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Major Article

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

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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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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,

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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.

METHODS

A literature review¹⁶ 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 EVD¹⁷—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 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 caregivers 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 epi-

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