

## Protecting Health Care Workers From Ebola: Personal Protective Equipment Is Critical but Is Not Enough

William A. Fischer II, MD; Noreen A. Hynes, MD, MPH; and Trish M. Perl, MD, MSc

Infections among health care workers have played a major role in outbreaks of Ebola virus disease since the virus was discovered in 1976. Available data from past outbreaks show that the deaths of health care workers were the canary in the coal mine signaling that an outbreak of a viral hemorrhagic fever had begun. The current Ebola outbreak that is devastating West Africa is unfortunately no different. In addition to an unprecedented number of total infections and deaths (2473 and 1350, respectively, at the time of this writing), this outbreak has surpassed all previous ones with respect to the number of health care workers infected (1). As of 11 August 2014, more than 170 health care workers have been infected and more than 80 have died (2).

In general, exposure and infection among health care workers typically occur before recognition of Ebola as the cause of a patient's illness. The nonspecific and nonpathognomonic presenting symptoms associated with Ebola, including fever, fatigue, and diarrhea, mirror the symptoms of more common ailments in sub-Saharan Africa, such as typhoid fever and malaria. The difficulty in the clinical recognition of Ebola combined with a lack of diagnostic capabilities complicates prevention efforts. Limited supplies of personal protective equipment (PPE) that prevents nosocomial transmission, including gloves, gowns, and face masks, in addition to inadequate training in standard precautions and poor public health care infrastructure, can create an environment that fosters infection of health care workers with Ebola, primarily at the start of an outbreak.

However, nosocomial transmission to health care workers can easily be mitigated with vigilance and the institution of barrier protection. In April 1995, a nosocomial cluster of Ebola was first identified among health care workers who participated in exploratory laparotomy of a laboratory worker with suspected typhoid-associated abdominal perforation (3). Many of the health care workers who participated in the procedure unknowingly contracted Ebola from the patient and then spread the virus to their subsequent contacts (3). In total, 80 of the 315 (25%) persons infected during this 6-month epidemic were health care workers (3). Transmission primarily occurred before Ebola was recognized as the etiologic agent, and this outbreak was successfully terminated with the initiation of barrier protection techniques.

If transmission of Ebola is effectively interrupted with barrier protection, why are so many health care workers in the current outbreak being infected, particularly this late in the epidemic? Two contributing factors include an insuffi-

cient supply of PPE and a lack of emphasis on the process of donning and doffing PPE.

The current Ebola outbreak is occurring in 3 of the world's poorest countries. Guinea, Liberia, and Sierra Leone are not only among the countries with the lowest per-capita gross national incomes but also have among the fewest physicians to serve their populations, with fewer than 0.1 physician per 10 000 persons (4, 5). As a result, the health care infrastructure is unable to sustain basic health care needs, let alone the surge in medical need brought on by this epidemic. The lack of sufficient PPE thus forces health care workers to choose between providing care with a heightened risk for infection or abandoning patients afflicted by this terrible disease. As of 16 August 2014, approximately 36 health care workers in Liberia alone (a country with a reported total of 51 physicians) have died of the disease and others are struggling with it (6). The absence of sufficient PPE is a major *reversible* reason underlying the recent increase in infections among health care workers that have occurred thus far in this Ebola epidemic.

Although PPE is effective at decreasing exposure to infected bodily fluids among health care workers, its presence is simply not enough. Ebola is transmitted through direct or indirect contact between bodily fluids from an infected patient and breaks in the skin or exposed mucous membranes of an uninfected person. The various PPE used and advocated by Médecins Sans Frontières, the World Health Organization, and the Centers for Disease Control and Prevention reduces the risk for direct exposure. However, even with PPE, a health care worker is still at risk if protective clothing that is contaminated with infectious bodily fluids is not removed in a manner that prevents exposure. The physical exhaustion and emotional fatigue that come with caring for patients infected with Ebola may further increase the chance of an inadvertent exposure to bodily fluids on the outside of the PPE. In addition, the impulse to wipe away sweat in the ever-present hot, humid environment during PPE removal may lead to inadvertent inoculation of mucous membranes.

The treatment sites administered by Médecins Sans Frontières have addressed this critical need by creating both a structure and a systematic, measured process to mit-

See also:

Related articles . . . . . 742-754

igate the risks associated with removal of PPE. First, a separate exit, physically removed from the entrance, is created to ensure that persons donning PPE do not come into contact with PPE from exiting health care workers that may be contaminated with bodily fluids. Second, and more important, a dedicated person is stationed at the exit with the sole focus of guiding the health care provider through each step of PPE removal, regardless of how many times the provider has been through the process. This standard of operations ensures that the process becomes ritualized, thereby protecting and reassuring the health care worker.

Despite its lethal nature, Ebola transmission can be interrupted with simple interventions and by focusing on basics. Improvement in basic health care infrastructure and providing an adequate supply of PPE along with a ritualized process for donning and doffing PPE are desperately needed to prevent further unnecessary infection and loss of life among the heroic health care workers who are on the frontlines of this war. Protection of health care workers in Ebola outbreaks does not happen by accident—it is achieved through the provision of adequate PPE and, more important, a focus on systems processes that enforce the safe use and removal of PPE. The challenges and successes in Africa should inform the discussion in the rest of the world about reducing the risk for transmission and refocus the conversation on the process of donning and doffing PPE rather than simply increasing the amount of it.

From University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, and Johns Hopkins University School of Medicine, Johns Hopkins Bloomberg School of Public Health, and Johns Hopkins Health System, Baltimore, Maryland.

**Disclosures:** Disclosures can be viewed at [www.acponline.org/authors/icmje/ConflictOfInterestForms.do?msNum=M14-1953](http://www.acponline.org/authors/icmje/ConflictOfInterestForms.do?msNum=M14-1953).

**Requests for Single Reprints:** William A. Fischer II, MD, University of North Carolina at Chapel Hill School of Medicine, Department of Medicine, Division of Pulmonary and Critical Care Medicine, Center for Environmental Medicine, Asthma, & Lung Biology, 104 Mason Farm Road, Chapel Hill, NC 27599-7310; e-mail, [William\\_Fischer@med.unc.edu](mailto:William_Fischer@med.unc.edu).

Current author addresses and author contributions are available at [www.annals.org](http://www.annals.org).

*Ann Intern Med.* 2014;161:753-754. doi:10.7326/M14-1953

## References

1. **World Health Organization.** Ebola virus disease update—West Africa. Geneva: World Health Organization; 2014. Accessed at [www.who.int/csr/don/2014\\_08\\_19\\_ebola/en](http://www.who.int/csr/don/2014_08_19_ebola/en) on 19 August 2014.
2. **World Health Organization.** Barriers to rapid containment of the Ebola outbreak. Geneva: World Health Organization; 2014. Accessed at [www.who.int/csr/disease/ebola/overview-august-2014/en](http://www.who.int/csr/disease/ebola/overview-august-2014/en) on 19 August 2014.
3. Khan AS, Tshioko FK, Heymann DL, Le Guenno B, Nabeth P, Kerstiëns B, et al. The reemergence of Ebola hemorrhagic fever, Democratic Republic of the Congo, 1995. *Commission de Lutte contre les Epidémies à Kikwit. J Infect Dis.* 1999;179 Suppl 1:S76-86. [PMID: 9988168]
4. **The World Bank.** GNI per capita ranking, Atlas method and PPP based. Washington, DC: The World Bank; 2013. Accessed at <http://data.worldbank.org/data-catalog/GNI-per-capita-Atlas-and-PPP-table> on 19 August 2014.
5. **The World Bank.** Physicians (per 1,000 people). Washington, DC: The World Bank; 2010. Accessed at [http://data.worldbank.org/indicator/SH.MED.PHYS.ZS?order=wbapi\\_data\\_value\\_2010±wbapi\\_data\\_value&sort=asc](http://data.worldbank.org/indicator/SH.MED.PHYS.ZS?order=wbapi_data_value_2010±wbapi_data_value&sort=asc) on 19 August 2014.
6. **Hinshaw D.** Ebola virus: for want of gloves, doctors die. *The Wall Street Journal.* 16 August 2014.

**Current Author Addresses:** Dr. Fischer: University of North Carolina at Chapel Hill School of Medicine, Department of Medicine, Division of Pulmonary and Critical Care Medicine, Center for Environmental Medicine, Asthma, & Lung Biology, 104 Mason Farm Road, Chapel Hill, NC 27599-7310.

Dr. Hynes: Division of Infectious Diseases, The Johns Hopkins University School of Medicine, 1830 East Monument Street, 4th Floor, Baltimore, MD 21205.

Dr. Perl: Department of Epidemiology & Infection Prevention, Johns Hopkins Medicine, 600 North Wolfe Street, Osler 327A, Baltimore, MD 21287-5425.

**Author Contributions:** Conception and design: W.A. Fischer, N.A. Hynes, T.M. Perl.

Analysis and interpretation of the data: W.A. Fischer, T.M. Perl.

Drafting of the article: W.A. Fischer, T.M. Perl.

Critical revision of the article for important intellectual content: W.A. Fischer, N.A. Hynes, T.M. Perl.

Final approval of the article: W.A. Fischer, N.A. Hynes, T.M. Perl.

Administrative, technical, or logistic support: W.A. Fischer, T.M. Perl.

Collection and assembly of data: W.A. Fischer, N.A. Hynes, T.M. Perl.