicated with viral interstitial pneumonia: a case report," BMC Infectious Diseases, 2015, 15:432, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4608352/.

[29] Tun-Thompson, G., D.A. Libera, et al., "Aerosolization of a Human Norovirus Surrogate, Bacteriophage MS2, during Simulated Vomiting," PLOS ONE, 2015, https://doi.org/10.1371/journal.pone.0134277.

[30] Piercy, T.J., S.J. Smither, et al., "The survival of filoviruses in liquids, on solid substrates and in a dynamic aerosol," J Applied Microbiology, 2010, 109(5): 1531-9, https://doi.org/10.1111/j.1365-2672.2010.04778.x.

[31] Akerlund et al., "Shedding of Ebola Virus in an Asymptomatic Pregnant Woman," *New England Journal of Medicine*, June 2015, https://www.nejm.org/doi/full/10.1056/NEJMc1503275.

[32] Richardson et al., "Minimally Symptomatic Infection in an Ebola 'Hotspot': A Cross-Sectional Serosurvey," *PLOS Neglected Tropical Diseases*, November 2016, https://journals.plos.org/plosntds/article?id=10.1371/journal.pntd.0005087.

Finally, implementation of symptoms-based tiers of occupational protections is unnecessarily complicated and burdensome on infectious disease staff. To implement the two-tiered system of PPE for EVD cases, CDPH recommends that an infection preventionist or infectious disease doctor continuously assess the patient's condition to determine what PPE level is needed for the health care workers who are caring for the patient. In contrast, because Cal/OSHA provides one set of guidance for health care workers who care for any patient with suspected or confirmed EVD, an infectious disease doctor's time does not have to be occupied with continually assessment of whether a patient has wet or dry symptoms.

III. Cal/OSHA must not permit flexibility in PPE protections provided by health care employers to workers caring for EVD patients.

In addition to our concerns regarding CDPH's symptoms-based recommendations on PPE for EVD cases, we are concerned that CDPH's guidance allows employers flexibility in PPE provision and supplies.

First, the CDC EVD guidance also provides for much weaker protections that Cal/OSHA's guidance with respect to PPE preparation and stockpiling. Cal/OSHA's 2014 EVD guidance specifies that hospitals need to prepare PAPR and PPE supplies to admit EVD patients, while, on the other hand, CDPH directs hospitals to prepare to house a patient under investigation (PUI) for only 12-24 hours and to plan for transfer to another facility.

Additionally, CDPH's guidance states that it agrees with both Cal/OSHA's 2-14 EVD guidance and the CDC's recent EVD guidance. However, the CDC's guidance is weaker in its recommended PPE protections than Cal/OSHA. CDC's guidance allows employer to provide either a gown OR a coverall for suspected EVD cases whereas Cal/OSHA requires a coverall; and CDC's guidance allows employers to provide either an N95 or a PAPR for patients with confirmed EVD or unstable PUIs whereas Cal/OSHA requires a PAPR.

Finally, while CDPH and Cal/OSHA's guidance both recommend that employees who assist with doffing EVD-contaminated PPE should use the same PPE ensemble as the workers who care for EVD patients, CDPH also refers to weaker CDC guidance on doffing. CDC guidance, unlike Cal/OSHA's guidance, recommends that workers assisting with doffing EVD-contaminated PPE wear a simple surgical mask instead of a respirator and a fluid-resistant gown or coverall but does not recommend coverage of all skin, hair, and all other parts of the workers' body.

IV. Cal/OSHA must ensure that hospitals have effective exposure management plans on EVD that include plans for PPE breaches.

CDPH and Cal/OSHA's EVD guidance differs in staffing preparations in anticipation of PPE breaches. Cal/OSHA is explicit that hospitals must prepare for possible PPE breaches by ensuring staffing that allows for a staff member experiencing a PPE breach to leave the room immediately without interrupting patient care. CDPH, in contrast, only recommends that facilities to limit the number of health care personnel entering the isolation room. Limiting the number of staff who cares for EVD patients does not ensure that a hospital effectively implements an exposure management plan.

V. Cal/OSHA should reaffirm the need for other elements of occupational safety and health protections that CDPH leaves unaddressed.

Finally, CNA is concerned with the lack of several elements of occupational safety and health protections that CDPH's EVD guidance leaves unaddressed. CDPH's EVD guidance does not include the following which Cal/OSHA includes in its EVD guidance.

- CDPH's EVD guidance does not mention employee involvement in the development of EVD exposure control plans, which Cal/OSHA's guidance requires.
- CDPH's EVD guidance does not mention the need for a written hazard control plan on EVD, which Cal/OSHA's guidance requires.
- Cal/OSHA's guidance provides significantly more details on what needs to happen after an exposure than either CDPH or CDC's EVD guidance.
- Unlike Cal/OSHA's guidance, neither CDPH nor CDC's guidance mention precautionary removal or pay and other job protections for workers who are removed from work to quarantine or isolate after an EVD exposure or infection.
- Cal/OSHA's guidance states that refresher training must be provided at least annually for workers but CDPH's guidance does not address such training.

The lack of each of these important occupational safety and health measures in CDPH's EVD guidance emphasizes the need for Cal/OSHA to reaffirm and make permanent its EVD guidance. CDPH lacks the expertise to address the most basic elements of occupational safety and health in its guidance. CDPH's attempt to determine EVD precautions for health care workers is inappropriate; Cal/OSHA is responsible for developing and enforcing California's standards for workplace safety and health, not CDPH.

VI. Conclusion.

CNA again appreciates the opportunity to discuss CDPH's EVD guidance. We urge Cal/OSHA to clarify for health care employers that Cal/OSHA's 2014 guidance not CDPH's provides the minimum requirements for health care employers in the preparation and response to EVD exposure and infection prevention and control in health care facilities.

Cal/OSHA must also act promptly to ensure that its EVD guidance is made permanent and to ensure that the requirements of the aerosol transmission disease standard and bloodborne pathogen standards permanently apply to EVD. To this end, please respond to our recommendations in by January 23, 2023. If you have any clarifying questions, you can reach me at pmaharaj@calnurses.org.

Sincerely,

Puneet Maharaj
Director of Government Relations
California Nurses Association/National Nurses United

cc: Secretary Mark Ghaly, California Health and Human Services Agency
Dr. Tomás Aragón, Director and State Public Health Officer, California Department of Public Health
Janice Prudhomme, Division of Occupational Safety & Health, Medical Unit

Appendix A

Selected Literature on Personal Protective Equipment for Ebola Virus Disease

A two-tier PPE standard for Ebola based on dry/wet symptoms is unprotective and would risk health care workers lives.

- **The transition from dry to wet symptoms isn't standard or predictable, so health care workers caring for patients with suspected or confirmed Ebola should be protected at all times.** A patient with suspected or confirmed Ebola could, at any point, suddenly develop wet symptoms or need an aerosol-generating procedure. A literature review found that the mean time from onset of dry to wet symptoms was 6.05 days, plus or minus 2.38 days.[33]

- **Cases with dry symptoms can still transmit the virus. For a virus where 10 or fewer viral particles are sufficient for infection,[34] lowering protections for health care workers is unconscionable.**
    - In an outbreak investigation, while onward transmission was more common from primary cases with wet symptoms, they found that one-third of households with primary cases with dry symptoms still had onward transmission.[35] Noting that the investigation did not go into details on transmission routes, but just looked at household transmission. There is some documentation that viral load is highest closest to death. But it is also possible that increased transmission during the wet symptom period is in part due to the increased need for hands on care from family members contributing to increased transmission.
    - One of the most common symptoms in patients with Ebola virus disease is cough (up to 49) especially during progression of the disease when viral loads in serum significantly increase.[36]
    - Ebola virus disease was detected in the pharynx in a patient prior to wet symptom onset, indicating the possibility for virus to become aerosolized during breathing, speech, coughing, and sneezing.[37,38]

---

[33] Velásquez et al., "Time From Infection to Disease and Infectiousness for Ebola Virus Disease, a Systematic Review," Clinical Infectious Diseases, June 2015, https://doi.org/10.1093/cid/civ531.

[34] Osterholm, M.T., K.A. Moore, et al., "Transmission of Ebola Viruses: What We Know and What We Do Not Know," mBio, 2015, 6(2), https://doi.org/10.1128/mBio.00137-15.

[35] Glynn et al., "Variability in Intrahousehold Transmission of Ebola Virus, and Estimation of the Household Secondary Attack Rate," The Journal of Infectious Diseases, November 2017, https://doi.org/10.1093/infdis/jix579.

[36] Lalle, E., M. Biava, et al., "Pulmonary Involvement during the Ebola Virus Disease," Viruses, 2019, 11(9): 780, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6784166/.

[37] Petrosillo, N., E. Nicastri, et al., "Ebola virus disease complicated with viral interstitial pneumonia: a case report," BMC Infectious Diseases, 2015, 15:432, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4608352/.

[38] Morawska, L., G.R. Johnson, et al., "Size distribution and sites of origin of droplets expelled from the human respiratory tract during expiratory activities," J Aerosol Science, 2009, 40(3), https://doi.org/10.1016/j.jaerosci.2008.11.002.

  - Asymptomatic cases have been documented and asymptomatic transmission is possible. For example, see Akerlund et al.,[39] which documented viral RNA samples indicative of possible transmission several days before the onset of obvious Ebola virus disease symptoms in a pregnant woman. Richardson et al. found that 25 percent of individuals in a Sierra Leone village were infected with Ebola virus but had no symptoms and concluded that it is likely that some transmission occurs from minimally symptomatic cases.[40]
- **The precautionary principle should govern protections when there are unanswered questions regarding a health hazard.**

Aerosol transmission of Ebola virus poses a threat to health care workers when providing care to patients with suspected or confirmed Ebola virus disease. Thus strong, optimal protections must be maintained. Weakening protections to a two-tier PPE standard is not protective.

- **Aerosol transmission of Ebola virus can occur during aerosol generating procedures and other work tasks.**
  - Aerosol-generating procedures can generate potentially infectious aerosols.[41,42,43]
  - Cleaning can generate potentially infectious aerosols.[44,45,46]
  - Doffing contaminated PPE can resuspend potentially infectious aerosols.[47,48,49]

---

[39] Akerlund et al., "Shedding of Ebola Virus in an Asymptomatic Pregnant Woman," New England Journal of Medicine, June 2015, https://www.nejm.org/doi/full/10.1056/NEJMc1503275.

[40] Richardson et al., "Minimally Symptomatic Infection in an Ebola 'Hotspot': A Cross-Sectional Serosurvey," PLOS Neglected Tropical Diseases, November 2016, https://journals.plos.org/plosntds/article?id=10.1371/journal.pntd.0005087.

[41] O'Neil, C., J. Li, et al., "Characterization of Aerosols Generated During Patient Care Activities," Clinical Infectious Diseases, 2017, 65(8): 1335-41, https://doi.org/10.1093/cid/cix535.

[42] Klompas, M., M. Baker, and C. Rhee, "What Is an Aerosol-Generating Procedure?," JAMA Surgery, Dec 15, 2020, https://jamanetwork.com/journals/jamasurgery/article-abstract/2774161.

[43] Judson, S.D. and V.J. Munster, "Nosocomial Transmission of Emerging Viruses via Aerosol-Generating Medical Procedures," Viruses, 2019, 11(10): 940, https://doi.org/10.3390/v11100940.

[44] Zemouri, C., H. de Soet, et al., "A scoping review on bio-aerosols in healthcare and the dental environment," PLOS ONE, 2017, https://doi.org/10.1371/journal.pone.0178007.

[45] Handorean, A., C.E. Robertson, et al., "Microbial aerosol liberation from soiled textiles isolated during routine residuals handling in a modern health care setting," Microbiome, 2015, 3(72), https://doi.org/10.1186/s40168-015-0132-3.

[46] Owen, L. and K. Laird, "The role of textiles as fomites in the healthcare environment: a review of the infection control risk," PeerJ, Aug 25, 2020, https://peerj.com/articles/9790/.

[47] Obuhoro, O. and R.M. Jones, "Assessing patterns of body contamination after personal protective equipment removal among health care workers: A scoping review," AJIC, Sept 16, 2022, https://doi.org/10.1016/j.ajic.2022.09.008.

[48] Andonian, J., S. Kazi, et al., "Effect of an Intervention Package and Teamwork Training to Prevent Healthcare Personnel Self-contamination During Personal Protective Equipment Doffing," Clinical Infectious Diseases, 2019, 69: S248-55, https://doi.org/10.1093/cid/ciz618.

[49] Phan, L.T., D. Maita, et al., "Personal protective equipment doffing practices of healthcare workers," JOEH, 2019, https://doi.org/10.1080/15459624.2019.1628350.

- Toilet flushes can generate aerosols, which can contain pathogens in flushed waste.[50,51,52] Flushometer type toilets, which are commonly found in healthcare and other institutional settings, significantly increase the amount of aerosol generated compared to gravity-fed toilets.[53] Human excreta, including stool and vomitus, from bedpans are often disposed of manually by health care workers into toilets.[54] Patients with Ebola virus disease may generate up to 9 L of liquid waste a day.[55]
  - One study found that flushing a flushometer type toilet seeded with test virus resulted in airborne virus with concentration ranging from 383 to 684 RNA copies/m^3 of air, demonstrating that viral pathogens can be aerosolized when a toilet is flushed.[56]
  - One study examined bioaerosol generation with toilet flushes in a hospital bathroom.[57] Bioaerosol concentrations when flushing fecal waste were found to be significantly greater than background concentrations, though bioaerosol concentrations did not differ significantly across time or distance from the toilet, "suggesting that aerosols generated may remain for longer than 30 min post flush." The majority of particles generated by toilet flush were 0.3 um in diameter and the particles generated included microorganisms remaining from previous uses or from fecal wastes.

- **Though evidence is not fully characterized, aerosol transmission of Ebola virus is possible even in the absence of aerosol generating procedures, which means that protections for health care workers should guard against the possibility of aerosol transmission when caring for patients with suspected or confirmed Ebola virus disease, including during both the dry and wet symptom periods.**
  - There are outbreaks where a proportion of cases had no direct or physical contact with an infected person or known infected body (6.6 percent of cases in 1976

[50] Johnson, D.L., K.R. Mead, et al., "Lifting the lid on toilet plume aerosol: A literature review with suggestions for future research," AJIC, 2013, 41(3): 254-8, https://doi.org/10.1016/j.ajic.2012.04.330.

[51] Barker, J. and M.V. Jones, "The potential spread of infection caused by aerosol contamination of surfaces after flushing a domestic toilet," J Applied Microbiology, 2005, https://doi.org/10.1111/j.1365-2672.2005.02610.x.

[52] Johnson, D., R. Lynch, et al., "Aerosol Generation by Modern Flush Toilets," Aerosol Sci and Tech, 2013, 47(9), https://doi.org/10.1080/02786826.2013.814911.

[53] Boles, C., G. Brown, and M. Nonnenmann, "Determination of murine norovirus aerosol concentration during toilet flushing," Scientific Reports, 2021, https://doi.org/10.1038/s41598-021-02938-0.

[54] Hallam, C., A. Denton, and G. Thirkell, "COVID-19: considerations for the safe management and disposal of human excreta," Infection Prevention in Practice, 2020, 2(4), https://doi.org/10.1016/j.infpip.2020.100085.

[55] Lowe, J.J., S.G. Gibbs, et al., "Nebraska Biocontainment Unit perspective on disposal of Ebola medical waste," AJIC, 2014, 42(12), https://doi.org/10.1016/j.ajic.2014.10.006.

[56] Boles, C., G. Brown, and M. Nonnenmann, "Determination of murine norovirus aerosol concentration during toilet flushing," Scientific Reports, 2021, https://doi.org/10.1038/s41598-021-02938-0.

[57] Knowlton, S.D., C.L. Boles, et al., "Bioaerosol concentrations generated from toilet flushing in a hospital-based patient care setting," Antimicrobial Resistance & Infection Control, 2018, https://doi.org/10.1186/s13756-018-0301-9.

SUDV outbreak in Sudan and 17.4 percent of cases during the 1995 Ebola virus outbreak in DRC), "thus pointing to other possible routes of transmission, e.g., human to human respiratory tract infection through droplet and aerosols."[58]

- Filovirus was detectable after suspended for 90 minutes in a dynamic aerosol.[59]

Respiratory aerosols

- Animal studies clearly show that aerosol transmission of Ebola virus is possible and can lead to infection and fatal disease. For example, one study found that placing piglets inoculated oro-nasally with Ebola virus in an open inaccessible cage system with macaques resulted in Ebola infection of all macaques.[60]
  - The authors of a review paper note, "As shown in animal studies, primary pulmonary infections could occur and cause active viral shedding from the respiratory tract, thus potentially setting up a cycle of ongoing respiratory transmission in humans."[61]
- Human data indicates that it is possible for Ebola virus to be emitted in respiratory aerosols.
  - One of the most common symptoms in patients with Ebola virus disease is cough (up to 49 percent) especially during progression of the disease when viral loads in serum significantly increase.[62]
  - Ebola virus was detected in half of saliva samples from patients.[63]
  - Ebola virus was detected in the pharynx in a patient prior to wet symptom onset.[64]
  - High viral load was detected in the bronchial aspirate of a patient presenting with interstitial pneumonia during the acute phase of the Ebola virus disease.[65]
  - Some human data suggests that Ebola virus may replicate in the lungs.[66]

---

[58] Lalle, E., M. Biava, et al., "Pulmonary Involvement during the Ebola Virus Disease," Viruses, 2019, 11(9): 780, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6784166/.

[59] Piercy, T.J., S.J. Smither, et al., "The survival of filoviruses in liquids, on solid substrates and in a dynamic aerosol," J Applied Microbiology, 2010, 109(5): 1531-9, https://doi.org/10.1111/j.1365-2672.2010.04778.x.

[60] Weingartl H.M., Embury-Hyatt C., Nfon C., Leung A., Smith G., Kobinger G. Transmission of Ebola virus from pigs to non-human primates. Sci. Rep. 2012;2:4. doi: 10.1038/srep00811.

[61] Lalle, E., M. Biava, et al., "Pulmonary Involvement during the Ebola Virus Disease," Viruses, 2019, 11(9): 780, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6784166/.

[62] Lalle, E., M. Biava, et al., "Pulmonary Involvement during the Ebola Virus Disease," Viruses, 2019, 11(9): 780, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6784166/.

[63] Bausch, D.G., J.S. Towner, et al., "Assessment of the Risk of Ebola Virus Transmission from Bodily Fluids and Fomites," J Infectious Diseases, 2007, 196: S142-7, https://doi.org/10.1086/520545.

[64] Petrosillo, N., E. Nicastri, et al., "Ebola virus disease complicated with viral interstitial pneumonia: a case report," BMC Infectious Diseases, 2015, 15:432, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4608352/.

[65] Petrosillo, N., E. Nicastri, et al., "Ebola virus disease complicated with viral interstitial pneumonia: a case report," BMC Infectious Diseases, 2015, 15:432, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4608352/.

[66] Lalle, E., M. Biava, et al., "Pulmonary Involvement during the Ebola Virus Disease," Viruses, 2019, 11(9): 780, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6784166/.

- Ebola virus RNA was found on the outer surface of an N95 that was not visibly soiled.[67]

Gastrointestinal aerosols

- Studies on gastrointestinal shedding of Ebola virus are not conclusive or missing, underlining the need for a precautionary approach to selecting prevention measures for health care workers.
  - Vomiting can generate aerosols that can contain Ebola virus.[68]
  - It is unclear whether Ebola virus can be recovered from vomitus, which requires a precautionary approach.[69]
  - Data on Ebola virus in stool is missing, though it "may well reach the intestine by means of viremia."[70]
  - Blood may be present in diarrhea.[71]

- Additional resource:
  - Rachael Jones and Lisa Brosseau, 2014, "COMMENTARY: Ebola virus transmission via contact and aerosol—a new paradigm," Center for Infectious Disease Research and Policy, University of Minnesota, https://www.cidrap.umn.edu/ebola/commentary-ebola-virus-transmission-contact-and-aerosol-new-paradigm.

[67] Vetter, P., W.A. Fischer, II, et al., "Ebola Virus Shedding and Transmission: Review of Current Evidence," J Infectious Diseases, 2016, 214(3), https://doi.org/10.1093/infdis/jiw254.

[68] Tun-Thompson, G., D.A. Libera, et al., "Aerosolization of a Human Norovirus Surrogate, Bacteriophage MS2, during Simulated Vomiting," PLOS ONE, 2015, https://doi.org/10.1371/journal.pone.0134277.

[69] Vetter, P., W.A. Fischer, II, et al., "Ebola Virus Shedding and Transmission: Review of Current Evidence," J Infectious Diseases, 2016, 214(3), https://doi.org/10.1093/infdis/jiw254.

[70] Vetter, P., W.A. Fischer, II, et al., "Ebola Virus Shedding and Transmission: Review of Current Evidence," J Infectious Diseases, 2016, 214(3), https://doi.org/10.1093/infdis/jiw254.

[71] McElroy, A., "Understanding Bleeding in Ebola Virus Disease," Clin Adv Hematol Oncol, 2015, 13(1): 29-31, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4667727/.