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Lessons from the domestic Ebola response: Improving health care system resilience to high consequence infectious diseases

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Abstract

Background: The domestic response to the West Africa Ebola virus disease (EVD) epidemic from 2014–2016 provides a unique opportunity to distill lessons learned about health sector planning and operations from those individuals directly involved. This research project aimed to identify and integrate these lessons into an actionable checklist that can improve health sector resilience to future high-consequence infectious disease (HCID) events.

Methods: Interviews (N = 73) were completed with individuals involved in the domestic EVD response in 4 cities (Atlanta, Dallas, New York, and Omaha), and included individuals who worked in academia, emergency management, government, health care, law, media, and public health during the response. Interviews were transcribed and analyzed qualitatively. Two focus groups were then conducted to expand on themes identified in the interviews. Using these themes, an evidence-informed checklist was developed and vetted for completeness and feasibility by an expert advisory group.

Results: Salient themes identified included health care facility issues—specifically identifying assessment and treatment hospitals, isolation and treatment unit layout, waste management, community relations, patient identification, patient isolation, limitations on treatment, laboratories, and research considerations— and health care workforce issues—specifically psychosocial impact, unit staffing, staff training, and proper personal protective equipment.

Conclusions: The experiences of those involved in the domestic Ebola response provide critical lessons that can help strengthen resilience of health care systems and improve future responses to HCID events.

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Keywords

Preparedness; Ebola; resilience; health care; response

During the 2014–2016 domestic response to the West Africa Ebola epidemic, 11 Ebola virus disease (EVD) patients were treated across 5 health care facilities in the United States.[1–7] Three facilities already had specialized biocontainment units for treating highly infectious patients: Emory University Hospital's Serious Communicable Disease Unit in Atlanta; the Nebraska Biocontainment Unit at the University of Nebraska Medical Center in Omaha; and the Special Clinical Studies Unit at the National Institute for Health (NIH) in Bethesda, Maryland. The fourth facility, NYC Health + Hospitals/Bellevue in New York, did not have a designated biocontainment unit, but established the Special Pathogens Unit in anticipation of a potential EVD patient, temporarily converting a negative pressure unit originally intended for patients with AIDS and tuberculosis.[8] These units were purpose designed to isolate and treat infectious patients and had staff trained in the use of enhanced personal protective equipment (PPE).

Texas Health Presbyterian Hospital Dallas was the only facility to treat an EVD patient without a specialized isolation unit. A traveler from Liberia presented to the emergency department with a fever in September 2014 and was discharged with a diagnosis of sinusitis.[1] He returned 2 days later with suspected EVD.[1] The hospital cleared an intensive care unit to create an ad hoc isolation unit, but the patient died shortly thereafter.[9] Two nurses who treated the patient were subsequently diagnosed with EVD and transferred to Emory and NIH for care.[10,11]

Each facility faced challenges during the domestic EVD response in part because of the evolving findings on key characteristics of Ebola virus transmission and persistence in survivors and the deceased,[12,13] which directly impacted infection control guidelines.

To improve readiness during the domestic response, the U.S. Centers for Disease Control and Prevention (CDC) and the Office of the Assistant Secretary for Preparedness and Response collaborated with state health departments to provide onsite technical assistance to local health care facilities.[14] Health departments used a CDC-developed standardized tool to assess each facility's readiness for infectious disease outbreaks across 11 capability domains.[15] Although most facilities never treated an EVD patient, many did encounter individuals with possible Ebola virus exposure.

The experiences of those involved in the domestic EVD response provide an opportunity to improve future responses to high consequence infectious disease (HCID) events. This project derived evidence-based recommendations and an actionable checklist to strengthen resilience to HCID events across the health sector, including emergency medical services (EMS), health care, and public health. This article summarizes the findings and presents a checklist specific to the health care system. Although there are a number of similarities, this checklist should be considered distinct from CDC's tool to assess hospital readiness for Ebola patients. Checklists for public health and EMS will be published elsewhere.

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METHODS

A literature review[16] was conducted to identify prospective interviewees and interview themes. Phone interviews were conducted from February-November 2016 to distill factors that influenced health sector resilience during the domestic EVD response. Participants (N = 73) were identified through the literature review, snowball sampling, and the researchers' knowledge of the response. A semi-structured interview guide facilitated discussions with individuals from Atlanta (n = 17), Dallas (n = 22), New York (n = 13), Omaha (n = 18), and the CDC (n = 3). Themes included the following: risk perception; health care; and local, state, and federal response. Each interview was audio-recorded, transcribed, and coded using NVivo software (QRS International, Melbourne, Australia). Two focus groups—New York (December 2016) and Dallas (January 2017)—further explored themes identified during interviews. An expert advisory group considered the preliminary findings and commented on recommendation relevancy, accuracy, and feasibility.

This research was designated exempt by the University of Pittsburgh Institutional Review Board and deemed not human subjects research by the CDC Human Research Protection Office.

FINDINGS

Health care facilities

Assessment and treatment hospitals—Health care preparedness for HCID events demands an infrastructure with the expertise, leadership, staff, equipment, and relationships needed for a response. As interviewees noted, potentially infectious patients can enter the health care system at any location, and every facility should, at minimum, be able to identify, isolate, and stabilize patients until they can be transferred to a better-equipped facility. Additionally, strong partnerships with other organizations (eg, EMS, airports) helped ensure a coordinated effort. Interviewees warned that relationships cannot be forged during a response, but rather should be established in advance through frequent trainings and other collaborative events.

Designated treatment centers helped ensure that persons under investigation (PUIs)—defined by the CDC as having nonzero risk for Ebola virus infection and symptomology consistent with EVD[17]—and confirmed cases received proper care by staff skilled in infection control. Identification and maintenance of specialized facilities that can isolate and treat HCID patients in advance of an HCID event could improve future responses. Informants noted, however, that budget shortfalls and waning staff interest postevent could jeopardize these facilities' survival.

During the domestic EVD response, PUIs and individuals with possible exposure who needed care for unrelated conditions (eg, childbirth) presented to health care facilities. Because of uncertain infection status and disease transmission concerns, these patients were often treated similarly to confirmed EVD patients. Patient care was resource intensive for all facilities, but especially those not designated as Ebola treatment centers. To address this problem, the CDC issued guidance to designate Ebola assessment hospitals to provide

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clinical care for PUIs awaiting confirmatory diagnosis.[18] Although not prepared to care for EVD patients beyond diagnosis, assessment hospitals were able to isolate and care for PUIs, decreasing the burden on other frontline hospitals without activating treatment centers.

Facility layout and waste management—Certain unit layouts were more conducive to treating EVD patients by ensuring appropriate isolation without disrupting the larger hospital. This included units with 1-way traffic flow, where care-givers had to enter the patient room from the PPE donning area and exit to the PPE doffing area, which also only had a single exit that led out of the hot zone; and treatment units that could be accessed without having to move through other patient care areas. Features of effective treatment and isolation areas noted by interviewees included designated areas for donning and doffing PPE, negative pressure ventilation and high-efficiency particulate air filtration, remote monitoring capabilities, and sufficient autoclave capacity located nearby. Additionally, informants identified the handling, storage, and transportation of hazardous waste as an unanticipated challenge. Of particular concern was waste transport across jurisdictional lines and public fear that hospital wastewater (although treated) could spread the disease.

Community relations—Unfamiliar to the public, EVD captured public interest and triggered widespread fear. Stigmatization sometimes occurred between hospital personnel at affected hospitals and spilled over into schools and daycares serving children of health care workers. Participants noted that information campaigns and public outreach by hospital employees helped calm public fear and decrease stigmatizing behaviors. Facilities that had opened their treatment units for public viewing and discussion in advance of the domestic EVD response benefited by fostering trust in their ability to safely treat HCID patients while protecting the larger community.

Patient identification and isolation—Some individuals being monitored by the local health department (LHD) experienced unrelated illnesses that required visits to health care facilities. To identify these individuals on entry into the health care system, close coordination and communication between frontline health care facilities (eg, ambulatory clinics) and LHDs were paramount. This allowed the receiving facility to prepare for an incoming patient with potential Ebola virus infection. Hospitals and other frontline facilities also faced incoming patients who were not being monitored but had EVD-like symptoms with worrisome epidemiologic factors (eg, contact with a PUI, recent travel to West Africa). Identifying these patients required astute clinicians who performed thorough assessments, including travel histories; knew of global infectious disease outbreaks; and isolated suspected patients quickly. Participants also noted that keeping suspected patients abreast of isolation procedures and facilitating contact with family and friends (eg, via Skype) provided comfort.

Limitations on treatment—Treating suspected or confirmed EVD patients presented unfamiliar medical hurdles to U.S. health care facilities. Many facilities had to weigh the benefits of specific procedures (eg, cardiopulmonary resuscitation, surgery) against the risks they posed to clinicians, hospital personnel, and other patients. This scenario was complex for PUIs and monitored individuals because facilities were potentially limiting the

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care for an individual who may not be infected with Ebola virus. Routine procedures (eg, computed tomography scan, magnetic resonance imaging) were suddenly more dangerous and burdensome given patient transport to and from the procedure and the potential for equipment contamination. Adaptations to overcome these challenges included using only diagnostic procedures that might significantly alter a patient's treatment course, and identifying suitable substitutes for diagnostics (eg, portable ultrasound instead of computed tomography scan).

Research—Treating patients with emerging infectious diseases such as EVD provides the opportunity to evaluate new interventions and gather observational (eg, hemodynamics, nutrition) and laboratory data to help identify best practices and improve treatment. As interviewees noted, preparation for these efforts must improve prior to HCID events, or important research opportunities will be lost. One participant discussed the considerable amount of paperwork required to obtain investigational pharmaceuticals, which is time-consuming and could delay treatment. Another noted the difficulty in identifying clinicians skilled in administering specific investigational products. Most agreed that creating protocols ahead of HCID events could streamline efforts and improve data collection and analysis.

Laboratories—Poor access to proper diagnostics and the need to send samples to the CDC in Atlanta for confirmatory testing delayed EVD diagnosis and rule-out. Routine laboratory tests were also challenging because of concerns about equipment contamination and training requirements for personnel handling HCID-associated specimens. Interviewees noted that onsite laboratory capacity for biocontainment units provided rapid access to some critical laboratory tests; however, this required additional personnel in the hot zone and limited the types of testing available.

Ebola virus is a Tier 1 select agent[19]; however, according to one interviewee, this only included specimens that had been confirmed through culturing, but not by molecular assay. Associated storage and shipping requirements led to difficulties in finding commercial couriers willing to transport specimens to the CDC for culturing, because they were not considered select agents, but were identified by the health care facility as being positive for Ebola virus.

Health care workforce issues

Psychosocial impact—Several interviewees commented on the stress of caring for EVD patients. They often felt isolated from other hospital staff, friends, and family because they were unable to share their experiences outside of the clinical team. Additional stigma from hospital personnel, family, and others added to their isolation, especially when it was directed at their family (eg, removing children from school). Informants indicated that support from hospital leadership and mental health programs (eg, clergy, counselors) helped mitigate stress and improve morale. Interviewees also indicated that rigorous training and exercise programs and involvement in developing infection prevention protocols built confidence in protective measures and helped to alleviate some of the stress involved with treating an HCID patient.

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Unit staffing—Additional staff was required to care for EVD patients because of the physical limitations of delivering care while wearing enhanced PPE and the need for specialized personnel such as PPE donning and doffing observers. Many personnel were taken from other units within the hospital and often could not return until their monitoring period ended. Some facilities did not anticipate this burden, which affected both the treatment team and the larger facility.

Clinicians for EVD patients and PUIs included voluntary and involuntary personnel, depending on the facility. One participant noted that self-selection ensured that individuals were invested in the training program and patient care. Many volunteer personnel had trained together and formed well-functioning, tight-knit groups, such as the Nebraska team. Another facility chose to assign staff to care for these patients, concerned about not having enough volunteers and about setting the precedent that staff could opt out of caring for certain patients. According to interviewees, the ideal scenario for any HCID event would be self-selected staff already trained to safely isolate and treat a patient; however, for various reasons (eg, staffing shortages, staff willingness), facilities may need to mandate work with HCID patients. Interviewees acknowledged that this could be controversial, and approaches will likely depend on the disease and facility characteristics (eg, staff availability, unionization).

Staff training and drills—Training and drills were noted as integral to preparing personnel for EVD patients. During the event, just-in-time training helped refamiliarize staff with infection prevention protocols and educate them on evolving guidelines. Additionally, one interviewee noted the usefulness of mystery patient drills, during which an individual with fictional symptoms presents to an emergency department without warning, to train staff to identify and isolate HCID patients.

Clinical PPE—Several participants noted the challenge of changing CDC PPE guidelines. Some solicited advice from peers experienced with EVD in West Africa, whereas others followed the recommendations of other facilities. One interviewee remarked that CDC guidance was for “minimum protection,” noting they chose to use a higher level of PPE and scale back as needed. Regardless of the guidelines followed, training staff on donning and doffing procedures and using observers to prevent inadvertent contamination were considered essential.

DISCUSSION AND RECOMMENDATIONS

Informed by these findings, the checklists aim to mitigate challenges that emerged during the domestic Ebola response and improve resilience to future HCID threats. Two checklists are provided: one which details recommendations for health care facilities (Table 1), and one which details recommendations for the health care workforce (Table 2). Some are concrete, actionable recommendations, whereas others spotlight issues that may not be anticipated prior to an HCID event or require collaboration outside the health care system. Given variable transmissibility, symptomology, disease severity, and treatment availability, these recommendations may not apply to all HCID-associated events.

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CONCLUSIONS

The domestic Ebola response provided invaluable lessons that can help improve future HCID event responses. Health care facilities shouldered much of the response, and even those facilities with designated treatment units had to adapt in real time. Incorporating these findings into preparedness efforts can help improve future responses and strengthen health care system resilience.

Limitations

Completed 1–2 years after the domestic Ebola response, this study is subject to recall bias. Although the recommendations are intended to be broadly applicable, the findings from the locales studied were not intended to be generalizable across all health care facilities. Identified primarily through a literature review, participants were skewed toward higher-profile responders; snowball sampling helped minimize this bias.

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References

1. Chevalier MS, Chung W, Smith J, Weil LM, Hughes SM, Joyner SN, et al. Ebola virus disease cluster in the United States—Dallas County, Texas, 2014. MMWR Morb Mortal Wkly Rep 2014;63:1087–8. [PubMed: 25412069]
2. Yacisin K, Balter S, Fine A, Weiss D, Ackelsburg J, Prezant D, et al. Ebola virus disease in a humanitarian aid worker—New York City, October 2014. MMWR Morb Mortal Wkly Rep 2015;64:321–3. [PubMed: 25837242]
3. Lyon GM, Mehta AK, Varkey JB, Brantly K, Plyler L, McElroy AK, et al. Clinical care of two patients with Ebola virus disease in the United States. N Engl J Med 2014;371:2402–9. [PubMed: 25390460]
4. Varkey JB, Shantha JG, Crozier I, Kraft CS, Lyon GM, Mehta AK, et al. Persistence of Ebola virus in ocular fluid during convalescence. N Engl J Med 2015;372:2423–7. [PubMed: 25950269]
5. Smith PW, Boulter KC, Hewlett AL, Kratochvil CJ, Beam EJ, Gibbs SG, et al. Planning and response to Ebola virus disease: an integrated approach. Am J Infect Control 2015;43:441–6. [PubMed: 25952046]
6. Matlock AM, Gutierrez D, Wallen G, Hastings C. Providing nursing care to Ebola patients on the national stage: the National Institutes of Health experience. Nurs Outlook 2015;63:21–4. [PubMed: 25645477]
7. Johnson DW, Sullivan JN, Piquette CA, Hewlett AL, Bailey KL, Smith PW, et al. Lessons learned: critical care management of patients with Ebola in the United States. Crit Care Med 2015;43:1157–64. [PubMed: 25756410]
8. Mann T, West MG. Bellevue was ready to go on Ebola. Wall Street Journal. 2014. Available from: http://www.wsj.com/articles/bellevue-was-ready-to-go-on-ebola-1414198270. Accessed June 23, 2017.
9. Sickles J Doctor gets emotional recounting Ebola patient Thomas Eric Duncan's final days, efforts to save him. Available from: http://news.yahoo.com/dallas-doctor-gets-emotional-recounting-

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ebola-patient-thomas-eric-duncans-final-days-efforts-to-save-him-195701003.html. Accessed June 23, 2017.

10. National Institutes of Health. Texas nurse free of Ebola virus; discharged from NIH Clinical Center. 2015. Available from: https://www.nih.gov/news-events/news-releases/texas-nurse-free-ebola-virus-discharged-nih-clinical-center. Accessed June 23, 2017.
11. Douglas-Brown L Fourth patient treated for Ebola virus disease discharged from Emory University Hospital. 2014. Available from: http://news.emory.edu/stories/2014/10/er_ebola_press_conf_amber_vinson/campus.html. Accessed June 23, 2017.
12. Vetter P, Fischer WA, Schibler M, Jacobs M, Bausch DG, Kaiser L. Ebola virus shedding and transmission: review of current evidence. J Infect Dis 2016;214:S177–84. [PubMed: 27443613]
13. Chughtai AA, Barnes M, MacIntyre CR. Persistence of Ebola virus in various body fluids during convalescence: evidence and implications for disease transmission and control. Epidemiol Infect 2016;144:1652–60. [PubMed: 26808232]
14. Hageman JC, Hazim C, Wilson K, Malpiedi P, Gupta N, Bennett S, et al. Infection prevention and control for Ebola in health care settings—West Africa and United States. MMWR Suppl 2016;65:50–6. [PubMed: 27390018]
15. Centers for Disease Control and Prevention. Interim guidance for preparing Ebola assessment hospitals | Ebola hemorrhagic fever. Available from: https://www.cdc.gov/vhf/ebola/healthcare-us/preparing/assessment-hospitals.html. Accessed September 12, 2017.
16. Toner E, Shearer M, Kirk Sell T, Meyer D, Chandler H, Schoch-Spana M, et al. Health sector resilience checklist for high-consequence infectious diseases-informed by the domestic US Ebola response. Johns Hopkins Center for Health Security and US Centers for Disease Control and Prevention. 2017. Available from: https://disasterlit.nlm.nih.gov/resources/content/public/files/health_sector_resilience_checklist.pdf. Accessed June 23, 2017.
17. Centers for Disease Control and Prevention. Case definition for Ebola virus disease (EVD) | Ebola hemorrhagic fever. Available from: https://www.cdc.gov/vhf/ebola/healthcare-us/evaluating-patients/case-definition.html. Accessed June 23, 2017.
18. Centers for Disease Control and Prevention. Interim guidance for U.S. hospital preparedness for patients under investigation (PUIs) or with confirmed Ebola virus disease (EVD): a framework for a tiered approach | Ebola hemorrhagic fever Available from: https://www.cdc.gov/vhf/ebola/healthcare-us/preparing/hospitals.html. Accessed June 23, 2017.
19. HHS Select Agents and Toxins. 42 CFR 73, 2005. Available from: https://www.selectagents.gov/regulations.html; 2014. Accessed July 24, 2017.

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Table 1

Recommendations for health care facilities

Thematic area	Checklist item
Assessment and treatment hospitals	Officials have plans to designate assessment and treatment centers during an HCID event. Assessment and treatment facilities have been identified; protocols are established with the designated facilities for patient transfer and logistics. All-hazards emergency response plan with an infectious disease annex (with formal ICS) has been created and exercised regularly with partners (eg, airports, EMS).
Facility layout and waste management	Isolation and treatment areas have been identified. Isolation area is removed from other patient areas and considers 1-way traffic flow (ie, clean to dirty), PPE storage, communication equipment, remote monitoring, laboratory requirements, negative pressure ventilation and HEPA filtration, staff showers and break area, and waste disposal. Protocols for waste storage, transport, and incineration, in coordination with state transportation authorities and the U.S. Environmental Protection Agency, have been created.
Community relations	Specialized units have been proactively publicized to establish public trust in advance of HCID events. Health care facilities have established a good neighbor reputation by identifying and responding to broader community health needs. Health care facilities are engaged in HCID communication planning with local health authorities.
Patient identification and isolation	Health care facilities communicate regularly with LHDs to allow rapid identification of monitored individuals. Health care facilities have protocols for screening and isolating incoming patients and for updating clinicians on global disease outbreaks that may present domestically. Health care facilities have a rapid response team who receive continuing training in isolation procedures (eg, enhanced PPE).
Limitations on treatment	Protocols for determining the level of care that will be provided to confirmed HCID patients and monitored individuals have been developed. Health care facilities are familiar with equipment and environmental decontamination procedures and manufacturer requirements.
Research	Research staff is included on the rapid response team. Protocols to rapidly identify and procure investigational drugs and therapies and process IRB applications have been developed.
Laboratories	Laboratories that are capable of testing for HCID-associated infections have been identified and specimen transport and shipping protocols (including identification of couriers) have been developed. Laboratories are familiarwith the Federal Select Agent Program.

EMS, emergency medical services; *HCID*, high-consequence infectious disease; *HEPA*, high-efficiency particulate air; *IRB*, institutional review board; *PPE*, personal protective equipment.

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Table 2

Recommendations for health care workforce

Thematic area	Checklist item
Psychosocial impact	Support systems are in place for personnel responding to an HCID patient. Communication plans are in place to update staff, patients, and the public about HCID patients.
Unit staffing	Plans are in place to provide additional staff, voluntary or involuntary, during and immediately after HCID events. Treatment unit staff include cross-trained personnel (eg, nurses who are also skilled in phlebotomy).
Staff training and drills	All hospital staff are trained in basic infection control measures (eg, room signage, handwashing). Clinicians for HCID patients have recurring training on patient isolation and infection control, including enhanced PPE donning and doffing. Mystery patient drills and other exercises are conducted to help identify areas for improved preparedness.
Clinical PPE	Health care facilities are prepared to provide staff with updated PPE guidance for a given disease. Health care facilities use observers for PPE donning and doffing.

HCID, high-consequence infectious disease; *ICS*, incident command system; *LHD*, local health department; *PPE*, personal protective equipment.