Is the United States Ready for a Deadly Airborne Disease Outbreak?

Lessons from Recent Experience in Evacuating Patients Exposed to Ebola from West Africa to the United States

by Conrad R. Wilmoski and Meghan C. Muller

In March 2014, the Centers for Disease Control and Prevention declared an Ebola virus disease outbreak in West Africa.[1] This was the most significant Ebola outbreak in history, with more than 10,000 Ebola virus disease (EVD) cases reported. Ebola is a highly-lethal, infectious disease transmitted through infected body fluids for which there is no vaccine or cure. Most of the cases were concentrated in Sierra Leone, Liberia, and Guinea. Thousands of humanitarians and healthcare workers deployed to these countries; many were U.S. citizens.[2] Their work in the region put them at risk of exposure to the Ebola virus. To assure humanitarians would deploy to the region in response to the crises, the U.S. government offered a mechanism to assist them if they became ill. The U.S. Department of State (State) has a team of visionary healthcare specialists who developed a program to repatriate U.S. citizens exposed to Ebola. However, before State could evacuate an infectious patient, it needed adequate medical transportation and a hospital to admit them. This article discusses lessons from building capability, sustaining capacity, and gaining access to critical healthcare resources for evacuating EVD patients during the 2014 Ebola outbreak in West Africa.

During the crisis, the U.S. government provided foreign states and international organizations, such as the World Health Organization (WHO), access to a unique medical evacuation service. The Foreign Assistance Act of 1961, Section 607, as amended, authorizes the U.S. government to provide assistance to foreign states and international organizations on a reimbursable basis. In addition to evacuating American citizens to the U.S., State assisted the WHO in the evacuation of humanitarians exposed to EVD to European hospitals with biocontainment capabilities. Thus, the WHO became the responding humanitarian's gateway into the Ebola evacuation system. The U.S. government and its partners developed many of the unique processes needed to conduct these complex medical

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evacuations after the Ebola crisis began.

The U.S. can prepare better for a public health crisis. A number of infectious disease experts have raised concerns on preparedness for infection control, patient isolation, personal protective equipment, and frequency in staff training to treat patients with these exotic diseases. In 2006, infectious disease experts suggested the U.S. develop a network of biological containment medical treatment units to prepare for an outbreak or other biological crisis.[3] Further, experts proposed that the Department of Health and Human Services (DHHS) manage these units as a national resource in coordination with local authorities and health officials. This is not a novel idea because other nations have similar networks. However, it is an excellent idea to ensure the government is prepared to respond during a health crisis.

The European Union is prepared to defend against an exotic disease epidemic.[4] The European Network for Highly Infectious Diseases is a network of hospitals with biocontainment for treating patients with deadly infectious diseases.[5] The European Union's researchers collected data on hospitals reported to have special isolation capabilities and stratified them in a way similar to the Centers for Disease Control and Prevention's four biosafety levels. Biosafety level 4 (BSL-4) refers to the deadliest diseases for which there is no known cure or vaccine. The researchers used a mail survey to collect data to calculate the biocontainment beds per population. Their network is extensive compared to the U.S.; however, the European Union struggled with a limited capacity to transport patients exposed to EVD via air ambulance evacuation. Moreover, it did not perform site visits to validate the capabilities, and the European Commission faces challenges regulating beds across member states.

Europe's thorough record of biocontainment and isolation beds has continued to improve since the latest 2013 update. The Ebola outbreak and evacuation of humanitarians infected with EVD encouraged further investigation into Europe's capability. A separate group of researchers, on behalf of the Platform for European Preparedness Against (Re-)emerging Epidemics (PREPARE) consortium, surveyed hospitals in 38 European and West Asian countries via questionnaire to analyze their preparedness to care for patients infected with EVD. They found that 111 (47 percent) of the surveyed hospitals would admit patients infected with EVD.[6] Their research identified gaps in preparedness and highlights how hospitals are training and preparing in response to the Ebola outbreak. One particular gap in preparedness is evacuating an infected patient from the field or other medical facility to a hospital with a biocontainment care unit.

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In September 2014, the European Commission examined hospitals among their member states to gain an understanding of the European Union's bed capacity. The researchers surveyed the hospitals for isolation and biocontainment bed capacity for patients infected with EVD. Unfortunately, the report is not available to the public and remains sensitive in nature, protected by the European Commission. However, select WHO staff had access to the report in order to connect with hospitals potentially capable of admitting EVD patients. Interestingly, the report suggests the member states have a minimum of 253 isolation beds and approximately 82 beds available for patients with EVD. This suggests they are more equipped than the U.S. in regards to capacity and dispersion of resources to treat patients with

Ebola. The difference in data collection from the others is that the member state authorities allegedly provided input as to how many patients they would accept for admission.

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Building Capability

Building relationships with institutions capable of caring for patients with unique, exotic, infectious diseases underpinned State's medical evacuation program. The Centers for Disease Control and Prevention classifies EVD as a BSL-4 infectious agent, which requires the highest level of biocontainment. State explored hospitals that support high-level containment research laboratories as potential receiving facilities for patients exposed to EVD. Three of five potential hospitals (Emory University Hospital, Atlanta; National Institutes of Health, Bethesda; and Nebraska Medical Center, Omaha) agreed to participate in the program. Not only did State need to identify hospitals to admit patients with EVD, it also needed to determine the procedures and means to transport a potentially contagious patient from the airport to the hospital.

Transporting patients infected with the deadliest kind of disease is a unique process. The State's Office of Medical Services supervised the air and ground medical evacuation of American citizens with EVD from West Africa. In 2014, State repatriated eleven patients from West Africa exposed to EVD and moved two domestic patients via an Aeromedical Biological Containment System (ABCS) aboard a specially-modified aircraft. The ABCS is a chamber that creates a negative pressure environment within the cabin of a mid-size aircraft, such as the Gulf Stream G3. The system maintains the highest level of infection control while providing the ability to deliver full spectrum care to the patient during evacuation. Unfortunately, this system can only transport one infectious patient at a time. Federal and local government authorities in coordination with the admitting hospital organized patient transfers from the aircraft to the hospital under the highest biocontainment conditions.

Following the September 11, 2001, terrorist attacks and subsequent anthrax attacks, the U.S. government developed the ABCS as part of an initiative to provide a response to biological threats. The system supported the U.S. Army biocontainment program. With no biological threat materializing, funding was shifted, and the ABCS government contract expired in 2007, leaving the Department of Defense (DoD) without a biological containment aeromedical evacuation system. Therefore, DoD did not have the ability to transport patients infected with the deadliest contagious disease by air. However, the contractor wisely stowed the system for future use. Fortunately, at the beginning of the 2014 Ebola crisis, Dr. William Walters, Director of Operational Medicine at State, who was familiar with the ABCS system, reissued the contract.

Dr. Walters' actions underscore the important principle to prepare for a crisis before one begins. Having unique resources to select from enables a timely response during a crisis. The U.S. led the international community in responding to requests for assistance in evacuating humanitarian healthcare workers from West Africa during the outbreak. However, it had been quite some time since any federal agency had prepared for an operation under such unique circumstances.

By October 2014, State evacuated five U.S. citizens from West Africa and two patients infected with Ebola from Dallas, TX, to one of

the few U.S. hospitals with a biocontainment unit using the unique aircraft with the ABCS. The first few patient transfer operations from the aircraft to the hospital were similar to a successive comparison method. There was a consensus of goals, but policies and best practices were still to be determined. The key federal departments involved in the process were State, DHS, Homeland Security, and Transportation. State and local governments in the public health and safety sectors were instrumental in the local access and management of operations, such as receiving the air ambulance at the local airfield, planning and executing the ground ambulance transportation, and performing hospital admission responsibilities.

Local special ambulance teams, organized to transport infected and potentially infectious patients, conducted the ground transportation for these patients at receiving medical facilities. It is important to note that several months after the outbreak began and a number of evacuation missions had taken place, the Centers for Disease Control and Prevention began to provide substantial guidance for the special circumstances. It provided guidance on its website for Emergency Medical Services, medical first responders, and law enforcement responding to an incident involving a person potentially infected with EVD.[7] The methods described here are for controlled movement of confirmed EVD patients. This is useful to fill the gaps in guidance for suspected EVD patient transfer to a medical facility to provide care in the highest level of biocontainment conditions. It is prudent to approach patient transports with the appropriate infection control precautions.

Transporting patients from the air ambulance to the hospital requires special techniques, equipment, and security. Category "A" diseases are classified similar to BSL-4 pathogens that lack cures, treatments, or vaccines. Because EVD is a hallmark Category "A" disease, ambulance teams employ the highest level of infection control precautions when transporting these patients—the same precautions as if it were an airborne transmission disease.[8]

Special dedicated ambulance teams are the gold standard for transporting patients exposed to EVD.[9/10] The DHHS is overall responsible for the ground transport. State has a supporting role, and at the beginning of the outbreak response, it significantly contributed to developing policies and procedures for the operation. Any plan to care for patients infected with Category "A" pathogens must include a ground transport capability and intensive care under appropriate biological containment conditions, such as a biocontainment unit.

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Teams transfer patients with EVD from the airport to the hospital using a regulated controlled movement process. State experts in the public health and safety sectors compiled a Biocontainment Ground Transport Standing Operating Procedure (SOP) as a guide for interagency procedures and biocontainment transport. Experts working for State, Grady Emergency Medical Services, and University of Nebraska Medical Center informed the procedures and protocols through best practices and action research. These organizations were leading the emergency medical transportation industry in developing industry standards. Therefore, experts in these organizations shared their knowledge with the ambulance service industry via academic publications.[11] The documents detail equipment and instructions for using items to protect equipment and personnel from contamination.

Ground ambulance operations for transporting a patient exposed to a Category "A"

pathogen take place through five general phases.

Phase one, planning and coordinating the transport with government and private stakeholders, begins with notification of an evacuation mission and continues throughout the operation. Each organization and state is different, so it is important to know the stakeholders and how to engage them.

Phase two, preparing the ambulance(s) and team(s) for transport, begins with securing an admission agreement with the receiving facility and ends when they receive the patient.

Phase three, patient transport from reception location to the biocontainment unit, begins when the ambulance team takes control of the patient and ends when the ambulance and crewmembers are at the decontamination site.

Phase four, equipment and personnel decontamination, begins when the ambulance team is in position for decontamination and ends when all personnel and equipment are decontaminated, and medical waste is secured in accordance with local biohazard waste management protocols.

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Finally, phase five includes health monitoring of high-risk personnel, preparing the ambulance and other necessary pieces of equipment for the next mission, procurement and reconstitution of supplies, and other administrative activities. This phase begins immediately after decontamination and ends when the next mission begins or the incubation period has passed.

Ground ambulances transport patients from the evacuation aircraft to a hospital with a biocontainment unit for definitive care. These special, medical care facilities provide definitive care for patients with exotic, infectious disease and biological threats, such as EVD. The staff delivers intensive medical care to patients while maintaining the same infection control standards that the highest biosafety level requires.[12] Government authorities and experts from the hospital work closely with the ground transport element to maintain the biological containment standards throughout the ground movement operation. Currently, there are no reports of nosocomial infection to healthcare workers from patients admitted to biocontainment units in the U.S. Given the high quality of U.S. hospitals, this is expected.

The DoD should reconsider policies to provide care throughout the disease cycle outside the U.S. for service members exposed to Category "A" pathogens. We recommend they inculcate the lessons from transporting patients exposed to EVD and transfer this knowledge into a contingency plan in which patients receive treatment in a capable medical facility, such as the National Institutes of Health in Bethesda, Maryland.

In October 2014, the DoD realized the possibility that service members could be at risk of exposure to EVD. particularly, service members deploying to West Africa in response to the Ebola outbreak. Moreover, State was limited to evacuating one patient per ABCS. Therefore, DoD, in coordination with other government agencies, began an initiative to develop a biocontainment unit capable of holding multiple patients during transportation on select U.S. Air Force transport aircraft. Although not ready for use by the end of the outbreak, they did build a Transport Isolation System capable of holding multiple infectious patients during transport.

Although this initiative aimed to address transporting multiple infectious patients in a single flight, the department failed to address how

to transport infectious patients using a military helicopter. It is obvious that some patients will be in places with terrain that restricts vehicle traffic, such as a dense jungle and mountainous area. A helicopter with a biocontainment system will be useful in circumstances where symptomatic Ebola patients walk through the jungles of Sierra Leone and Liberia to a road in order to ride on a vehicle to the treatment center.

Sustaining Capacity

Strong relationships foster capacity and sustainment for future crisis response. Visiting medical institutions within the U.S. and its partners is invaluable to understand the environment, address potential challenges, and build relationships. Meeting stakeholders and visiting the facilities provided a foundation for understanding the U.S. bed capacity for patients evacuated from West Africa. Additionally, site visits aimed to strengthen relationships and establish partnerships with stakeholders to call upon for support. Further, the visits developed situational awareness in terms of bed capacity, training, and concerns related to EVD patient admissions. Moreover, face-to-face visits and frequent communications foster synchronization and strengthen relationships. For instance, the University of Nebraska Medical Center converted one of its treatment units into a BSL-3 laboratory in order to enhance its ability for point-of-care diagnostics.[13] The infrastructure change reduced an already limited nation-wide bed capacity. Understanding such resource changes underpins the importance of maintaining relationships with organizations. In this case, knowing that retrofitting treatment units to BSL-3 units reduced bed capacity ultimately allowed State to be flexible in its bed-regulating process for future mission requirements.

Gaining Access

Diplomacy was critical in providing the evacuation aircraft access to airspace and landing privileges, which is critical for fueling as they traverse the Atlantic Ocean. State and DoD worked together and shared resources for refueling between West Africa and North America. The key lessons are to engage governments early and use diplomacy to negotiate air ambulance overflight and landing permits.

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One must remember that there is risk to the transiting country if an aircraft transporting a patient with an infectious disease lands and is unable to depart. For example, the patient might need to disembark the aircraft, which is a serious concern without the appropriate infrastructure to support such a patient. State and WHO learned early that private air ambulance companies would not transport contagious patients. Private companies failed to obtain overflight and landing permissions. They observed that diplomatic engagement was a much more successful method. Thus, a private and public partnership through government contracting allowed State to evacuate EVD patients using a private air ambulance company. Medical evacuation is a U.S. government mission: contractors submit overflight and landing permission requests under the auspices of the U.S. government.

State awarded and executed a contract with the ambulance company, but supported the DHHS and DoD by providing evacuation services at their request. The Economy Act of 1932, as amended, 31 U.S.C. § 1535, permits federal government agencies to purchase goods or services from other federal government agencies or other major organizational units within the same agency. The Economy Act

allowed the federal government to share resources but was inapplicable when the international community also requested support. For these requests, apply the Foreign Assistance Act of 1961, Section 607, to authorize the U.S. government to provide assistance to foreign states and international organizations on a reimbursable basis. Moreover, an agreement between the U.S. government and the UN provided State the means to deliver medical evacuation services to the WHO and additional healthcare workers responding to the outbreak on a fully reimbursable basis. Thus, the spirit of these two pieces of legislation empowered the federal government to utilize a limited evacuation resource to support a whole-of-government and international approach to the outbreak response. It is critical to consider these funding mechanisms for similar circumstances in the future.

Recommendations

Synchronizing departments and agencies presents several daunting challenges during a crisis. Common understanding is crucial during any call for a whole-of-government response to a disaster, threat, or other extraordinary circumstance. In such cases, joint military, interagency, intergovernmental, and multinational forces, along with humanitarians operate in foreign countries with exotic, infectious diseases and other personal hazards.

First, this consortium of governmental and nongovernmental personnel should plan to transport infected patients by air medical evacuation. In doing this, the U.S. military should continue its efforts in developing an improved biological containment system, rather than the hastily developed Transport Isolation System, to move several patients in a single airlift using a strategic air platform. In addition, develop a biological containment system and procedures for use in military helicopters. Further, ensure these biological containment systems are available for use when needed, rather than allowing a contractor to decide its fate. The capability must be available to other government agencies as needed. Moreover, DoD should consider a policy to evacuate service members and other authorized employees exposed to a Category "A" pathogen. Such a policy should be similar to the one emplaced during Operation United Assistance, the U.S. military operation in West Africa in response to the Ebola outbreak.

Second, the interagency community should prepare for future, exotic, infectious disease outbreaks. The DoD should develop and maintain a contingency plan that includes the consensus and participation of other government stakeholders in which patients arrive at Dulles International Airport, VA or Joint Base Andrews, MD for onward transportation via ground to National Institutes of Health for treatment in a biocontainment unit. It might also be beneficial to create an intensive care biocontainment unit within Walter Reed National Military Medical Center specifically for infected service members. DHHS's role is to coordinate with civilian hospitals that have biocontainment units and other relevant stakeholders to build a consensus and maintain a robust pool of hospital beds ready for any patients infected with contagious, exotic diseases.

The air medical evacuation of patients exposed to Ebola is a unique mission that is often conducted in a complex environment with multiple agency involvement. Interagency lessons in capability availability, capacity, and access underscore the particular complexity of an international public health crisis. It is prudent to review such lessons from the 2014 West Africa Ebola outbreak to ensure the best response possible during a future outbreak. ***IAJ***

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