

Title: Personal Protective Equipment during the 2014-2016 Ebola Outbreak

Activities: Train workforce on IPC guidelines; Manage PPE supply chain

Stakeholders: World Health Organization; Médecins Sans Frontières

Phases: Early response; Intervention

Years: 2014-2016

Countries: Guinea; Liberia; Sierra Leone

Agent: Ebola

Case study prepared by: Emily Sherman, August 12, 2019

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During the 2014-2016 Ebola virus disease (EVD) outbreak in West Africa, healthcare workers were subjected to a risk of contracting EVD 21-32 times higher than that of the general population¹ due to their exposure to EVD patients and their highly infectious bodily fluids. Every healthcare worker was vital to the containment effort; there were less than 0.1 physicians for every 10,000 people in Guinea, Sierra Leone, and Liberia. In the absence of a vaccine, the correct use of personal protective equipment (PPE) proved to be critical in limiting the spread of Ebola virus between patients and healthcare workers.²

Because EVD is transmitted when infected bodily fluids come into contact with the mucous membranes or broken skin of an uninfected person, the PPE required for the EVD outbreak focused on barrier protection.³ The World Health Organization (WHO) guidelines for ideal PPE when treating Ebola patients included a scrub suit, rubber boots, two pairs of disposable gloves, a disposable gown or coverall, a face mask, a face shield or goggles, a head and neck covering or hood, and a disposable waterproof apron.⁴ The components of the PPE were meant to overlap as

¹ Ebola health worker infections. *World Health Organization*. <https://www.who.int/features/ebola/health-care-worker/en/>. Accessed August 5, 2019.

² Fischer WA, et al. Protecting Health Care Workers From Ebola: Personal Protective Equipment Is Critical but Is Not Enough. *Ann Intern Med*. 2014;161(10):753-754. DOI: 10.7326/M14-1953

³ Fischer WA, et al. Protecting Health Care Workers From Ebola: Personal Protective Equipment Is Critical but Is Not Enough.

⁴ Steps to put on personal protective equipment (PPE) including gown. *World Health Organization*. https://apps.who.int/iris/bitstream/handle/10665/150115/WHO_HIS_SDS_2015.1_eng.pdf?sequence=1. Accessed August 7, 2019.

to not leave any skin exposed.⁵ Unfortunately, there were challenges associated with putting on (donning) and removing (doffing) PPE that compromised its ability to serve as an effective barrier from Ebola virus-infected fluids.

Improper donning greatly increased the likelihood of EVD patients' bodily fluids coming into contact with healthcare workers' skin and mucous membranes, and incorrect doffing exposed healthcare workers directly to the infectious fluids on the surface of used PPE. While protocols were put in place to combat the likelihood of mistakes, healthcare workers exhausted from long shifts tended to make errors. Even the most cautious healthcare workers made mistakes in doffing due to complicated protocols and a lack of proper training and oversight.⁶ In a study that observed 18 healthcare workers donning and doffing Ebola PPE, 27% of them deviated from donning protocol, and 100% of them deviated from doffing protocol. The most prominent issues in donning were deviations from gloves/hand hygiene and gown/apron protocols (20% failed to follow protocol in each area). The most prominent issues in doffing were boot-cover removal (78% failed to follow protocol) and gloves/hand hygiene (67% failed to follow protocol).⁷

In October 2014, the U.S. Centers for Disease Control and Prevention updated their guide to PPE during an EVD outbreak to reflect clearer procedures for donning and doffing that included enhanced oversight. It was recommended that healthcare facilities thoroughly train healthcare workers in correct PPE use and that there be a trained person stationed at donning and doffing areas. The observer was to carefully watch healthcare workers and alert them if they were contaminating themselves or breaking procedure.⁸ Protocols implemented by Médecins Sans Frontières (MSF) stressed that during doffing, the observer should audibly walk the healthcare worker through each step of PPE removal, regardless of how many times the healthcare worker has been through the process. Furthermore, donning and doffing areas were to be physically separated to prevent exposure of infectious fluids to healthcare workers whose PPE was not fully secured.⁹

While PPE was mostly effective in protecting healthcare workers from contracting EVD when it was used properly, it had other limitations unassociated with the degree to which procedures

⁵ Margaret Glancey, Patience Osei, William Alexander Patterson, et al. Design Improvements for Personal Protective Equipment Used in Ebola and Other Epidemic Outbreaks. *Global Health: Science and Practice* Jun 2017, 5 (2) 325-328; DOI: 10.9745/GHSP-D-17-00152.

⁶ Narra, Rupa, et al. "CDC safety training course for Ebola virus disease healthcare workers." *Emerging infectious diseases* 23.Suppl 1 (2017): S217.

⁷ Kwon, Jennie H., et al. "Assessment of healthcare worker protocol deviations and self-contamination during personal protective equipment donning and doffing." *infection control & hospital epidemiology* 38.9 (2017): 1077-1083.

⁸ Hageman JC, Hazim C, Wilson K, et al. Infection Prevention and Control for Ebola in Health Care Settings — West Africa and United States. *MMWR Suppl* 2016;65(Suppl-3):50–56. DOI: http://dx.doi.org/10.15585/mmwr.su6503a8external_icon

⁹ Fischer WA, et al. Protecting Health Care Workers From Ebola: Personal Protective Equipment Is Critical but Is Not Enough.

were followed. First and foremost, complete PPE was scarce or inaccessible in many areas of West Africa. In Sergeant Kollie Town, Liberia, hospitals faced severe shortages of protective equipment as basic as rubber gloves. When healthcare workers began rapidly contracting EVD, these hospitals were forced to shut down. Not only did this leave EVD patients without care, but it also deprived patients with other illnesses such as dysentery, typhoid, and malaria of medical attention. Additionally, many pregnant women had no option but to give birth at home. With an already high rate of death during childbirth in West Africa, home-births were dangerous for the mother and baby.¹⁰ In areas where PPE was available, it increased the difficulty of treating patients. 44 physicians and nurses deployed to West Africa by MSF and the WHO were surveyed about their experiences using PPE while treating EVD patients. Most participants said respirators, masks, and hoods hindered their ability to communicate with patients. Goggles compromised quality of care as they tended to become foggy, impeding their ability to see. Participants also testified that they became easily overheated and dehydrated in gowns and coveralls.¹¹ However, increased protection with PPE generally meant decreased comfort, and comfort was viewed as a trade-off for maximized protection against EVD.¹²

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During the 2014-2016 Ebola virus disease (EVD) outbreak in West Africa, the use of personal protective equipment (PPE) was critical to limiting the spread of EVD from patients to healthcare workers. However, unclear protocols, improper donning and doffing, and limited supply of PPE compromised the effectiveness of the PPE in protecting healthcare workers from contracting EVD. Additionally the PPE was not well suited to the climate.

¹⁰ Hinshaw D. Ebola virus: for want of gloves, doctors die. The Wall Street Journal. 16 August 2014.

¹¹ Den Boon S, Vallenias C, Ferri M and Norris SL. Incorporating health workers' perspectives into a WHO guideline on personal protective equipment developed during an Ebola virus disease outbreak [version 2; peer review: 2 approved]. *F1000Research* 2018, 7:45 <https://doi.org/10.12688/f1000research.12922.2>

¹² Ronald Shaffer. Fighting Ebola: A Grand Challenge for Development - How NIOSH is Helping Design Improved Personal Protective Equipment for Healthcare Workers. February 5, 2015. <https://blogs.cdc.gov/niosh-science-blog/2015/02/05/ebola-ppe/>