GUEST COMMENTARY

The 2014 Dallas, Texas, Ebola Incident: Global Implications to All-Hazards Preparedness and Health Care Worker Protection

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Ebola and Risk

The Ebola virus is a zoonotic, nosocomial, and priority bioterrorism agent that is categorized under the rubric "viral hemorrhagic fevers (Centers for Disease Control and Prevention [CDC], 2013, 2015; Institute of Medicine, 2009)." In this article, we examine the personal protective equipment (PPE) utilized in U.S. hospitals during viral hemorrhagic fever (VHF) outbreaks by reviewing applicable, relevant, and appropriate guidance, published scientific literature, and other available information sources.

We examined a series of well-documented nosocomial VHF outbreaks, including the 2014 U.S. Ebola incident in Dallas, Texas, and a single nurse assistant in Madrid, Spain. They share common epidemiological attributes and indicate that a rapidly evolved Ebola patient viral load (which approximates 5–8 days of first symptom) causes a very short period between diagnostic recognition to response and opportunity for PPE escalation (Locsin, Barnard, Matua, & Bongomin, 2003; Towner et al., 2004). Infective dose is in the virus particle range (<10 virions); late stage infections render the patient increasingly contagious (Burd, 2015; Henderson, Inglesby, & O'Toole, 2002). Patient signs, including the loss of up to 8 L of highly viremic vomit and diarrhea daily (CDC, 2015; Kreuels et al., 2014), may present challenges to traditional hospital emergency room PPE procedures and practices. Terminal stage patients with VHF may present a severe risk to health care workers exposed to blood and other bodily fluids, both by direct and cutaneous contact (Mardani, Keshtkar-Jahromi, Ataie, & Adibi, 2009). Further, scientific consensus on the viability of Ebola transmission by aerosol/respiratory pathways remains equivocal (Brosseau & Jones, 2014; Osterholm et al., 2015). Hospitals are required to assess workplace hazards and control risk by the hazard vulnerability analysis assessment process (Pandemic and All-Hazards Preparedness Reauthorization Act [PAHPRA], 2013), including the selection of worker PPE based upon those evaluated hazards.

Nosocomial VHF

Historically, VHFs have caught health care facilities off guard. From seven documented outbreaks of nosocomial VHF (Ebola nonendemic countries), 27 secondary or tertiary nosocomial infections occurred. The outbreaks are significant to the Ebola 2013–2014 epidemic globally and to the 2014 Dallas, Texas, Ebola incident specifically due to instances of misdiagnosis, patient morbidity, and the secondary infection of health care workers wearing various levels of PPE. The outbreaks involved dengue, Crimean-Congo hemorrhagic fever (CCHF), or Ebola, all of which are designated as Category A bioweapons agents (CDC, 2013; Henderson et al., 2002). The pathogens were determined to be primarily vectored by tick bites or direct human contact or needle stick accidents in Russia, Turkey, Iran, Germany, Pakistan, and Afghanistan. An American soldier was misdiagnosed with foodborne illness and later tested positive for CCHF (bitten by a tick in Afghanistan), and after infecting two military medical workers who did not wear respirators during aerosol-generating processes (bronchoscopies), he died (Conger et al., 2015). A Madrid nurse assistant wearing standard precaution PPE became infected with Ebola from an unconfirmed transmission pathway, while involved in the disposal of liquid Ebola waste "absorptive material (Parra, Salmeron, & Velasco, 2014)."

Transmission Pathways

Although the Centers for Disease Control and Prevention (CDC) advise that Ebola cannot be transmitted by airborne pathways, the routes of transmission are unclear (Brosseau & Jones, 2014). Ebola has long been known to be transmissible by aerosol (Henderson et al., 2002; U.S. Army Medical Research Institute of Infectious Diseases, 2011). Recent research by Osterholm and co-authors suggests that Ebola is potentially transmissible as a "respiratory pathogen with primary respiratory spread (Osterholm et al., 2015)." Other VHF transmission pathways include person-to-person (bodily fluids), arthropod (insect) vectors, nosocomial, laboratory accident, fomite (contaminated environmental surfaces), human-animal contact, and the intentional use as bioweapons (Osterholm et al., 2015).

The VHF outbreaks throughout Eurasia show that an all-hazards preparedness scope must go beyond Ebola to include all VHFs due to natural vector transmission, accident, and potential intentional attacks through bioweapons. Environmental health risk factors, social and physical vulnerabilities, and individual susceptibility should be analyzed for patients admitted into the hospital during diagnostic evaluation: travel to endemic countries, contact with diseased live or dead animals, contact with sick humans, and bites from insects (Henderson et al., 2002). The same risk factors previously listed may be completely absent in the case of an intentional act of terrorism or war, and further complicates the task of diagnosing and managing emergency patients (Henderson et al., 2002).

Clinical Crisis, Dallas, Texas, 2014

Based on the ASTM Standard Guide for Hospital Preparedness and Response, the 2014

U.S. Ebola incident could not be defined as a disaster by local officials. The ASTM standard defines a disaster as "…an event that exceeds (or might exceed) the resources for patient care at that time, for a community, a hospital, or both (ASTM, 2004)." On October 8, 2014, however, the Dallas Ebola index case, a Liberian man, died of hemorrhagic fever 14 days after being originally diagnosed with a sinus infection (Sack, 2014; Texas Health Resources, 2014). The Dallas Ebola index case progressed from first symptoms to explosive diarrhea and projectile vomiting in three days (*Nina Pham v. Texas Health Resources, Inc.,* 2015). A series of errors, including misdiagnosis, miscommunication, and treatment delay, may have irreversibly impacted the fate of the patient and the health of two nosocomially infected nurses (CNN, 2014; Gillman, 2014; House Energy and Commerce Committee Subcommittee on Oversight and Investigations, 2014; Texas Health Resources, 2014). In addition, the two nurses were flown separately from Dallas to research hospitals at the National Institutes of Health in Bethesda, Maryland, and CDC in Atlanta, Georgia (equipped for emergency Ebola treatment) (Texas Health Resources, 2014).

All-Hazards Disaster Preparedness

Hazard Vulnerability Assessment

All-hazards disaster preparedness, required by the Joint Commission and the Pandemic and All-Hazards Preparedness and Response Act (PAHPRA) (2013), is accomplished by a broadly designed hazard vulnerability assessment (HVA) tool. It includes the designation of appropriate health care worker PPE based upon that assessment of risk (ASTM, 2004; Austin, Nitta, Picanzo, Schramm, & Wasielewski, 2013; Campbell, Trockman, & Walker, 2011; U.S. Department of Homeland Security, 2008, 2014). Many key elements of an effective hospital emergency plan are driven by the correct assessment of "worst-case-scenario" hazards; emergency plan; hospital incident command system (HICS) structure and operating and communication procedures; selection and designation of employee PPE; and systematic disaster simulation drills with community first responders and other stakeholders (ASTM, 2004). The key is to be able to provide a "rapid and effective all-hazards response to any event (ASTM, 2004)." It has been documented, however, that hospitals do not follow standardized methods for performing HVAs, and a high degree of variation exists in scope and process (Campbell et al., 2011).

The PAHPRA reauthorized to include an emphasis on national public health security and hospital preparedness in 2013, also focuses on emerging threats, biosurveillance, and necessary funding to accomplish all-hazards objectives (PAHPRA, 2013). Nevertheless, many HVA models assume that low probability events merit lower priority, while it is suggested that high consequence events must be *emphasized,* regardless of estimated probability of occurrence (ASTM, 2004; Eddy & Sase, 2015). The costs of the U.S. Ebola incident to the Dallas hospital managing entity and the communities involved around the world, in terms of human harm and economic loss, include the following:

- Three hundred forty-three patient contact cases (eight Madrid contacts subtracted from total) were monitored by health care professionals in Texas and Ohio.
- Ninety-three people were either self-quarantined, legally isolated under order, or "placed under controlled movement restrictions."
- A financial settlement with the Dallas index case family was established.
- The temporary closure of the emergency department at the Dallas hospital occurred.
- A public relations firm was hired by the Dallas hospital managing entity (McCarty et al., 2014; *Nina Pham v. Texas Health Resources, Inc.,* 2015; Smith et al., 2015; Texas Health Resources, 2014; Washkuch, 2014).

Occupational Safety and Health Administration (OSHA) and Relevant and Appropriate PPE Guidance

Regulatory and nonregulatory reasons cited above compel the reevaluation of PPE for VHFs potentially encountered in the health care environment. Ebola is listed as a priority bioterrorism agent due to the following criteria: ease of transmission between people; high mortality rate; threat to public health and potential for disturbance of society; and the requirement for "special action for public health preparedness (CDC, 2015)."

OSHA governs worker PPE regulation by requiring the employer to assess the hazards present in the workplace and provide appropriate levels of protection (CFR 1910.120). In the event that hazards are unknown, OSHA requires the provision of level B PPE, including a self-contained breathing apparatus (Occupational Safety and Health Administration [OSHA], 2005). Because Ebola pathogen modes of transmission are not well understood, morbidity is high, and proven treatment and vaccines do not exist (Brosseau & Jones, 2014), consideration should be given to classifying them as unknown hazards. Further, The InterAgency Board (IAB), a collaboration of "all levels of government" that specializes in all-hazards preparedness, assigns Ebola a "high risk" classification when exposure potential is severe, and suggests the "highest recommended protection level," based upon proximity and "the likelihood for any exposure to body fluids or contaminated waste as part of operations (The InterAgency Board [IAB], 2014)." Based upon the individual assessment of potential worker exposure, IAB recommends specific combinations of PPE such as a fully encapsulated worker garment (with covered, virus-resistant seams) and a respirator with a sealed hood (or helmet) that has overlapping protective covers (IAB, 2014). It also states that higher levels of PPE for high-risk scenarios are acceptable, such as the self-contained breathing apparatus and chemical, biological, radiological, nuclear, and explosive protection–qualified PPE (IAB, 2014). Additionally, evidence indicates the successful protection of health care workers utilizing "pressurized suits equipped with HEPA filtered ventilators," when working in high viral load environments (Kreuels et al., 2014).

Hospital PPE: Standard Precautions

Standard precaution PPE (gowns, gloves, surgical mask, and eye protection), may also include the N-95 paper filter respirator and the purified air powered respirator for contact and airborne precautions (Conger et al., 2015; Kortepeter et al., 2008). The U.S. Department of Health and Human and Services (DHHS), however, provides written PPE guidance that states both the N-95 and powered air-purifying respirators (PAPRs) are not negative pressure respirators: both can allow contaminants to breach the units (DHHS, 2014). Some entities advise against the automatic assumption of PAPRs as protective for hazardous hospital

environments, while advocating the performance of a full HVA to assess the adequacy of PPE against potential health care worker hazards (OSHA, 2005).

Additionally, surveyed health care workers show uncertainty about all respirator usage, including equipment donning and doffing. Administrators consider PAPRs favorable to N-95 paper respirators, due to the absence of required fit testing, despite superior protection (Liverman, Domnitz, & McCoy, 2015). Fewer than 1% of all the U.S. surveyed hospitals, however, had PAPRs in emergency caches (Association of State and Territorial Health Officials [ASTHO], 2014). The costs of PPE fit-testing and training have driven hospital administrator's decisions when considering PPE selection (Liverman et al., 2015). The annual calculated costs of reusable and cleanable elastomeric respirators and PAPRs are actually less than the disposable (and less effective) N-95 paper filter respirators (ASTHO, 2014; Brosseau & Jones, 2014).

Biosurveillance, Early Event Detection, and Prevention

The International Health Regulations (IHR) overseen by the World Health Organization (WHO) are chartered to prevent the transnational movement of infectious diseases (World Health Organization, 2008). Yet WHO has received some criticism for delaying the declaration of a "public health emergency of international concern" in 2014, causing it to be less effective than intended (Gostin & Friedman, 2014). As were the cases in Dallas and Madrid, biological agents are often first detected in the hospital, not through biosurveillance systems (Austin et al., 2013; U.S. Department of Homeland Security, 2014), which indicates a diminished preparedness capacity. Early-detection biosurveillance systems, however, are presently incompletely formed (Eddy, Sase, & Schuster, 2010; Eddy, Stull, & Balster, 2013; Gates, 2015; *The Lancet,* 2014; World Health Organization, 2008).

Conclusion

The hazard vulnerability assessment, required to be performed internally by all hospitals (Austin et al., 2013; PAHPRA, 2013), provides hospitals an opportunity to reevaluate their emergency plan and strengthen preparedness by applying the lessons learned from the 2014 U.S. Ebola incident. Paper filter N-95 respirators, even when utilized with face shields, may be challenged to dependably protect the worker in such an extremely hazardous occupational exposure environment. Due to the volume and infectivity of bodily fluids, the late stage, highly viremic, and hemorrhagic patient environment may present a hazard to health care workers similar to hazardous material exposures that first responders might experience. The PAPR should also be revisited for effectiveness via the HVA, in addition to full-body garment protection.

U.S. national guidance requires the preparedness for terrorism and other disasters (ASTM, 2004; PAHPRA, 2013; U.S. Department of Homeland Security, 2008, 2014), which could involve the natural or intentional introduction of VHFs with high human and economic consequence into the hospital and community. To adequately assess the potential risk to workers, Ebola ecology, epidemiology, and transmission modality must be better understood. Yet, early VHF signs and symptoms are not easily distinguishable from many other communicable infectious diseases. Therefore, the following must be established to assure that health care workers become well-prepared for all-hazards: biosurveillance information, correct and immediate diagnosis, algorithms to determine the potential for zoonotic or other specific environmental contact sources, operational and practiced HICS systems including effective internal and external communications, and appropriate PPE for health care workers.

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NEHA **NEWS**

Note of Thanks to Departing Board Members

We would be remiss if we did not acknowledge the dedication, hard work, and efforts of two members of the NEHA board of directors on the occasion of their departure from the board: Immediate Past President Alicia Collins and Region 2 Vice President Marcy Barnett.

Immediate Past President Alicia Collins leaves the board after 10 years of dedicated service and leadership. In 2010, she was elected second vice president and served as president of NEHA in 2013–2014. Prior to that Alicia served as NEHA's Region 2 vice president from 2005 to 2010. Preceding to her work on the board, she chaired NEHA's air/land technical section from 2002 to 2005.

Alicia is a food safety program manager with The Steritech Group, Inc., and works closely with Chick-fil-A, Inc.'s, Food Safety Team at their headquarters in Atlanta. From 2006 to 2013, she was employed by the Sacramento County Environmental Management Department where she served as the deputy chief of the Environmental Health Division. During this time the Sacramento County Environmental Management Department was awarded the Samuel J. Crumbine Consumer Protection Award in 2008 with Alicia acting as team lead for planning and implementation of food program enhancements. Alicia was also the recipient of the California Conference of Directors of Environmental Health's Manager of the Year, Robert Merryman Award for 2006–2007.

Although her time on the NEHA board is at an end, she is still active within the association. Alicia is currently the president of the Past Presidents affiliate and is a member of NEHA's new Industry Affiliate.

Reflecting upon her experience, Alicia states, "It has been an honor to serve NEHA and our profession alongside so many esteemed and dedicated professionals who are committed to protecting the health and well-being of our communities. Thank you for your service to NEHA and for using your expertise to protect humankind. I extend my deepest gratitude to our members, who are talented, caring, unsung, everyday heroes."

Region 2 Vice President Marcy Barnett leaves the board after two years of dedicated service and leadership.

Marcy is currently an emergency preparedness liaison for the California Department of Public Health Center for Environmental Health in Sacramento. In this capacity she works with the state and local environmental health programs to expand capacities for disaster response and recovery.

As a board member, Marcy represented NEHA members on matters of policy, governance, and oversight of the association. She served on the finance, nominations, and AEC committees.

Marcy states, "I am proud to have served NEHA and its members at a time of significant change for the organization. The board has worked diligently for the past two years to adapt to changes in our profession and technology to ensure that NEHA remains a leader in environmental health and continues to offer high quality services and training for environmental health professionals across the country and the world. I have enjoyed my time on the board and deeply respect the work of the dedicated members of the NEHA board of directors."